Review

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Introduction

The 2019 edition of the Leipzig Interventional Course, held 22–25 January, marked the 15th anniversary of the renowned international meeting committed to advancing the scientific and clinical evaluation and treatment of patients with complex vascular disease through an interdisciplinary discussion of novel endovascular techniques.

Almost 5,000 were in attendance to participate in a four-day programme of lectures, trial updates, device innovations, debates and Scrub-in with the experts sessions. As always, live cases were a central theme, with 13 centres in Germany, Italy, USA, Ireland, France and Switzerland showcasing exemplary interventional cases replete with advanced techniques, tips and tricks, complex and challenging anatomies and lessons learned, spanning a broad range of vascular arenas.

What's more, 'First-time data release' presentations, featured throughout the programme, offered the chance to witness new data at its freshest, unravelling new understanding and discussion in real time.

The ever-popular and always enlightening '@LINC' collaborations were also a highlight, offering a perfect opportunity to share unique perspectives and regional challenges from leading meetings across the globe, namely: The Charing Cross (CX) Symposium, Vascular InterVentional Advances (VIVA), the International Congress of Interventional Surgery (CICE), the International Symposium on Endovascular Therapeutics (SITE), Complex Cardiovascular Therapeutics (CCT), the China Endovascular Course (CEC) and the Japan Endovascular Treatment (JET) Conference.

The *LINC Review* brings you just some of the highlights from the hundreds and hundreds of presentations, cases, discussions and debates that took place during the entire LINC 2019 meeting. For even more, we encourage you to head to the LINC website and dedicated LINC App to view a selection of key sessions, live cases and presentation slides.

On behalf of the LINC 2019 organisers, we would like thank all delegates and industry sponsors for their continued support, and look forward to seeing you next year at LINC 2020, held January 28–31 at the Trade Fair Leipzig.

http://www.leipzig-interventional-course.com; The LINC 2019 App is available for iPhone and iPad in the App Store.

Contents

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www.slaek.de

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www.angioweb.ch

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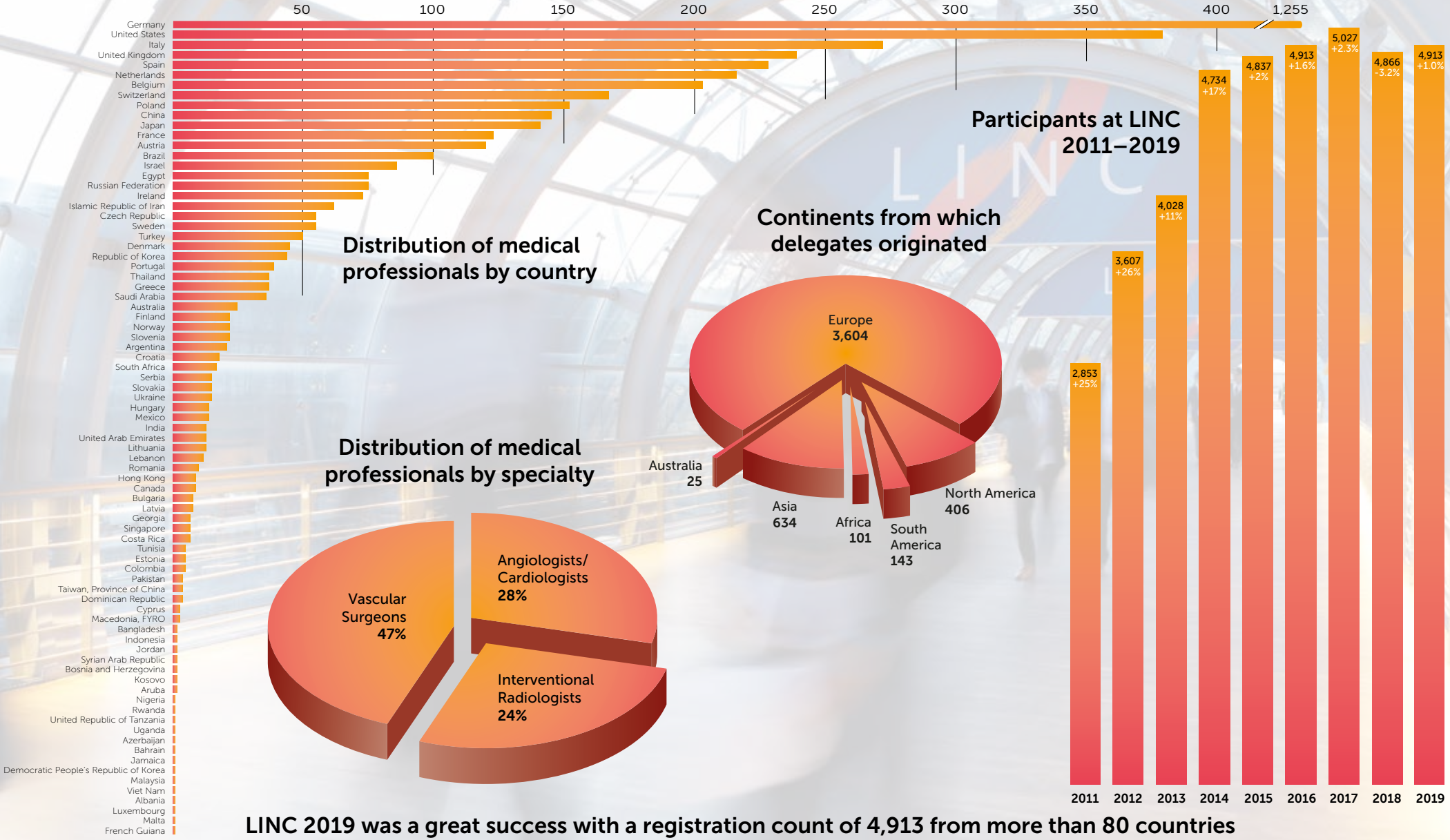
LINC in numbers



Distribution of medical professionals by country

Continents from which delegates originated

Distribution of medical professionals by specialty

Participants at LINC 2011–2019

LINC 2019 was a great success with a registration count of 4,913 from more than 80 countries

Could paclitaxel technologies be under threat?

The first morning of LINC 2019 featured one of the most hotly-anticipated sessions of the whole meeting, in which a fundamental question in the era of drug-eluting interventional devices was laid bare: are they safe? Recent findings, controversies and future outlooks for the use of drug-coated balloons (DCB) and stents (DES) were all explored, including patient-level data from a number of major clinical trial programmes.

The session was framed around the recent meta-analysis from Konstantinos Katsanos (Patras University Hospital, Greece) and colleagues, which looked at the risk of death following application of paclitaxel-coated DCBs and DES in the femoropopliteal artery.[1] The landmark paper has been met with mixed views, and the session reflected this sentiment.

Specifically, the meta-analysis focused on 28 randomised controlled trials (RCTs) investigating paclitaxel-coated devices in the femoral and/or popliteal arteries. Corresponding to more than 4,600 patients, the authors looked at all-cause mortality in the active, paclitaxel-receiving patient arms versus control. At one year follow-up (28 RCTs with 4,432 cases), all-cause patient death was similar between paclitaxel-coated devices and control arms (2.3% versus 2.3% crude risk of death; risk ratio, 1.08; 95% CI, 0.72–1.61).[1]

"Any kind of difference in terms of treatment effect between the study arms is expected to be attributed to the effect of paclitaxel... This is very critical to understand when interpreting the findings."

Konstantinos Katsanos

However, at two years (12 RCTs with 2,316 cases), there was significantly increased all-cause death in the case of paclitaxel versus control (7.2% versus 3.8% crude risk of death; risk ratio, 1.68; 95% CI, 1.15–2.47; —number needed to harm {NNH}, 29 patients [95% CI, 19–59]).[1]

Out to (up to) five years, (3 RCTs with 863 cases), all-cause death further in the case of paclitaxel (14.7% versus 8.1% crude risk of death; risk ratio, 1.93; 95% CI, 1.27–2.93; — NNH, 14 patients [95% CI, 9–32]).[1]

Speaking to *LINC Review*, Dr Katsanos took the time to walk through some of the methods, findings and insights from the paper, as well as offer hypotheses as to why and how paclitaxel appeared to be causing increased mortality in these patient datasets. "This was a meta-analysis of RCTs, so whatever the finding is, it is because of the randomisation process and because of the balance of the different

confounders among the different groups," he began.

"Any kind of difference in treatment effect between the study arms is expected to be attributed to the effect of paclitaxel. This was the common denominator in terms of treatment amongst all those studies. This is very critical to understand when interpreting the findings."

Touching on the different devices and drug coatings used across the 28 RCTs incorporated, Dr Katsanos stressed that the concentrations, excipients and ultimately the dose of paclitaxel varied greatly. For example, some devices had as low as 1/20 of the amount of paclitaxel compared to other devices of the same size, he said. "So there are massive differences in the load and density of paclitaxel in current devices. We need to understand and learn each device's unique properties.

"In terms of the [effect of the] dose, we did see that there were variations in outcomes. For example, the 2-µg devices at two years had a risk ratio of 1.27, which meant a nonsignificant risk of death … but the risk of death escalated and indeed became significant with a risk ratio of up to 2.3 in the case of the high-dose devices."

He continued: "We calculated the total dose of paclitaxel delivered and we also introduced a function of time, to account for the different time intervals, patient follow-up, pharmacokinetics etc. We saw that there was a significant relationship to what we call in the paper paclitaxel dose-time product, and absolute risk of death in the paclitaxel arms."

But just how is paclitaxel potentially causing increased mortality? This question was a common theme during the session, with Dr Katsanos conceding that the answer is still ultimately yet to be found. In any case, he underlined the importance of first understanding the broader relationship between devices, paclitaxel dose, and the body. "Fundamentally, the more paclitaxel you give, the more exposure the patient gets… there seems to be a higher risk of death with increasing dose and increasing length of follow-up," he said.

"A lot of physicians, and I myself included, have been missing [one fact] for a long, long time: the paclitaxel on a DCB or a DES is not the same formulation as that patients receive intravenously during chemotherapy. It has a different formulation, known as amorphous or crystalline paclitaxel, and the distinction affects solubility.

"Paclitaxel has very low solubility, and when it is transferred into the vessels and arteries it stays there for a long, long time. In a chemotherapy session, during which people may receive several mg of course, the paclitaxel dose will have a half-life of around six hours, maybe up to 12 or 15 hours depending on the infusion rate. On the contrary, the paclitaxel of DCBs and DES has been shown in animal studies to be readily detected at up to three months (and there is one study where it has been detected even at six months).

"This work has to be criticised – it has to be interpreted and understood in the context of science and the benefit of the patient – not as a black-and-white argument for the dismissal of all paclitaxel-coated devices."

Konstantinos Katsanos

"So, the paclitaxel does stay for a long time, and I mean in the tissues, not the plasma. We do not know what harm it does, what effect it has on the human body … but at the end of the day, the half-life is in the order of weeks if not months so you can imagine it has a completely different bioabsorbability, pharmacokinetic profile and biodistribution to what people might actually think. It is something we need to learn more about. It is completely fascinating, and perhaps worrisome at the same time."

Since publication of the meta-analysis, Dr Katsanos has been exposed to criticisms of several aspects of the paper, from the statistical methods used, to the data itself, and interpretations thereof. A lack of specific cause-of-death data (the authors used an all-cause-death metric), some have argued,[2] could be crucial to establish whether there is cause and effect between paclitaxel and death, and if so, how to modify practice.

What's more, the lack of patient-level data included in the meta-analysis has been a sticking point with several esteemed physicians[2,3]. However, on this point Dr Katsanos does share common ground: "There is so much detail to be gleaned from the patient-level data, so I want to take the opportunity to say that industry needs to give open and transparent access to all data," he said.

"This is a unique example of how open and transparent access to patient-level data may hopefully help us to learn so much and to improve our treatments and devices." To that end, the session at LINC included several key patient-level datasets, thereby adding extra insights into the core information that was fed into the meta-analysis.

Dr Katsanos continued, underlining that the meta-analysis by no means suggests an open-and-shut case for paclitaxel: "This work has to be criticised – it has to be interpreted and understood in the context of science and the benefit of the patient – not as a black-and-white argument for the dismissal of all paclitaxel-coated devices," he said.

"In pharmacology, every kind of medication has a safe, effective side, and of course a toxic side. We need to understand how much is too much, and we need to understand to better design paclitaxel devices. We know that this is a very, very strong substance, and it is also very effective. Again, we do not know what we do not know. We have to make our treatments better for the sake of the patient."

He concluded: "We need to decide, together, what are the merits, what are the limitations, and above all – what to do next."

Patient-level data from Stellarex

Following Dr Katsanos' presentation of the meta-analysis, several patient-level datasets were presented, hoping to shed more light on the possible harms, or not, of paclitaxel from an individual study

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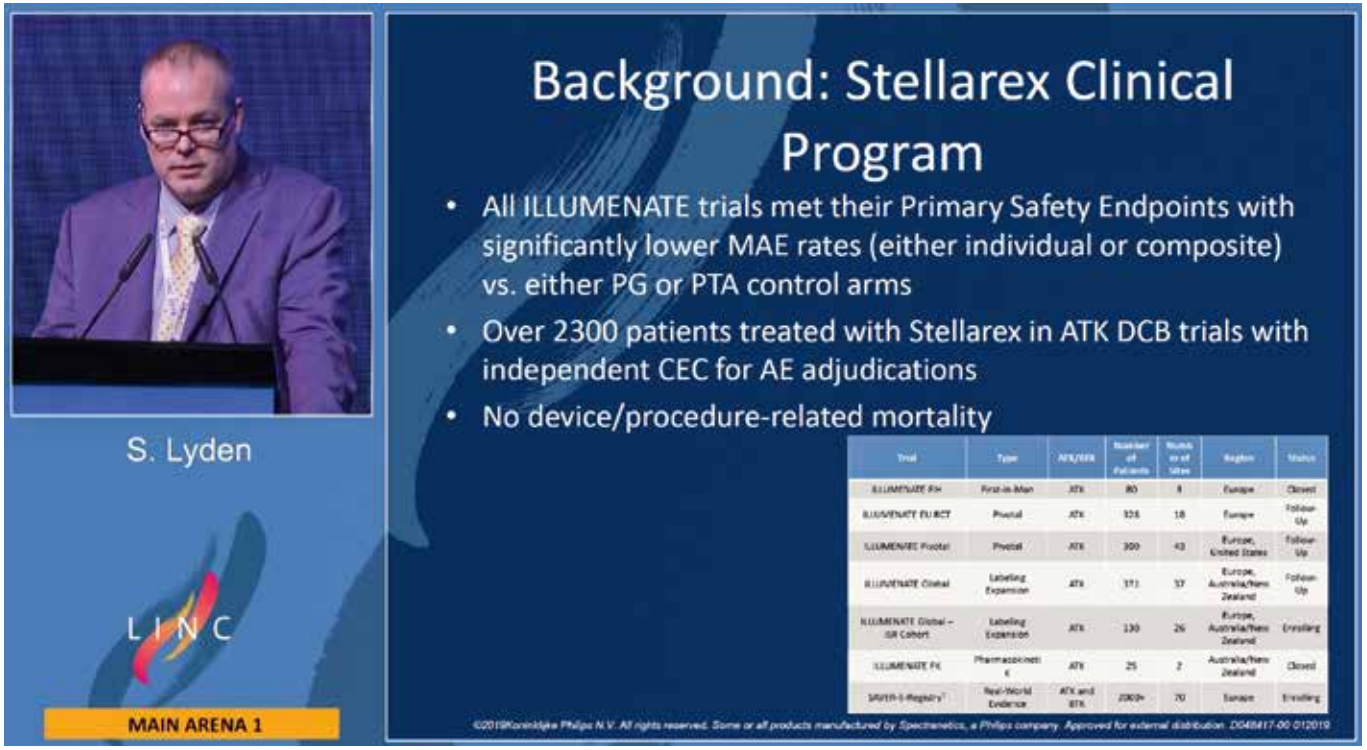
perspective. Sharing the pooled trial results from the Stellarex DCB (Spectranetics / Philips) programme – comprising seven clinical trials with above the knee (ATK) intervention – was Sean Lyden, co-principal investigator for the ILLUMENATE trial.

Dr Lyden, a vascular surgeon at the Cleveland Clinic, Ohio, USA, relayed that all ILLUMENATE trials met their primary safety endpoints with significantly lower major adverse event (MAE) rates (either individual or composite versus either PG or PTA control arms). Over 2,300 patients were treated with Stellarex in ATK DCB trials, and all studies included independent adjudications of AEs from clinical events committees (CECs). There was no device/procedure related mortality.

Dr Lyden told the LINC audience: "Our objective was to obtain independent third-party patient-level analysis of available mortality data from the Stellarex ATK clinical programme. We also wanted the pooling of a more homogenous population treated with the same paclitaxel-coated device (Stellarex) in 2,351 patients."

Dr Lyden noted that the types of study involved included the first-in-human ILLUMENATE FIH, pivotal studies such as ILLUMENATE EU RCT and ILLUMENATE PIVOTAL, single-arm studies including ILLUMENATE GLOBAL ISR and ILLUMENATE PK, and real-world studies such as SAVER. Explaining the methodology of the study, Dr Lyden stressed that third party systematic analysis of all available mortality data from all Stellarex DCB ATK clinical studies and registries was used.



Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

Two RCTs (N = 589) were pooled to compare mortality through three years using Stellarex DCB versus control (PTA) cohorts.

> *"Our objective was to obtain independent third-party patient-level analysis of available mortality data from the Stellarex ATK clinical programme."*
>
> **Sean Lyden**

A separate integrated analysis of mortality rates in patients treated with Stellarex DCBs of all ATK lesions from all seven studies was also carried out. As Dr Lyden outlined, the pooled RCT baseline characteristics showed that the patients had similar comorbidities including hypertension, angina, high cholesterol etc, the only real difference was that patients in the DCB arm had a more prevalent history of smoking.

Crucially, he shared that in terms of mortality data there were no significant differences in all-cause death, cardiovascular death or non-cardiovascular death between the PCB and PTA arms at one-, two- or three-year endpoints of the 2,351 patients treated in Stellarex clinical studies. The findings "confirm and reinforce" the safety profile of the Stellarex DCB, he said, adding that a further larger data set with RCTs of paclitaxel-coated DCBs are warranted to confirm the long-term safety of paclitaxel use in PAD.

What's the real IN.PACT?

Peter Schneider (Kaiser Permanente Medical Center, Moanalua, HI) presented long-term safety data from the IN.PACT clinical programme of the IN.PACT Admiral DCB (Medtronic, USA), including an individual patient-level analysis to investigate the plausibility of a relationship between paclitaxel and mortality.

"We owe it to ourselves, we owe it to our patients and we owe it to the peace of mind of all involved to take this extremely seriously and judiciously," he said of the meta-analysis results. "In that spirit, Medtronic opened their books and transferred their data to an independent analysis of 1,980 patients."

Dr Schneider presented an investigation of trials of superficial femoral artery (SFA) therapy, including analysis of all-cause death rates at two years corresponding to DCB, DES, bare metal stent (BMS) and PTA therapy. He drew attention to the ranges of mortality rates yielded these trials, with PTA cohort mortality rates ranging from 0.9% to 12.2%, and DCB cohorts ranging from 2.9% to 9.5% at two-year follow-up. "This is well within the range of what we usually see," he commented.

Safety outcomes of the IN.PACT DEEP trial at five years were excluded, Dr Schneider said, because the product was ultimately withdrawn due to a trend towards higher amputation rates in the DCB group: "These were all critical limb ischaemia [CLI] patients," he said. "And you may also remember that the mortality rate was a little bit higher in the DCB group at one year, but by five years the mortality rate was higher in the PTA group."

"We owe it to ourselves, we owe it to our patients and we owe it to the peace of mind of all involved to take this extremely seriously and judiciously."

Peter Schneider

As such, the patient-level analysis from the IN.PACT clinical programme included data from IN.PACT I and II, IN.PACT Japan, IN.PACT China and the IN.PACT Global study. Conducted independently by the Bain Institute (formerly Harvard Clinical Research Institute), the analysis included: a review of baseline, procedure and follow-up data of individual patients; a comparison of survival versus mortality between treatment groups; nominal dosage of paclitaxel between survival and mortality DCB groups; and testing for alternative hypotheses.

Further contrasting this patient-level meta-analysis with the Katsanos *et al*. meta-analysis, Dr Schneider explained that the present analysis included all studies from the IN.PACT clinical programme (single-arm trials as well as RCTs), as well as including raw patient-level data across these studies. Additionally, available long-term data from IN.PACT SFA and IN.PACT Japan were included, with access granted to data such as patient narratives, times to events, comorbidities, DCB usage and

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mortality adjudication. "It is a larger, deeper dataset with longer-term follow-up.

"The summary-level analysis generates hypotheses, but if we want to identify specific trends and causes we have to look at the raw data."

The 1,980 patients included 1,837 patients treated by DCB, who were compared with 143 patients treated by PTA. With the proviso that the PTA patient group was smaller, and that the DCB group included more CLI patients as well as a higher rate of longer, more calcified lesions and higher rates of CTO and stenting, a comparison was carried out. "No statistician in their right mind would allow me to show you how a small group of PTA patients compares to a large group of probably sicker DCB patients. But if this paclitaxel issue is a runaway train; we need to know right away."

With these reservations in mind, freedom from all-cause mortality was compared between these two groups, with statistically non-significant differences identified at five years. Regarding paclitaxel dose, no significant differences were found, with 11.8 mg applied in the patients that died following DCB therapy versus 11.4 mg in those that survived. A further analysis of mortality rates with DCB group-stratification by paclitaxel dose into terciles was carried out, with no significant difference found.

Comparing these doses (ranging from a mean of 5 mg in the lower tercile to 20 mg in the upper tercile) to those used in the oncological setting, where paclitaxel is administered intravenously at doses of 135–175 mg/m2 in 3-hour or 24-hour infusions, Dr Schneider said, "DCB doses are dramatically less than those administered in oncology, even in the smaller patients – and of course that dose is administered repeatedly as the patient requires it."

Turning to key baseline characteristics, he said: "Patients in the DCB cohort who died were older, had more carotid and coronary heart disease, renal insufficiency, CLI and below-the-knee [BTK] disease. And the longer you follow somebody, the more likely they are to die."

Further analyses also yielded some interesting alternative hypotheses: "PTA patients were much more likely to be followed-up than the DCB patients. This could be due to more failures, more target lesion revascularisations [TLRs] etc. If you look at those patients who survived after DCB versus those who died, those who died had a lower level of compliance in follow-up."

These preliminary findings, concluded Dr Schneider, suggest that follow-up compliance – as a surrogate for repeat touch points with the healthcare system – is associated with lower mortality risk.

Lutonix long-term safety data

Dierk Scheinert (University Hospital Leipzig, Germany) addressed the long-running Lutonix DCB (BD/Bard, USA) programme, which includes the most patients under a clinical trial protocol with over 200,000 patients treated worldwide.

"Personally, I must say, based on many of the patient-level shown today from various trials, I am at least partially reassured."

Dierk Scheinert

"As with other DCBs, paclitaxel is the main agent," he began, describing the preclinical work on the Lutonix device: "There was a lot of clinical work done to optimise the Lutonix formulation, to achieve the lowest possible active dose. That was due to optimising the carrier in the formulation to get a good tissue penetration into the vessel wall."

Professor Scheinert went on to highlight that preclinical tests demonstrated the safety of the device. Furthermore,

pharmacokinetic studies as part of Levant II showed serum paclitaxel levels at one hour of lower than 3 ng/ml, and a mean elimination half-life of 6.88 hours. "Only a very small systemic dose is actually given to the patient."

He relayed safety and all-cause death rates within randomised trials and large registries relating to the Lutonix device, including the RCTs Levant I and II, Levant Japan and the Levant in-stent restenosis (ISR) trial. "In none of the randomised trials was there any significant difference in all-cause death rate," noted Professor Scheinert. "Probably the most relevant dataset is Levant II cohort, which is comprised of 1,029 DCB treated patients and 145 PTA patients from the randomised cohort."

In addition, Kaplan Meier analysis of all-cause death to five years in Levant II indicated no significant difference between DCB and standard PTA groups.

Professor Scheinert continued: "Clearly, based on the observations by Dr Katsanos it was important to look at any potential correlation with paclitaxel dose, and all-cause death rates in different dosage groups."

As such, binary and Kaplan Meier analyses were carried out with paclitaxel dosages stratified into four quartile groups. For DCB, rates of death were similar when the four dosage quartiles were compared, with no statistically significant effects.

Furthermore, mortality rates at different time points were also analysed between the DCB and PTA groups, with none of the time points in the Lutonix II trial evidencing any significant difference. "If you compare that to published literature on the mortality rates in general in peripheral arterial disease cohorts, we can see that these death rates really compare favourably. Generally speaking, there is no excess death rate observed in any of the programmes so far."

Causes of death in the Levant II trials indicated that the highest two causes of death were cardiovascular and respiratory in nature, added Professor Scheinert.

In closing, he summarised: "Clearly this device was designed to be safe. In the SFA studies, Levant II showed no significant difference in all-cause death rates between DCB and PTA arms, and also no correlation based on the applied dose. Similar findings were made in Levant I, Levant Japan and the ISR group. The death rates observed in the larger registries are very comparable to literature findings."

The audience votes...

At the end of the session, the audience was asked to vote on their confidence in paclitaxel-eluting devices. The vote revealed that 72% believed the risk-to-benefit ratio of paclitaxel to still be favourable, thus they will continue to use such devices for the foreseeable future.

"I think all of us have asked ourselves this question," said Professor Scheinert. "Personally, I must say, based on many of the patient-level shown today from various trials, I am at least partially reassured."

The session 'Long-term safety of drug- eluting technologies in the leg – Recent findings, controversies, and future outlook' is available to view in full on the LINC website: www.leipzig-interventional-course.com.

References

1. Katsanos K, Spiliopoulos S, Kitrou P, Krokidis M, Karnabatidis D. Risk of Death Following Application of Paclitaxel-Coated Balloons and Stents in the Femoropopliteal Artery of the Leg: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Am Heart Assoc. 2018;7:e011245. DOI: 10.1161/JAHA.118.011245.
2. Without additional long-term and patient-level data, Katsanos *et al*'s conclusion is premature. Interventional News. 2018. Available at: https:// interventionalnews.com/meta-analysis-paclitaxeldevices-death/; accessed January 2019.
3. Meta-analysis finds a higher risk of death in the long term when paclitaxel-coated devices are used in the leg. Interventional News. 2018. Available at: https://interventionalnews.com/ meta-analysis-paclitaxel-devices-death/; accessed January 2019.

Scrub-in with the experts: Chronic deep vein obstructions

Gerry O'Sullivan walked audiences through a complex case of inferior vena cava (IVC) and iliac venous reconstruction, conducted live from Galway University Hospitals, Ireland.

The patient was a 31-year-old man, who was fit and healthy until June 2017 when noticing a scrotal mass. CT scan showed massive peritoneal retroperitoneal lymphadenopathy, and he began chemotherapy (no radiotherapy) for metastatic seminoma. After four weeks, however, his legs began to swell due to thrombus extending from the renal veins inferiorly. An acutely expanded IVC was evident on CT imaging, with thrombus extending into both common iliac veins.

"Over time, his leg swelling has developed," explained Dr O'Sullivan. "He has on-and-off ulceration in his right leg. He was only 28 years of age. He is on full anticoagulation."

Dr O'Sullivan discussed preoperative planning, first stressing: "This is not a starter case. You need to have a good plan of what you are going to do beforehand."

He underscored the importance of information gathering, involving formal review that includes expertise in haematology, vascular surgery, pre-op anaesthetics, interventional radiology, as well as detailed discussion with patient and family.

With regards to pre-operative imaging, Dr O'Sullivan cited both direct CT venography (CTV) and MR venography (MRV) as important modalities, as well as noting more generally the essential usefulness of combination imaging for complex cases.

"Unfortunately when we tried to do direct CTV on this man, it failed – we couldn't get anywhere near his foot because it was so swollen. You can see from the indirect CTV (from an injection into his arm) that there is dilated azygos, there are lots of collaterals along the anterior abdominal wall. Then he has basically got no IVC (or, it is very, very tiny). Both iliacs are shrunken, particularly the right external iliac vein."

Additional MRV revealed the presence of synechiae in the right common femoral vein, confirmed by ultrasound. This, explained Dr O'Sullivan, held implications for the procedural plan: "The hypertrophied right profunda is important, because if you are going to be doing stenting, you may need to stent down into that, and therefore there is no point in puncturing the common femoral above it. Therefore, in all these cases we do a triple puncture of right neck and both groins."

"You have got to be patient. You should allow about four hours for these cases."

Gerry O'Sullivan

Triple access was achieved via the right internal jugular vein (with a 10 F sheath), the right profunda femoris vein and the left common femoral vein (5 F sheaths). The patient was under general anaesthesia.

Dr O'Sullivan also highlighted the importance of lateral projection (rather than anteroposterior) to confirm positioning anterior to vertebral bodies. "The collaterals are so hypertrophied that it is very easy to slip from what you think is anterior into the epidural or lateral lumbar veins. It is very easy to go off-course – and then you are in trouble."

Commenting from the panel was Stephen Black (Guy's and St Thomas' NHS Foundation Trust, London, UK): "The key point is regular lateral views in these cases. I would emphasise that it is very, very easy to wander into those ascending lumbar collaterals and find yourself in the spine. If you don't pick that up, and stent into there, it is not a good look."

Regarding complex crossing techniques, Dr Black asked, "What do you have as your go-to trick if you are struggling and you find

yourself stuck on these veins?"

Dr O'Sullivan responded: "For a start, most people are probably trained on arteries. But this is a different sensation. It is stickier and grittier. I have a choice of wires. We start off with a regular glide from Terumo (Japan) or Merit (USA), and move on to a stiff glide.

"My go-to wire – and the wire that got through today – is the Roadrunner [Cook Medical, USA). It is an 0.035" wire, very hydrophilic, and I use it in a lot of biliary work as well. For here it is fantastic. The only caveat with this wire is that it can easily go into a lumbar or epidural. So you need to be very sure of where you are. But once you keep going into obliques and laterals, you will make sure you are anterior to the vertebral body. Once you have got across, I quite like having the back-up of a CXI catheter [Cook Medical]. I know there is a variety of others out there – everyone has got their own. The Triforce [Cook Medical] is useful as well. There are lots of different wires and lots of different catheters."

He added more generally: "You have got to be patient. You should allow about four hours for these cases. Obviously, the longer the occlusion, the bigger chance you have of not getting into the veins.

"Identifying whether your common femoral veins are normal or abnormal is a big, big step. If they are not normal then you have to figure out where you are going to puncture down into the thigh."

After lesion crossing, balloon-dilatation was carried out first with 5-mm balloons in order to expand the venous tracts from the renal veins to the common femoral

"The key point is regular lateral views in these cases."

Stephen Black

veins bilaterally. This was followed by 14 x 60 mm high-pressure Atlas balloons (BD/CR Bard, USA) in the same fashion.

He touched briefly on the possibility of venous rupture: "The first thing to do is not lose your cool, but the most important aspect is to have everything ready, so that if you do get a rupture, you have your [kit ready]. If rupture happens, believe me you want to be prepared for it. That is why you need access from above and below; you need an arterial line; you need blood on standby. You need all of your ducks in a row."

Prior to placement of double-barrelled Veniti Vici stents (Boston Scientific, USA), Dr O'Sullivan also commented on his choice of stent: "No one has shown me that one stent is superior to another. I think we are at a very early stage of stent usage, and I am delighted to have as many stents as we have available.

"The specific aspects of the Veniti Vici are that it does have a degree of foreshortening. It has high degree of anti-compressibility, and it probably has a tendency to straighten slightly over time (most stents tend to straighten, so this isn't exactly shocking). It is my go-to stent for malignancy. It is my go-to-stent for the superior vena cava and the IVC. Equally, there are many others out there now - the Venovo [CR Bard], the large (20-mm) Venovo and Abre [Medtronic, USA]. We are very fortunate in Europe that we have so many available."

From the panel, Mike Dake (Stanford University, CA, USA) asked: "Now that we have the availability of venous stents that go up to 20 mm, in your thinking is there any reason to put a single-lumen stented IVC as opposed to kissing stents – are you perfectly happy with kissing stents?"

"That is a really good question," responded Dr O'Sullivan. "Probably the people with the largest experience would be Houman Jalaie and Rick de Graaf with the Maastricht team, and Olivier Hartung in Marseilles. We know what doesn't work, which is fenestrated. Then, either you are talking about the 'tour d'eiffel' where you have one large stent above and two stents going into it. Or, as Stephen Black has shown, double-barrelled Veniti Vici, joined with whatever stent you wish from below.

"The point is that the tricky area is the confluence. The Maastricht group were adding a balloon-expandable stent at that specific point, so that one stent didn't crush the other, which they otherwise typically do. That's where the Veniti might have a bit of an advantage. But it is early days yet, and is there any randomised controlled data? Absolutely not. But flow dynamics are certainly a hot topic, and I do not know the answer."

Mahmood Razavi (St Joseph

"The flow dynamics of a single-lumen cava with two kissing stents going into it are very different from a double-barrelled IVC."

Mahmood Razavi

Hospital, Orange, CA, USA) added from the panel: "The flow dynamics of a single-lumen cava with two kissing stents going into it are very different from a double-barrelled IVC."

During positioning of the kissing stents – conformed in a 'ballerina' (cross-legged) position – cross-sectional CT angiography revealed the right renal vein to be positioned several cm lower on the IVC than the left renal vein, possibly due to collateralisation following thrombosis of the original right renal.

While this did not affect the double-barrelled stent configuration, stenting was ultimately carried out in a slightly lower position in the IVC, with 14x90 mm and 14x120 mm Veniti Vici stents, both of which extended into the common iliac veins.

Imaging was then performed from above and below, indicating residual narrowing of the IVC, demanding extension of the stents upwards into the IVC to the level of just below the left renal vein.

IVUS was then carried out in order to confirm this, and an abnormally small right renal vein was revealed, which led Dr Black to conclude: "Based on these pictures, I would extend both stents up to the area just below the left renal vein. You have a really tiny right renal vein, and you are probably going to lose nothing by covering it to some extent."

Discussing whether the closed-cell Veniti Vici versus a more open-cell design would provide better right renal vein outflow, the panel agreed that there was insufficient data on this question. The procedure continued after the session's conclusion with placement of two further 14x60 mm Veniti Vici stents, covering the right renal vein but preserving the left.

See clearly, treat optimally: image-guided therapy on the rise

Delegates gathered in Main Arena 1 for a showcase of image-guided therapy innovations from Philips (the Netherlands), introduced by Dierk Scheinert (University Hospital Leipzig, Germany) who opened the session for the speakers.

"This symposium takes you a little bit further, I would say – clearly beyond what we actually do in our daily practice," he began. "It is very dedicated to innovations in the cath-lab space, and we are very happy that Philips is supporting this session. More importantly, Philips now has a strong commitment to work with us on the vision of making endovascular procedures in the future even more effective, and more ergonomic."

He added: "This will allow us, in the future, to implement the latest imaging technologies and [obtain] patient information in a very comprehensive way."

First to present was Constantino Peña, an interventional radiologist from Miami Cardiac & Vascular Institute, Miami, USA, who spoke about next-generation vascular suites. "It is a pleasure to be here to today to really discuss our journey to what we think is the creation of the ultimate imaging suite," he began.

Before revealing the details of such a system, Dr Peña offered some insights into the limitations and challenges faced thus far. "As our cases have become more complex, our imaging suites have become less effective, less ergonomic and less safe," he said, noting a pressing need to improve the interventional work environment.

"It is a pleasure to be here to today to really discuss our journey to what we think is the creation of the ultimate imaging suite."

Constantino Peña

The solution lies in three pillars, he continued: radiation dose management, usability and efficiency, and positioning and geometry.

Tackling the first aspect, Dr Peña began with Philip's Clarity IQ system, featuring hardware and software advancements designed to help reduce radiation dose. Its benefit has been well-documented, he went on, with over 18 peer-reviewed publications showing a range of dose-reduction benefits across iliac digital subtraction angiography (DSA), EVAR and transarterial chemoembolisation (TACE) procedures.

Of particular note, he said, was the work of van Strijen *et al*.[1] who saw significant reduction of radiation dose by 83% using the Clarity IQ system compared to an Allura Xper system, all the while maintaining image quality.

In terms of improving usability and efficiency, Dr Peña moved onto the Azurion IGT Platform, featuring a simplified and intuitive user interface standardised amongst other cardiovascular systems and other imaging modalities such as CT and MR. "This is a platform based to improve workflow and efficiency solutions," he said.

With complete flexibility to monitor displays and inputs, it has simplified tableside controls to ensure everything is at reach, including the touch screen module for improved usability. Finally, two parallel work spots allow users to do two things at the same time, said Dr Peña.

With protocols, manuals and applications built in to the system, the Azurion IGT Platform also allows the user to undertake more complex types of imaging – those they may be less familiar with – with ease.

The platform also includes procedure cards, continued Dr Peña – standardised but customisable case information that increases consistency and maximises physician time and efficiency. "Each procedure card shows how a room should be prepared for a particular case," he explained.

Dr Peña continued, relaying data as to how procedural times could be reduced when using the system. Looking at six different physicians and their practices (over 700 procedures) before and after the use of the platform, it was determined that the Azurion IGT Platform would improve patient prep time by 12%, and procedural and post-procedural times by 17% and 20%, respectively.

What's more, usability of the platform, as measured by the commonly used System Usability Scale, revealed a score of 85% – higher the industry standard of 68%, noted Dr Peña.

Moving on to the third and final pillar, positioning and geometry, Dr Peña continued: "As we started to redesign our institute about five years ago, we were faced with the question of what are the present limitations with our imaging systems, and what are the future requirements? If you are going to determine and create a future imaging laboratory, what are the procedures that we can foretell are going to be in front of us 10 years down the road, and can we prepare our imaging systems to be leaders in this type

of environment?"

Effective and safe ergonomics are particularly important, he added, as more and more orthopaedic, musculoskeletal and spine problems are now known to occur when ergonomics are poorly thought out. "We must make sure that our imaging systems are created for the operators as well as the patients," said Dr Peña. "So, we decided the solution would be a new, ideal geometry."

The key criteria for this ideal geometry includes access to the patient from any approach, and the ability to image the whole patient from head to toe and arm to arm. Furthermore, minimised obtrusiveness of the detector system, a minimal footprint and good vantage points for observers sit alongside the need for easy and intuitive operation of the system, and with the ability to include multiple disciplines around the workspace.

Detailing the "ultimate" system he alluded to earlier, Dr Peña introduced the Azurion with FlexArm – a revolutionary innovation from Philips hoping to set a new standard for patient imaging and positioning flexibility in image-guided procedures. Powered by a smart kinematic engine, the system moves on eight different axes, all controlled with the single 'Axsys' controller. [2]

Dr Peña outlined its multitude of applications for complex

cases. "It makes your simple cases easier, and your difficult cases easy," he said. To study the real-world impact of the FlexArm, Dr Peña initiated a study at his centre, including 200 cardiology and interventional procedures separated into a pilot (n = 40) and final phase (n = 160). Questionnaires on ergonomics, and data on how mobile the table, the detector and operators were, were collected.

"What we found was that the movement of the C-arm, instead of the table, had significant benefits – not only to the operators, but to the patients," said Dr Peña. "There is less risk of dislodging tubes and lines, and less ergonomic risks in terms of having to move a table back and forth."

He added that because of the ease of moving the system, a wider range of overall movements during procedures was recorded when compared to standard imaging. Physician ergonomics were also improved, with reports of reduced (perceived) physical discomfort during interventions.

Recalling the three pillars of radiation dose management, usability and efficiency and positioning and geometry, he concluded of the FlexArm: "It really has come together."

"To understand why we fail and how to improve, we need much more information, and perfusion angiography is one of the new methods to get more information."

Jim A Reekers

SmartPerfusion for treatment of the diabetic foot

Stepping up to the podium to share how we can optimise planning and treatment of the diabetic foot, Jim A Reekers (Interventional Radiologist, Amsterdam, the Netherlands) set the scene: "To understand why we fail and how to improve, we need much more information, and perfusion angiography is one of the new methods to get more information."

While traditional angiography only visualises the arteries, he said, 90% of information from the microcirculation is unseen. "With more information we could make better decisions."

This, he said, is where the power of perfusion angiography lies. Specifically, Dr Reekers spoke of Philips' SmartPerfusion imaging analysis software, which provides functional information about tissue perfusion based on the total contrast distribution of a DSA run, which is formed into a colour-coded image to assist the user.

Key benefits of the software include assistance in determining treatment endpoints, support for physicians in assessing treatment effects (by providing instant perfusion parameter changes), and seamless and automated guidance that standardises pre- and post-comparison runs through guided positioning.

To harness the full power of SmartPerfusion, Dr Reekers emphasised the need for meticulous preparation, including a dedicated foot rest to immobilise the patient's foot, rotation of the C-arm by 40 degrees contralaterally, and a contrast injection from the mid popliteal artery.

Other requirements include high-density contrast (iso-osmolar to maintain bolus and avoid calf cramps), pump injection with 9 cc over 3 seconds, and strict maintenance of foot positioning for pre- and post-angiography.

Continued on page 16

See clearly, treat optimally: image-guided therapy on the rise

Continued from page 15

"What do we do with this SmartPerfusion software?" he said. "We measure the absolute increase in total foot perfusion after revascularisation, which is not only the arteries but also the 90% microcirculation, and another thing we do is look at the functionality of the sympathetic nervous system."

In his work, including a recently published paper,[3] Dr Reekers has used perfusion angiography in a treatment algorithm in order to predict/establish functional or non-functional outcomes for diabetic patients and those with neuro-ischaemic foot ulcers. As he outlined, perfusion angiography offered a very simple test to evaluate the functionality of the sympathetic nervous system by measuring change in total blood flow through the foot, and facilitated a strong predictor of early major amputation.

Concluding with his views on SmartPerfusion, he said: "Now we have an objective, measurable, repeatable [technology]," adding that it takes away the "gamble" of procedural decision-making. "You can really understand when things are going in a certain direction."

Role of IVUS within a 'treat optimally' algorithm of care

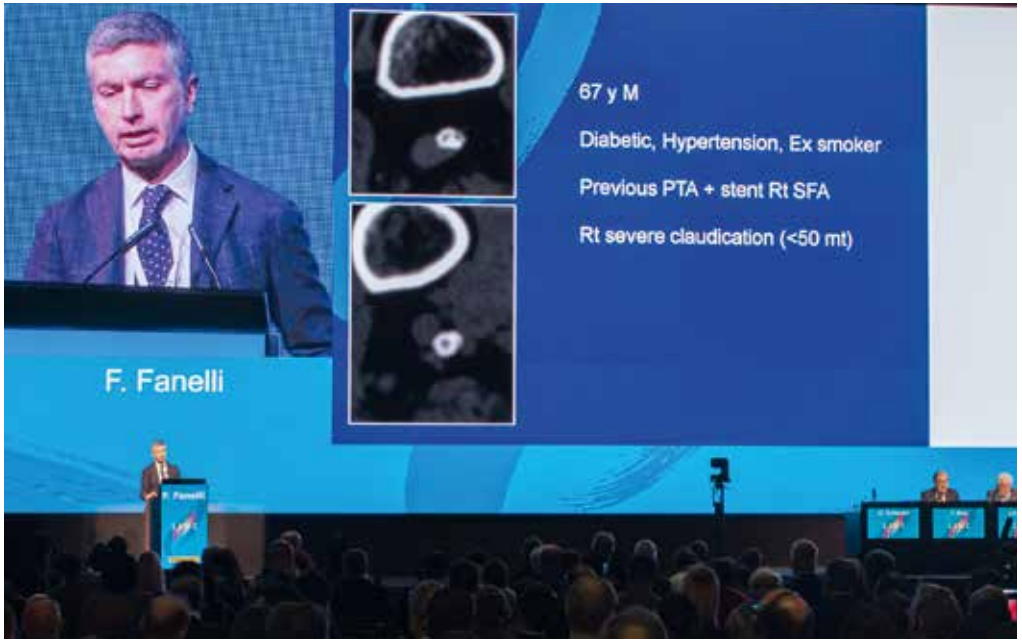
Fabrizio Fanelli, a vascular and interventional radiologist from Florence, Italy, introduced the role of intravascular ultrasound (IVUS) for optimal treatment. By way of background, he noted that DSA is still considered the gold-standard image modality for the evaluation of the peripheral vessels, yet it falls short in several aspects, including assessment of degree of stenosis.

"Many times we have to do dual projections because obviously with a single projection we are not able to completely see the lumen," said Dr Fanelli, adding: "This also increases the amount of contrast media and radiation dose to the patient."

Outlining the advantages of IVUS, he underlined that it can provide a wealth of lesion information including morphology (plaque, thrombus, calcium), plaque geometry, lesion type, determination of true and false lumens, guidance for stent placement and, very importantly, it can reduce radiation exposure for both patient and operator.

Dr Fanelli also relayed data demonstrating that the use of IVUS alongside DSA for stenting significantly improved primary patency at 3- and 6 years when compared to DSA alone.[4] "The main reason was that IVUS was able to correctly select the size of the stent," he said.

To harness the power of IVUS, Dr Fanelli touched on the suite of IVUS catheters by Philips, including the Visions PV series of devices and the Pioneer Plus catheter. "These can be selected accordingly – whether you are working in the peripheral, aorta or venous [arena], where we know IVUS is pretty much mandatory in all cases," he said.



"The importance of IVUS is in driving our treatment plan, and also in modifying our strategy."

Fabrizio Fanelli

Dr Fanelli went on to note that, according to data unearthed by colleagues, IVUS can change treatment plans in 79% of cases.[5] This is echoed in his personal experience, he added.

"What is also important is that IVUS is used not just to evaluate/image, but to also integrate with all of the other devices available," said Dr Fanelli, noting examples in the Philips family of devices including crossing catheters, the Turbo-Elite, Turbo-Power and Phoenix atherectomy systems, AngioSculpt scoring balloons and Stellarex drug-coated balloons.

Offering his conclusions, Dr Fanelli commented: "IVUS can be considered a very interesting and valid tool in our daily activities – especially now we are performing more and more complex procedures. The importance of IVUS is in driving our treatment plan, and also in modifying our strategy according to the condition. Also, it is very important to integrate this system with all of the other devices that are now available in our daily practice."

Innovations at the forefront

Last to speak during the session was Maria Louisa Izamis, a clinical scientist from Eindhoven, the Netherlands, who gave a glimpse of the future of image-guided

therapy. "While interventional practice today experiences progressive technologies, it is still basic biology that eludes us," she began.

Her core message from the outset was that, owing to the entrenched nature of X-ray for many decades, any imaging modality setting out to improve on X-ray will be met with high barriers to adoption. "This is the modality to beat," said Dr Izamis. "You have to be able to improve patient outcomes and reduce complications, otherwise how can you justify the reason for changing the status quo?

"Any alternative should be easy to use, and everybody should have access to it. You need to be able to maximise the number of patients you can reach, and minimise ever-rising costs in healthcare."

Philips' suite of imaging modalities, she went on, including AlluraXper and AlluraClarity, have rose to challenge by reducing up to 83% of X-ray dose, saving upwards of 30% of procedural time, and facilitating the treatment of at least one more patient per day.

Newer technologies offer 3D visualisation and quantified flow measurements from X-ray, she added, but images are still inherently black and white. Thus, there is great scope in "seeing more clearly".

Sharing three possibilities to do just that, she first touched on Philips' Fiber Optic RealShape (FORS) technology – an innovative guidance solution that pulses light through devices to provide real-time 3D device visualisation, without the need for fluoroscopy. Transmitted through optical fibres that are embedded in the devices, the light signal is translated into a colour rendered 3D visualisation that greatly enhances the detail and clarity of device navigation and positioning during endovascular procedures when compared to fluoroscopy. More detailed information on FORS was presented by Joost van Herwaarden during LINC (see page 75).

"Philips continues to evolve its interventional excellence, spanning the spectrum from the greatest to the finest of details."

Maria Louisa Izamis

Next, Dr Izamis spoke of 3D-ultrasound, underscoring the combination of "beautiful, exquisite image detail with interventional simplicity."

She went on: "You can simply place your probe on the region of interest that you care about, capture a volume, rotate it … and comprehend it easily. Then, in real time, watch your treatment being deployed. Ultrasound plays an enormous role in complementing large field-of-view navigation because it offers focal, soft-tissue detailed information on both the anatomy and function."

Dr Izamis added that, not only is the intelligence and the image quality of ultrasound improving, the technology in being miniaturised, now able to be incorporated in wearable technologies for patient monitoring.

"As the usability and intelligence of ultrasound increases, it becomes a technology that is able to be patient-specific, and no longer practitioner-specific," she said.

Finally, Dr Izamis outlined Philips' advancements in augmented reality, offering the chance to incorporate data from different outputs in one field. The data, said Dr Izamis, can then be easily manipulated and assessed to ensure the best outcomes for that patient.

"As Philips continues to evolve its interventional excellence, spanning the spectrum from the greatest to the finest of details, augmented reality is one means to bring the communication of all of these different systems together into one integrated solution."

Harking back to her opening comments about X-ray alternatives, Dr Izamis concluded that X-ray alternatives don't have high barriers to adoption after all, they have high standards: "Only when you possess the knowledge that is able to take you one step further, will the path become clear to you," she said in closing.

Also featured during the session was a recorded case by Marco Manzi (Italy), and a live case from Leipzig.

References

1. M.J.L van Strijen *et al*. JVIR. 2015
2. Philips launches Azurion with FlexArm to set new standard for the future of image guided procedures. Jan 17, 2019. Available at: www. philips.com/FlexArm.
3. Schreuder SM, Nieuwdorp M, Koelemay MJW, *et al* Testing the sympathetic nervous system of the foot has a high predictive value for early amputation in patients with diabetes with a neuroischemic ulcer BMJ Open Diabetes Research and Care 2018;6:e000592.
4. Buckley CJ, Arko FR, Lee S, Mettauer M, Little D, Atkins M *et al*. Intravascular ultrasound scanning improves long-term patency of iliac lesions treated with balloon angioplasty and primary stenting. J Vasc Surg. 2002 Feb;35(2):316-23.
5. Spark I, Allan R. The role of IVUS in peripheral interventions. Charing Cross Symposium 2018, London, UK. (N = 47; not indicative of future performance).

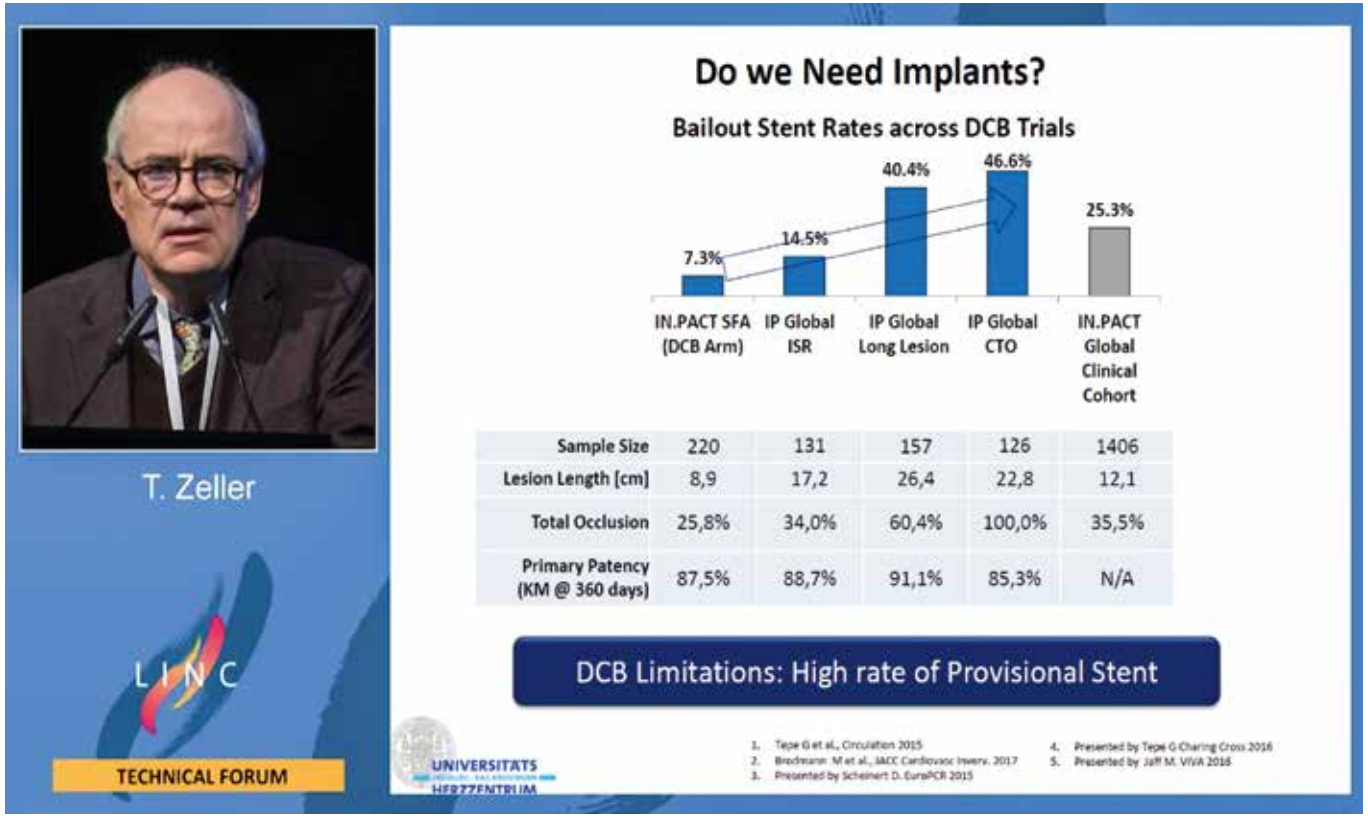
Leaving as little as possible behind in the fem-pop arteries

Thomas Zeller of the University Heart Center Freiburg-Bad Krozingen, Germany proposed a treatment algorithm as a strategy to 'leave as little as possible behind' in femoropopliteal lesions. "We have learned that the introduction of nitinol stents has significantly improved the performance of femoropopliteal interventions," said Professor Zeller.[1]

But despite improvements, he said, there are certain disadvantages. "Long stent segments are facing the problem of long-term patency. With increased lesion length, stent patency is reduced, and if we are faced with in-stent restenosis we are dealing with a really ugly animal which is hard to treat in the long term."

Professor Zeller went on to note that drug-coated balloon (DCB) treatment as a stand-alone therapy is not the answer, as shown in data of bailout stent rates across DCB trials (Figure 1). "What we see is the longer the lesion length with DCB, the more likely we need to implant stents at least in some areas," he said. "This is the general limitation of any balloon-based approach regardless of whether you are using DCB or plain balloons."

The trials featured included IN.PACT SFA (DCB Arm)[2], where the lesion length and bailout stent rate were 8.9 cm and 7.3%, respectively, IP Global ISR[3] (17.2 cm; 14.5%), IP Global Long Lesion[4] (26.4 cm; 40.4%), and IP Global CTO[5] (22.8 cm; 46.6%).



Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

Every aspect of stent design and placement has some association with restenosis, said Professor Zeller, from mesh configuration to stent material. "The key question we have to ask ourselves is what drives the development of in-stent restenosis if we are performing bailout stenting? One of the aspects is stent overlap and stent length," he explained.

Professor Zeller described an interesting retrospective analysis by Hong *et al*. looking at the performance of spot stenting following balloon angioplasty as compared to full-metal-jacket stent implementation.[6] The study sought to compare the outcomes of spot stenting versus long stenting after an intentional subintimal approach for long femoropopliteal chronic total occlusions in 163 patients, implanted with bare nitinol stents. Primary patency was compared between spot stenting (n = 129) and long stenting (n = 67). "We can see really long lesions had been included in the study – a mean of 25 cm," began Professor Zeller.

"The difference was that, in the full-metal-jacket cohort, there was stenting along the entire lesion length," he explained. "Whereas the focus stent cohort received only 10 cm of stent. So, about 30% of the entire lesion length was stented."

According to Professor Zeller, this did not adversely affect clinical outcomes, with post-procedural ankle brachial index similar in both cohorts. "However, if you look at the follow-up examination up to two years later, you can see that this spot

stenting strategy was associated with significantly better primary patency and significantly better freedom from TLR [target lesion revascularisation]."

Indeed, the risk of restenosis was especially higher when long stenting was extended to the distal popliteal artery. "More interestingly, if we look at further stratification of the stent extension into the P1 or P2 segment, we can see that as soon as the popliteal arteries are involved, the outcome for the long-standing cohort is really bad," said Professor Zeller. Primary patency at two years was below 40%.

"The predictors for re-stenosis in this analysis have been coverage of the P2 and P3 segment as well as long stenting," he explained. "The key question is in lesions that develop dissections, do we really need to entirely cover the dissected area or is it sufficient to place just a short stent into the entry zone?"

He added that the question is particularly important given the kind of mechanics that develop after stent placement, particularly in the popliteal artery. "This is probably why the outcome of the full metal jacket stent cohort extending into the P2 and P3 segment was so bad," explained Professor Zeller. "We are creating kinking areas which are very likely to generate stenotic regions or cause stent fractures."

One option to overcome the problem of these changes in the vessel biology may be the implantation of short-stent systems like the VascuFlex Multi-LOC (B. Braun, Germany) which delivers six individual stents on top of one delivery system. "This gives the artery the option to preserve the natural bending areas in between the stents that have been implanted," said Professor Zeller. "Although you do have to leave gaps that are long enough – so at least 4 mm."

"If we are faced with in-stent restenosis we are dealing with a really ugly animal which is hard to treat in the long term."

Thomas Zeller

The first study[7] that has evaluated the performance of this device was just recently published, noted Professor Zeller, the Multi-LOC for flOw liMiting Outcomes after POBA and/or DCB Treatment in the infrainguinal position with the objecIVE to implant multiple stent segments (LOCOMOTIVE) study.

Plain balloon angioplasty and/or DCB were performed upfront, followed by Multi-LOC stent. At 12 months, primary patency was 85.7% and all-cause TLR rate 9.3%. "There was a slight reduction in patency and a slight increase of the TLR between six and 12 months," said Professor Zeller.

Another option for this focal stent approach is 'tacking', noted Professor Zeller. The Tack Endovascular System (Intact Vascular, USA) is designed to spot-treat dissections of vessels that may occur following POBA or drug-coated balloon (DCB) treatments.[8] Using small nitinol 'tacks', with gold radiopaque markers, multiple tacks can be placed via a single catheter, using 'pin-pull' delivery.[9]

"The key question is in lesions that develop dissections, do we really need to entirely cover the dissected area or is it sufficient to place just a short stent into the entry zone?"

Thomas Zeller

The goal of the tacking modality is to provide the anatomic result of a stent, said Professor Zeller, minimise injury and hyperplasia, maintain physiologic vessel compliance, facilitate operator control (placement, number of tacks, timing) and maintain options for future reintervention.

"The primary patency for this approach following bare balloon angioplasty is almost 80%," he added.

Professor Zeller went on: "Long distant stent implementation is associated with reduced patency, increased fracture rates, and impairment of vessel physiology and anatomy during leg motion."

As such, he proposed a treatment algorithm in long lesions and TASC C lesions that are not severely calcified. "If pre-dilatation looks good, you can proceed with DCB angioplasty, and if you have some areas that need to be supported by a foreign body you can use focal stents or tacks on indication," he said.

"If you have a severe dissection from the very beginning, you should go directly for a stent approach. If the lesion is severely calcified and you have a good result after pre-dilatation you can proceed with the Supera [Abbott Vascular, USA] or Multi-LOC system. If it is severely dissected or its showing recoil in these long lesions, I would go for a Supera or Viabahn [WL Gore, USA] approach."

References

1. 12-month Restenosis vs. Lesion Length: Data from Randomized Trials. Presented by Prof Schillinger Euro-PCR 2008.
2. Tepe G, Laird J, Schneider P, Brodmann M, Krishnan P, Micari A *et al*. Drug-coated balloon versus standard percutaneous transluminal angioplasty for the treatment of superficial femoral and popliteal peripheral artery disease: 12-month results from the IN.PACT SFA randomized trial. Circulation. 2015;131(5):495–502
3. Brodmann M, Keirse K, Scheinert D, Spak L, Jaff MR, Schmahl R *et al*. Drug-Coated Balloon Treatment for Femoropopliteal Artery Disease: The IN.PACT Global Study De Novo In-Stent Restenosis Imaging Cohort. JACC Cardiovasc Interv. 2017;10(20):2113–2123.
4. Presented by Scheinert D. EuroPCR 2015
5. Presented by Tepe G Charing Cross 2016
6. Hong SJ, Ko YG, Shin DH, Kim JS, Kim BK, Choi D *et al*. Outcomes of spot stenting versus long stenting after intentional subintimal approach for long chronic total occlusions of the femoropopliteal artery. JACC: Cardiovascular Interventions. 2015;8(3):472–480.
7. Sigl M, Beschorner U, Zeller T, Waliszewski M, Langhoff R, Tautenhahn J at al. Focal Stenting of Complex Femoropopliteal Lesions with the Multi-LOC Multiple Stent Delivery System: 12-Month Results of the Multicenter LOCOMOTIVE Study. CardioVascular and Interventional Radiology. 2019;42(2):169–175.
8. Intact Vascular. TACK ENDOVASCULAR SYSTEM®. Available at http://www.intactvascular.com/
9. William A. Gray. CLINICAL TRIAL UPDATE: TOBA II A Unique Study Device Using a Distinctive Trial Design The Tack Optimized Balloon Angioplasty Study Using the Tack Endovascular System™. LINC 2016 proceedings.

Viabahn VBX: Expanding the indications in the peripheries

Delegates witnessed an exploration of endoluminal solutions for aorto-iliac obstructive disease in a session partially sponsored by Gore.

During the session, Michele Antonello (Head of Endovascular Surgery Section, Clinic of Vascular Surgery, University of Padova, Italy) discussed the complexity of iliac occlusive disease, current treatment algorithm, and treatment gaps.

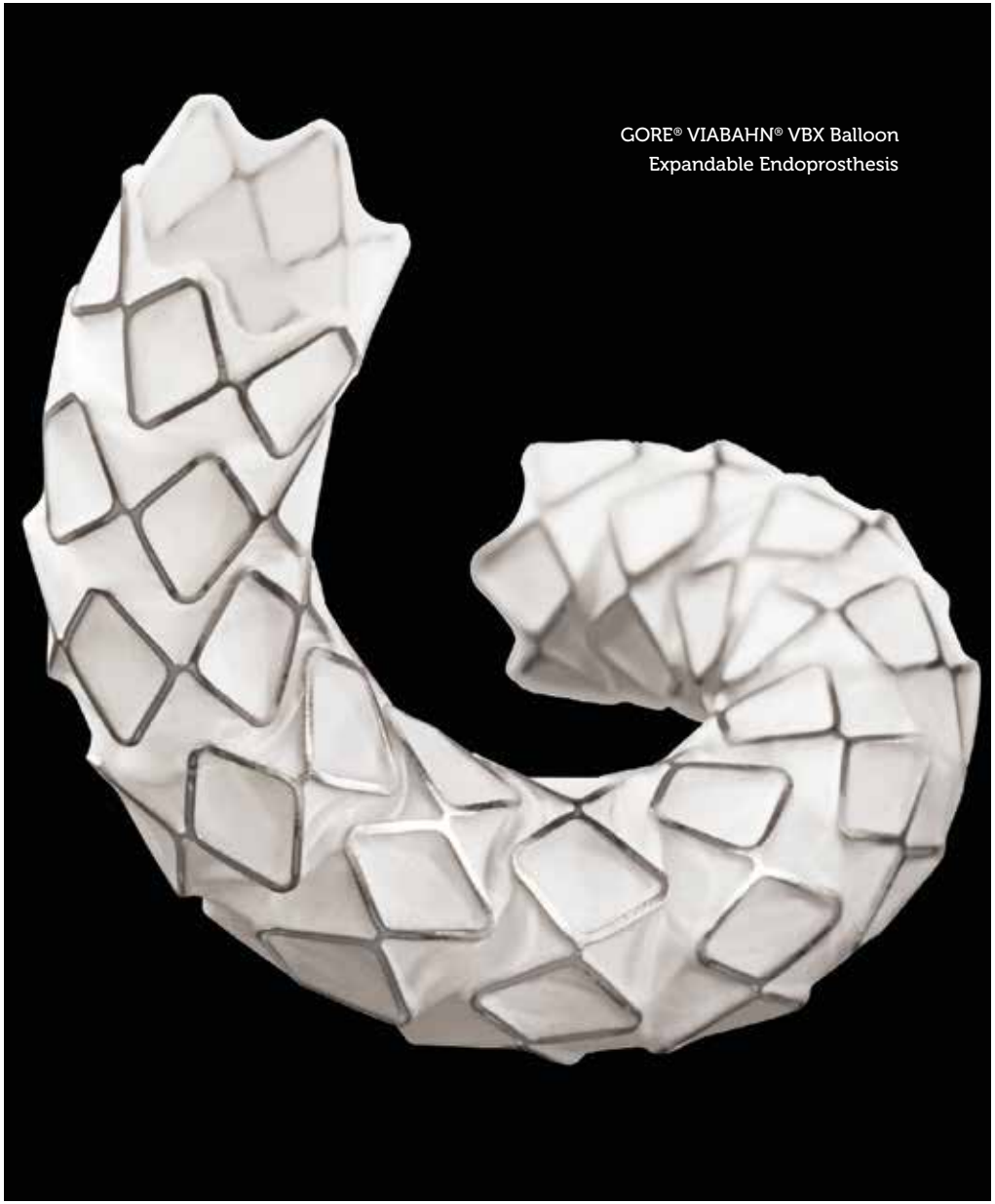
Dr Antonello recently wrote of the benefit of covered over bare metal stents in the context of aortoiliac occlusive disease, as demonstrated by the COBEST randomised trial[1], as well as the concerns over existing balloon-expandable covered stent devices regarding how their rigidity affects their performance in tortuous vessels such as the external iliac arteries, and their risk of dislodgement in extremely calcified or lengthy occluded segments.[2]

The development of the Viabahn Balloon Expandable (VBX) Endoprosthesis (W. L. Gore & Associates, USA) sought to address these unmet needs, marrying the properties of self-expanding and balloon-expandable covered stents in a single device with a combination of radial force, flexibility and accuracy in the treatment of iliac occlusive disease.

Michele Antonello

FDA approval was gained in January 2017, indicated for the treatment of *de novo* or restenotic lesions found in iliac arteries with reference vessel diameters ranging from 5–13 mm and lesion lengths up to 110 mm, including lesions at the aortic bifurcation. A CE mark was obtained in December 2017, indicated for the endovascular grafting of peripheral vessels.

The VBX stent graft was developed utilising the small diameter, expanded polytetrafluoroethylene (ePTFE) stent graft technology from the



GORE® VIABAHN® VBX Balloon Expandable Endoprosthesis

Gore Viabahn endoprosthesis. The VBX device is configured in diameters of 5 to 11 mm and lengths of 15, 19, 29, 39, 59, and 79 mm.

First-in-human experience with the VBX was published by Holden *et al*. (2017), in a pilot study of 30 patients for the treatment of *de novo* or restenotic common and/or external iliac artery lesions, with positive results[3].

Subsequently, results from the VBX Flex pivotal study evaluating the safety and efficacy of the VBX in the treatment of aortoiliac occlusive disease (AIOD) were published. The study cohort reflected real-world practice with a wide range of different lesions treated, including a total of 213 iliac lesions in 134 patients, 75% of whom were classed as Rutherford 3, 32% presented with TASC II C/D lesions, and 43% received kissing stents. A 100% technical success was achieved. Independent core laboratory quantitative angiographic analysis confirmed no incidence of foreshortening device length following deployment. At nine months, only 2.3% (n = 3) patients experienced target lesion revascularisation, and there were no device-related serious adverse events or unanticipated adverse device effects.[4]

In Europe, the post-market registry of the VBX, EXPAND, was initiated in late 2018 with the aim of capturing real-world VBX stent graft use in multiple pathologies and conditions. Enrollment is ongoing, with an anticipated 140 patients who will be followed for 12 months, with an estimated study completion date of December 2020.[5]

A selection from the first European cases treated using the VBX was presented at LINC by Hany Zayed (Consultant Vascular and Endovascular Surgeon, Guy's and St Thomas' Hospital, London, UK), Raffaello Bellosta (Director of the Complex Operative Unit of Vascular Surgery, Poliambulanza Foundation Hospital, Brescia, Italy) and Gianmarco de Donato (Associate Professor of Vascular Surgery, University of Siena, Italy).

A case of challenging bilateral iliac occlusion with heavy calcification

Hany Zayed delivered a case discussion of bilateral iliac occlusion in a patient (male, age 74) who presented with very limiting intermittent claudication that did not respond to optimal medical therapy.

Speaking to *LINC Review* ahead of the session, Dr Zayed explained: "The gentleman is the carer of his wheelchair-bound wife, so he essentially has to take her out and push her up and down hills etc. He had been through our supervised exercise programme but despite this and medical optimisation of his cardiovascular risk factors, his symptoms remained life-limiting."

Describing the patient as "the typical arteriopath", Dr Zayed noted a history of ischaemic heart disease with previous coronary stenting and hypertension.

"In view of his home circumstances, he was very keen to have something done that would not entail a long hospital stay. Anatomically, he had bilateral iliac occlusions with extensive calcification.

"We know that to be able to treat these lesions, there are certain challenges: first, whether we would be able to recanalise these chronically occluded vessels or not; second, after recanalisation, whether we will be able to stretch them open (vessel preparation) or not; and lastly, what type of stent we should use. We ideally need a stent which has the ability to withstand the compressive forces that would be put on it by the heavy calcification in the vessel wall."

"We were pleased with the performance of VBX in this case and the patient was delighted with the outcome."

Hany Zayed

The endovascular procedure was combined with an endarterectomy procedure to clear an occluded right common femoral artery. This was also used as one of the access vessels to treat the iliac occlusions. A re-entry device was used to recanalise one of the external iliac arteries in a retrograde fashion. The second iliac proved uncrossable from below, and the lesion was ultimately crossed by an antegrade approach through a transbrachial access.

Following recanalisation, vessel preparation proved a challenge: "Because of the level of calcification, we started with a small diameter balloon," said Dr Zayed. "However, every time we tried to upsize the balloon, it burst because it could not withstand the compression and heavy calcification. This, again, tells us that this is a challenging lesion for any stent we will use."

Dr Zayed's unit at Guy's and St Thomas' Hospital was the first In the UK to have access to the VBX. "We thought that this would be a good case to try how reliable and durable the VBX stent is.

"Normally, when you have a new stent to evaluate, you don't try it out in the straightforward cases where a few other stents would do a good job. You try it out in a challenging, extreme case where, if the stent does well, it means it is likely to perform in less challenging lesions. If it does not do well, it tells you that you should stick to your existing choice of stents.

"Using the VBX, these vessels remained open. Our protocol for these challenging cases is to get these patients a non-contrast CT scan to examine the structural integrity of the covered stent and its interaction to the heavy vessel calcification. This is in addition to duplex scan which provides the haemodynamic information about the flow in the covered stent. We were pleased with the performance of VBX in this case and the patient was delighted with

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Viabahn VBX: Expanding the indications in the peripheries

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the outcome.

"In the UK, the VBX is fairly new, having only been available for the past few months. So far we used them in aortoiliac disease, and chimney stent grafting, and we feel that VBX will be a useful addition to the endovascular armamentarium."

Speaking more broadly, Dr Zayed commented on the expansion of endovascular procedures in the setting of aortoiliac occlusive disease, and how evolving device designs have risen to the challenge of increasing case complexity. "In terms of aortoiliac disease, many years ago the standard was to do open operations such as the aortic bifemoral bypass," he said. "But currently 80–90% of our practice dealing with aortoiliac occlusion is done endovascularly, which is a paradigm shift in the management of aortoiliac disease.

"We are quite liberal with the hybrid techniques too, with low-risk, small surgical procedures, such as femoral endarterectomy, to make the execution of the endovascular procedure possible. Certainly in our own practice we see that the endovascular approaches are safe and feasible with good durability.

"The tools now available allow us to deal with challenging cases in terms of recanalisation and high-pressure ballooning. More important is keeping the blood vessel open with the currently available balloon-mounted covered stents, which have very good durability and long-term outcomes."

While the benefit of covered stents was demonstrated by COBEST[1] and other studies, Dr Zayed pointed out that the next criteria that covered stents need to fulfil is strength and resistance to compression. "We have very strong stents currently on the market.

"But I think that what the VBX adds to these available options lies in its design, which potentially adds the flexibility to compression resistance. Therefore it could conform better to tortuous anatomy."

Case discussion: iliac bifurcation occlusion accompanied by internal iliac artery stenosis

Raffaello Bellosta presented a case of extensive aortoiliac occlusive disease with endovascular treatment involving the use of the VBX alongside the dual-component Tigris stent (W. L. Gore & Associates).

The patient was a 72-year-old woman who, two months prior to the procedure, had presented with early progressive limb claudication, and had been experiencing foot pain at rest for a duration of two weeks. She was a heavy smoker, with no history of diabetes or coronary heart disease.

Clinical investigation revealed an absence of left limb pulse, and poor ankle brachial indices on both sides. With the use of duplex ultrasound an occlusion of the left external iliac artery was revealed. In addition, CT imaging indicated disease at the level of the aortic bifurcation, alongside partial thrombosis of the common iliac artery, complete thrombosis of the external iliac artery with no neck and a mild stenosis of the hypogastric artery. Angiography confirmed the CT findings.

Commenting on the procedural strategy, Dr Bellosta told *LINC Review*: "Like in open surgery, the goal is to treat all of the diseased artery. In bypass you should land in healthy artery, so in the same fashion you have to stent from healthy to healthy.

"So we planned to cover all of the disease. In this case, first I recanalised the external iliac artery in a retrograde fashion. We pushed a guidewire into the left hypogastric artery. We inserted a 5-cm Viabahn in the external iliac artery and simultaneously a balloon in the hypogastric artery to avoid occlusion of this artery. Then, we inserted the second 5-cm Viabahn and ballooned it. Then we placed a Tigris stent in the hypogastric where there was a stenosis. This was the first step.

"After that, because of the stenosis of the aortic bifurcation, which extended from the common iliac artery to the distal aorta, I placed two stent grafts here, in order to exclude the irregular thrombus, in a kissing configuration."

"The VBX stent graft is a good device for the common iliac because of the high resistance for its radial force."

Raffaello Bellosta

Commenting on the choice of VBX in this particular scenario, he added: "The VBX is the perfect device for external iliac artery, because this artery is a tortuous vessel and Viabahn has a perfect conformability. I chose this device for its compliance and geometry. The VBX stent graft is a good device for the common iliac because of the high resistance with its radial force.

"The final result shows patency well restored and to date, at nine months follow-up, the patient is doing well."

In his concluding remarks, Dr Bellosta commented on the necessity to be highly meticulous with respect to observing best technical practice. This, he said, applies to procedural planning, as well as to restricting oversizing to less than 1 mm (although one to one sizing is recommended per IFU), the optimal use of dual antiplatelet therapy, and careful patient follow-up. "In this manner, the stent graft becomes a real 'endobypass'," he said in closing.

A case of complete aortic graft occlusion

Gianmarco de Donato discussed an unusual case of a frail elderly patient who had previously undergone endovascular treatment for aortoiliac disease and now presented with complete aortic graft occlusion.

Dr de Donato told *LINC*

Review that "now is the time to push" the range of aortoiliac disease treated by endovascular means in light of the evolution of techniques and device options. "The guidelines are quite conservative for endovascular treatment of aortoiliac occlusion," he said, referring to the 2017 ESC/ESVS guidelines[6].

Alongside the findings by Piazzi *et al*. (2017) evidencing the superior performance of self-expanding PTFE-covered stents over bare metal stents in chronic iliac arterial occlusion[7], Dr de Donato cited a commentary he co-authored alongside Carlo Setacci (2016) calling for a redrawing of the boundaries for endovascular treatment of infra- and juxtarenal aortic occlusive disease[8]. "In the last two decades we have a clear paradigm shift for abdominal EVAR treatment, from open to endo. Now we imagine more or less the same paradigm shift in the future for aortoiliac occlusion. We are now moving from aortic bifurcation occlusive lesions to even more complex infrarenal occlusions and even juxtarenal occlusions."

Indeed, the case he presented illustrated this shift. The patient, an 82-year-old male, had a history of coronary artery bypass grafting, chronic obstructive pulmonary disease, gastric cancer surgery and intracerebral haemorrhage. In 2010, he underwent an EVAR

procedure extending into the iliac bifurcation. Seven years later he presented with mild left buttock claudication, revealed by CT to be due to thrombosis of the left iliac limb graft.

"At that time, only medical treatment was suggested because of the high risk of the patient," explained Dr de Donato. "But one year later he had complete occlusion of the entire endograft. At that point, because of comorbidities the patient was clearly unfit for open, and lysis was also not an option because of his previous intracerebral haemorrhage. So we decided to go for an endovascular relining with covered balloon-expandable VBX stent."

"In this situation, with just two stents I was able to have a wonderful relining of the previous endograft."

Gianmarco de Donato

Antegrade recanalisation via brachial access was carried out (due to risk of thrombus dislodgement) followed by wire rendezvous via common femoral artery access. Initially, two VBX 8x79 mm stents were placed in kissing configuration to reline the occluded stent graft, alongside a single renal chimney (a 5x29 mm VBX). However, angiography revealed persistent thrombus at the juxtarenal level, demanding the relining of the vessel with a double renal chimney.

"The final angiographic result was very nice, very promising – also at the five-month follow-up," commented Dr de Donato.

"The VBX really allows very precise proximal and distal landing. In my mind, the Gore VBX is a unique combination of radial strength and flexibility. It is the only covered stent graft with no longitudinal stent struts. The accuracy is something that I really consider in a case like this, because the VBX is the only one providing compliance cards, which allows me to know perfectly how the stent behaves when I post-dilatate it. I know exactly the shortening of the stent during flaring and post-dilatation manoeuvres.

"The length is also very important in this particular case, because this is the only balloon-expandable covered stent on the market with this length of 79 mm. In this situation, with just two stents I was able to have a wonderful relining of the previous endograft. The trackable delivery system and the retention – the capability to have the stent very fixed on the semi-compliant balloon during the manoeuvre – means that there is no need for predilatation (which in this case might have meant renal embolisation). That is very important.

"This is also the only covered stent on the market with a heparin surface. This gives me an 'insurance' against secondary graft thrombosis, because a patient like this is more prone to have another thrombosis in the future."

References

1. Mwipatayi BP, Thomas S, Wong J, Temple SE, Vijayan V, Jackson M *et al*. Covered Versus Balloon Expandable Stent Trial (COBEST) Coinvestigators. A comparison of covered vs bare expandable stents for the treatment of aortoiliac occlusive disease. J Vasc Surg. 2011;54:1561-70.
2. Piazza M, Antonello M. Commentary: The First Balloon-Expandable Stent-Graft Approved for Treatment of Iliac Occlusive Disease. J Endovasc Ther. 2017;24(5):638-9.
3. Holden A, Merrilees S, Buckley B, Connor B, Colgan F, Hill A. First-in-Human Experience With the Gore Balloon-Expandable Covered Endoprosthesis in Iliac Artery Occlusive Disease. J Endovasc Ther. 2017;24(1):11-18.
4. Bismuth J, Gray BH, Holden A, Metzger C, Panneton J; VBX FLEX Study Investigators. Pivotal Study of a Next-Generation Balloon-Expandable Stent-Graft for Treatment of Iliac Occlusive Disease. J Endovasc Ther. 2017;24(5):629-37.
5. Post-Market Registry of the GORE® VIABAHN® VBX Balloon Expandable Endoprosthesis Implanted in Peripheral Vessels (EXPAND). ClinicalTrials.gov. https://clinicaltrials.gov/ct2/show/NCT03720704 (accessed Jan 2019).
6. Aboyans V, Ricco JB, Bartelink MEL, Björck M, Brodmann M, Cohnert T *et al*; ESC Scientific Document Group. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). Eur Heart J. 2018;39(9):763-816.
7. Piazza M, Squizzato F, Dall'Antonia A, Lepidi S, Menegolo M, Grego F, Antonello M. Editor's Choice – Outcomes of Self Expanding PTFE Covered Stent Versus Bare Metal Stent for Chronic Iliac Artery Occlusion in Matched Cohorts Using Propensity Score Modelling. Eur J Vasc Endovasc Surg. 2017;54(2):177-185.
8. de Donato G, Setacci C. Commentary: Endovascular Reconstruction of Infra- and Juxtarenal Aortic Occlusion: Is it Prime Time for Normal-Risk Patients? J Endovasc Ther. 2017;24(1):25-26.

CICE@LINC: Parallel grafts in the real world

In another global collaboration, CICE joined forces with LINC in a session dedicated to the real-world performance of parallel grafts. CICE, the international Congress on Endovascular Surgery, took place this year between 3 and 5 April in Sao Paulo, Brazil.[1]

Speaking to *LINC Review*, CICE course director Armando C Lobato (Sao Paulo Vascular & Endovascular Surgery Institute, Brazil) discussed lessons learned in the use of the sandwich technique (ST) for hypogastric artery (HA) revascularisation during aortoiliac aneurysm (AIA) repair. Techniques to preserve HA patency have developed in response to the complications of its interruption, including buttock claudication, ischaemic colitis, neurologic deficits, bowel or bladder dysfunction, and erectile dysfunction.[2]

Robalo *et al*. (2018) recently reviewed endovascular HA preservation strategies, including the bell-bottom technique, iliac branch devices and parallel grafts including the sandwich and chimney techniques. Encouraging short and mid-term outcomes come from four small studies, wherein patients' complex anatomies precluded the performance of standard EVAR.[3]

In 2013, Dr Lobato and Luciana Camacho-Lobato reported on a series of 40 consecutive patients treated electively at the São Paulo Vascular and Endovascular Surgery Institute with the ST between 2008 and 2011 for complex AIA, isolated common iliac artery aneurysms, and abdominal aortic aneurysms with bilateral short, non-diseased common iliac artery, ineligible for standard EVAR.

Over a mean follow-up period of 12 ± 4.4 months, HA aneurysm repair technical success rate was 100%. Primary patency rate was 93.8% on account of three HA occlusions, occurring early in the study. Early- and late-related mortality rate was nil and late unrelated mortality rate was 2.5%. Iliac aneurysm sac evolution demonstrated a significant (at least 5-mm) decrease in diameter in 16 (34.8%) common iliac artery aneurysms, no change in 29 (63%) common iliac artery aneurysms, and an increase in one patient (2.2%).[4]

Dr Lobato spoke of an extended patient series of 151 HA revascularisations using the ST. He noted that, since the introduction of the ST in 2008, it has rapidly evolved to address all four types of complex aortic and/or iliac aneurysms. "The concept of this technique is based on the trihedron of feasibility, immediate availability, and cost-effectiveness," he said.

"The ST was primarily developed to overcome anatomical and device constraints that limited the endovascular approach in either elective or urgent settings. "Over 10 years, the sandwich technique has proved safe, long-lasting, and unparalleled with regards to low rates of spinal cord ischaemia, flexibility to allow the surgeon to use any available stent graft and use in the urgent or emergent settings for aortic arch, thoracoabdominal, aortoiliac and isolated iliac aneurysms endovascular repair. Due to these specific characteristics the ST, itself or with some technical variations, has been widely used in all five continents of the earth."

"The concept of this technique is based on the trihedron of feasibility, immediate availability, and cost-effectiveness."

Armando C Lobato

Dr Lobato listed exclusion criteria for the ST, including: < 4 mm diameter of target vessels (HA, or visceral arteries) poor runoff, shaggy aorta, left internal mammary artery (LIMA) bypass, and common iliac artery with lumen < 8 mm. Commenting on other techniques that address the demands of distal landing zone fixation in AIA cases extending to the HA, Dr Lobato turned first to iliac branch devices. He explained that placement of the endograft

side branch into the HA cannot be performed in the setting of tortuous anatomy, narrow lumen (common iliac artery lumen < 18 mm in diameter), or short common iliac arteries (< 40 mm in length) and HA aneurysm.

The anatomic suitability for the iliac branched device is disappointing, he added, with only 35% to 58% of AIAs appropriate for this device. Addressing branched and fenestrated techniques, he went on: "A similar technical skill set is required to successfully perform ST-EVAR and branched and fenestrated EVAR procedures. In some cases, the experience from the ST procedures served as a bailout strategy for the branched/fenestrated strategies. We believe that both techniques will have utility moving forward, given the downward-going renal artery issue, as well as the wait-time for the custom fenestrated graft."

He added: "Preoperative planning and three-dimensional software familiarity encompass a large portion of the learning curve for b/f-EVAR, and the technical limits of the procedure are related to successful and expeditious catheterization of renal arteries through fenestrations.

"Future and continued development of fenestrated and branched graft technology should focus on the challenges of misalignment of branches, difficult renal cannulation, and shrinking device calibre." During his presentation, Dr Lobato discussed procedural steps and tips and tricks for HA cannulation in complex EVAR. He recommended a percutaneous left brachial artery approach (90-cm, 7-F sheath) in combination with a bilateral femoral artery approach, with femoral accesses either open or percutaneous based on the surgeon's preference.

"Results have been similar in terms of mid-term durability and technical success rates in comparing with fenestrated and branched graft technology."

Armando C Lobato

A stepwise approach to AIA repair is taken. First, insertion of the main body of the bifurcated stent graft is undertaken through a femoral approach, leaving the distal end of the ipsilateral iliac limb 10 to 20 mm above the HA origin. The ipsilateral HA is then cannulated through the left brachial access. The distal end of a self-expanding covered stent is placed at least 2 cm inside the HA, and the iliac limb extension is positioned 10 mm below the proximal end of the self-expanding covered stent to overlap by at least 5 cm.

The iliac limb extension is then deployed and modelled using a latex balloon. The self-expanding covered stent is deployed, and a bare self-expandable stent is then deployed inside of it. Finally, the contralateral limb is then deployed in a similar fashion.[4]

Dr Lobato concluded: "The popularity of sandwich, chimney and snorkel techniques is in large part due to the theoretical advantages of having an off-the shelf device at significant lower cost. Results have been similar in terms of mid-term durability and technical success rates in comparing with fenestrated and branched graft technology."

References

1. CICE website. http://cice.com.br (accessed Jan 2019).
2. Lobato AC, Camacho-Lobato L, Cury M, Kolber C, Simão JR. Applying Sandwich Techniques for Complex Aortoiliac and Thoracoabdominal Aortic Aneurysms. Endovascular Today. 2016;15(3):82-8.
3. Robalo C, Sousa J, Mansilha A. Internal iliac artery preservation strategies in the endovascular treatment of aortoiliac aneurysms. Int Angiol. 2018;37(5):346-355.
4. Lobato AC, Camacho-Lobato L. The sandwich technique to treat complex aortoiliac or isolated iliac aneurysms: Results of midterm follow-up. J Vasc Surg. 2013;57(2 Suppl):26S-34S.

Encouraging data from Roadsaver & Renzan stents

Dual layer micromesh technologies, including the carotid Roadsaver stent (Terumo, Japan) and the peripheral Renzan stent (Terumo), were reported during a session supported with an educational grant from Terumo.

Opening the session, Stefan Müller-Hülsbeck (Academic Hospitals Flensburg, Kiel University, Germany) spoke of the influence of the Roadsaver stent on his carotid artery stenting (CAS) practise.

"We know that there are some unmet needs in the CAS market," he began. "One unmet need is sustained embolic protection."

Two-thirds of neurological events such as stroke and transient ischaemic attack (TIA) are post-procedural, he noted, suggesting that adequate plaque coverage by way of small-cell-sized stents could confer sustained embolic protection.

In 2014 Müller-Hülsbeck *et al*. evidenced the efficacy, reliability and safety of closed-cell stents in a series of patients with symptomatic internal carotid stenoses, finding them to confer a low rate of complications in the absence of cerebral embolic protection[1].

He commented that the Roadsaver's design confers a smaller cell size relative to its contemporary competitors. "The inner and outer layers together makes the dual-layered braided stent technology and micromesh technology possible," he explained. These features may limit plaque prolapse and embolic release, while retaining conformability and flexibility.

"In Flensburg, the Roadsaver is our workhorse."

Stefan Müller-Hülsbeck

In 2016, the Roadsaver was evaluated in the prospective, multinational, single-arm ClearRoad study, which included 100 subjects at high risk for carotid endarterectomy requiring revascularisation undergoing CAS. The Roadsaver stent was found to be safe and effective in this cohort, with 100% technical success achieved, along with a 30-day major adverse event (MAE) rate of 2.1%.[2]

Ruffino *et al*. (2016) also reported encouraging results on the Roadsaver stent, focusing on incidence of new ischaemic lesions in a single centre series of 23 patients, in each case employing distal embolic protection[3].

Professor Müller-Hülsbeck addressed the possibility that decreasing pore size increases thrombogenicity. Referring to ongoing clinical data from Flensburg between 2014 and 2018, including 139 patients (122 of whom were treated with the Roadsaver, 17 with the CGuard [Inspire MD, Israel]), he cited an overall 30-day stroke rate of 1.4%, with no strokes occurring in the asymptomatic patient subgroup. Furthermore, the restenosis rate in the overall cohort was 3.6% at 12 months (based in duplex ultrasound), and all these cases were asymptomatic.

"In our personal experience in Flensburg, the Roadsaver is our workhorse," he commented. Referring to the especially challenging acute stroke patient, he added: "We have to clear the brain of thrombus but we also have to treat a haemodynamically relevant lesion of the internal carotid artery. We have done that in 53 patients. We never observed an acute occlusion. In 1/53 patients we observed an asymptomatic occlusion within 12 months (1.9%)."

Detailing the stringent protocols behind such excellent patient outcomes in Flensburg, Professor Müller-Hülsbeck described elements of bridging therapy, antiplatelet regimens and post-procedural antiplatelets in both emergency and elective cases. Appropriate stent sizing is crucial, he said, both in terms of diameter and length, as well as continuous stent deployment: "Probably if you follow this concept, especially the patient preparation and the ongoing antiplatelet medication, the outcome will be excellent."

This has been demonstrated in several studies published so far, he said, as well as the 2018 meta-analysis by Sannino *et al*[4]. He also highlighted the ongoing prospective, single-arm, multicentre European observational ROADSAVER study, which aims to recruit 2000 patients with an estimated primary completion date of January 2020[5].

Summarising the Roadsaver

system's delivery features and benefits, he continued: "The stent is fully re-sheathable and repositionable even after 50% deployment. That means you are able to perform a really accurate placement of the stent. The delivery catheter is 5 F compatible and has a rather low profile. This has advantages especially in terms of crossability."

He concluded: "We switched a long time ago from single- to dual-layer stents. It is prime time for the Roadsaver technology. Of utmost importance, if you use a new technology and perform CAS, is that you have another two ways of avoiding stroke – patient selection and operator experience."

In the same session, Piero Montorsi (University of Milan, and Centro Cardiologico Monzino, Milan, Italy) explored the role that different carotid stents and cerebral protection devices have on cerebral microembolism during CAS, in patients with high risk, lipid-rich plaque.

The study included 104 eligible subjects enrolled between 2016 and 2018, randomised to receive one of four possible paired combinations of the procedural variables, i.e. choice of carotid stent (Roadsaver vs Carotid Wallstent [Boston Scientific, USA]) and embolic protection (FilterWire [Boston Scientific] vs Mo.Ma [Medtronic, USA]).

The primary endpoint was

"The combination of Mo.Ma and Roadsaver performed significantly better than the combination of [FilterWire and Wallstent]."

Piero Montorsi

the number of microembolic signals (MES) from transcranial doppler, and secondary endpoints included in-hospital and 30-day major adverse cardiac and cerebrovascular events (MACCE), and technical and clinical success.

FilterWire and Mo.Ma were compared in terms of the primary endpoint of number of MES at initial procedural stages, prior to stent deployment, and during: target vessel access ($p = 0.503$); lesion crossing with wire/filter ($p < 0.0001$); lesion predilation ($p = 0.114$); and lesion crossing with stent ($p < 0.0001$).

Then, from stent deployment onwards, all four subject groups were compared as follows: during stent deployment (Mo.Ma vs FilterWire, $p < 0.001$; Roadsaver vs Wallstent, $p = 0.12$); during stent postdilation (Mo.Ma vs FilterWire, $p < 0.001$; Roadsaver vs Wallstent, $p = 0.33$); and during FilterWire or Mo.Ma retrieval (Mo.Ma vs FilterWire, $p = 0.006$; Roadsaver vs Wallstent, $p = 0.15$).

The investigators then compared the mean MES over these three steps, which revealed statistically significant superiority of Roadsaver over the Wallstent ($p = 0.031$), along with Mo.Ma over FilterWire ($p < 0.001$). Including MES data recorded in between procedural steps further increased the significance of the difference between the Roadsaver and Wallstent ($p = 0.026$).

Secondary endpoints did not differ both in short-term and six-month follow-up.

Dr Montorsi concluded: "The combination of Mo.Ma and Roadsaver performed significantly better than the combination of the other two."

Presenting the Roadsaver experience at the John Paul II Hospital in Krakow (Poland), Piotr Odrowaz-Pieniazek described how his centre achieves excellence in terms of technical success and complication rates.

"For many years we have carried out tailored CAS. We select neuroprotection devices and stent type according to plaque morphology and symptoms of the patient," he told delegates.

"From 2014, however, we changed our strategy. We started to treat high-risk CAS with the Roadsaver stent, due to the extremely low cell area of this stent... Our main goal was sustained anti-embolic protection."

He presented data accumulated between 2014 to 2018, pertaining to 213 CAS procedures, of which 162 (76.1%) of lesions were deemed high risk, and 68 patients (31.9%) were symptomatic.

In this cohort, in-hospital and 30-day complication rate was 1.4%. Kaplan-Meier analyses of all-cause and cardiovascular survival rates over a mean of 1,460 days (nearly three years) found survival rates of 84.0% and 90.4%, respectively. There was no difference between symptomatic and asymptomatic patients.

Dr Odrowaz-Pieniazek

"We started to treat high-risk CAS with the Roadsaver stent, due to the extremely low cell area of this stent."

Piotr Odrowaz-Pieniazek

commented: "Why do we achieve such fantastic results? It is because we have excellent devices now."

He further commented on the limited availability of proximal protection in some institutions,

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Encouraging data from Roadsaver & Renzan stents

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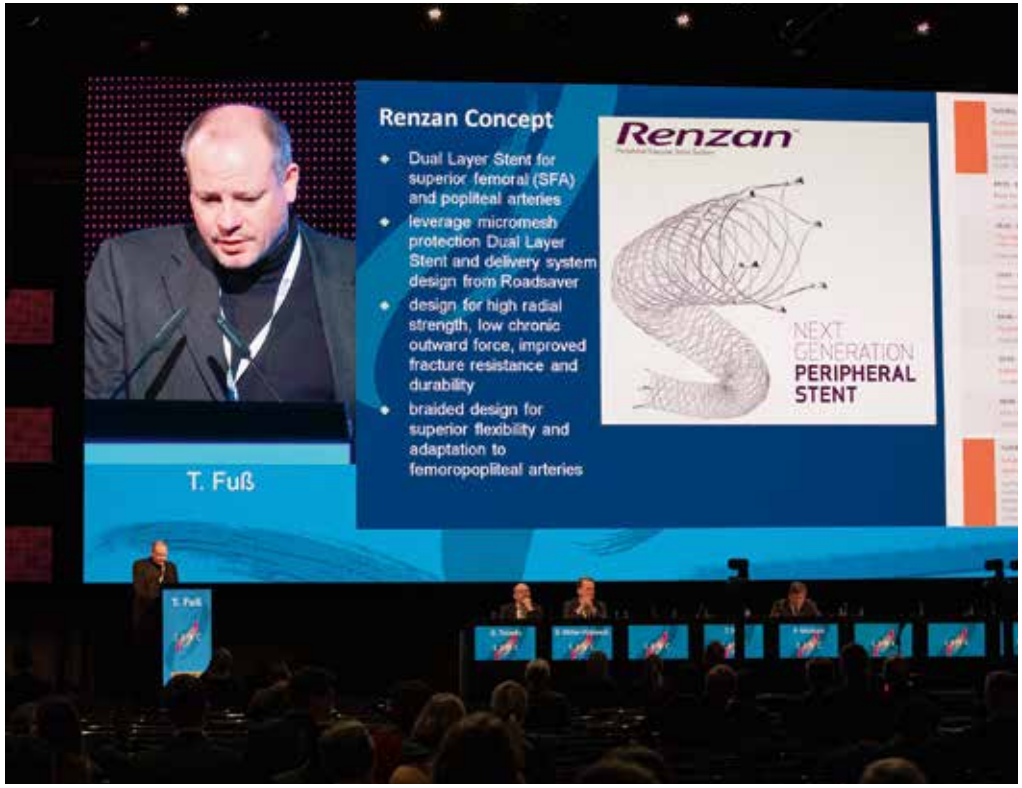
advising: "Triple protection in high risk patients can be done safely. Distal protection with filter or mesh, Roadsaver stent and Paladin [Contego Medical, USA] for post-dilatation can work. [This gives] very easy access and retrieval of the Paladin within the Roadsaver."

Dr Odrowaz-Pieniazek was also critical of 2017 ESC Guidelines on the diagnosis and treatment of peripheral artery disease, in which acceptable stroke/death rates are given as < 3% in asymptomatic patients and < 6% in symptomatic patients. "In 24 years, CAS technology has changed a lot. However, the guidelines for acceptable complication rates are still from the previous century.

"If you still have complications around 3% in asymptomatic and 6% in symptomatic patients, stop your carotid CAS program immediately," he said in his concluding statements, adding: "But the best treatment strategy for CAS in 2019 is Mo.Ma embolic protection and the Roadsaver stent."

Torsten Fuß (Vascular Centre of Elblandclinic Radebeul & Riesa, Germany) gave his latest insights on the use of dual layer micromesh stents in the peripheral vessels. The Renzan stent (Terumo), he said, is very similar to the Roadsaver in terms of design and delivery, but differs in aspects allowing it to conform to the femoropopliteal territory, combining flexibility and fracture resistance.



The Renzan catheter has a working length of 130 cm, he described, and is suitable for both antegrade and retrograde techniques. With a rapid exchange construction, the stent is fully repositionable within up to 50% deployment. The delivery catheter includes a radioopaque tip and distal and proximal markers.

Preclinical data include fatigue testing, and ovine and porcine studies. To date, Dr Fuß and colleagues have implanted Renzan stents in seven real-world patients, including four with occlusions of 4–8 cm, within the femoropopliteal, common femoral and iliac arteries, including up to 12 weeks of follow-up.

"We have very good early results [with Renzan]."

Torsten Fuß

"We saw, in all case, very good performance from this stent, with good visibility, easy, safe and correct placement. We had very good performance in complex lesions, lesions with severe calcification and severe recoil and in challenging lesions with tortuous anatomy.

"We haven't seen any peripheral embolisation in lesions with soft plaques or soft occlusions, and no occlusions of important side branches. We have very good early results, after four weeks and three months, without restenosis, early thrombosis or reocclusion under dual antiplatelet therapy for four weeks. But very important, if you want to implant these kinds of stents, is aggressive vessel preparation."

Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

References

1. Hopf-Jensen S, Marques L, Preiß M, Müller-Hülsbeck S. Lesion-Related Carotid Angioplasty and Stenting with Closed-Cell Design without Embolic Protection Devices in High-Risk Elderly Patients-Can This Concept Work Out? A Single Center Experience Focusing on Stent Design. Int J Angiol. 2014;23(4):263–70.
2. Bosiers M, Deloose K, Torsello G, Scheinert D, Maene L, Peeters P *et al*. The CLEAR-ROAD study: evaluation of a new dual layer micromesh stent system for the carotid artery. EuroIntervention. 2016;12(5):e671–6.
3. Ruffino MA, Faletti R, Bergamasco L, Fonio P, Righi D. Incidence of New Ischaemic Brain Lesions After Carotid Artery Stenting with the Micromesh Roadsaver Carotid Artery Stent: A Prospective Single-Centre Study. Cardiovasc Intervent Radiol. 2016;39(11):1541–1549.
4. Sannino A, Giugliano G, Toscano E, Schiattarella GG, Franzone A, Tesorio T *et al*. Double layered stents for carotid angioplasty: A meta-analysis of available clinical data. Catheter Cardiovasc Interv. 2018;91(4):751–757.
5. Observational Study to Confirm Safety and Efficacy of the ROADSAVER Stent for the Treatment of Carotid Artery Stenosis (ROADSAVER). ClinicalTrials.gov. https://clinicaltrials.gov/ct2/show/NCT03504228 (accessed Mar 2019).

BEST-CLI trial: How will it change our practice?

Matthew T Menard (Brigham and Women's Hospital, Boston, MA, USA) took to the podium to introduce the BEST-CLI (Best Endovascular versus Best Surgical Therapy in patients with Critical Limb Ischemia) trial[1], which aims to address the evidence shortfall within the treatment of critical limb ischaemia (CLI).

Offering a glimpse of his presentation to *LINC Review*, Dr Menard – co-Principle Investigator of BEST-CLI – framed the need for such a trial. Complications of atherosclerosis are the leading cause of morbidity and death in the United States, he began, with peripheral arterial disease (PAD) rapidly growing into a global epidemic, in large part driven by markedly increasing rates of diabetes.

Indeed, he added that there are substantial health-care and societal costs associated with the management of CLI, and the price tag for caring for CLI patients is expected to further escalate given current demographic and disease trends. Therefore, the need for high value clinical data such as BEST-CLI to help guide clinical decision making has never been higher, he reasoned.

***LINC Review* sat down with Dr Menard to explore more about the trial.**

Looking to the data, is there is a paucity of knowledge in how to treat CLI when compared to other areas of clinical therapy?

Unlike our counterparts in the fields of cardiology, where large randomised controlled trials are routinely carried out to answer specific clinical treatment problems, there is a stark paucity of Level I evidence to help vascular specialists decide what treatment strategies are optimal for patients with PAD and CLI.

Apart from the BASIL trial, which is now over 15 years old, there are no randomised trials comparing common treatment options for CLI. As a result, there is a notably high degree of variability in how patients are managed, and the consequence is that the treatment a given patient receives is largely determined by the individual biases of the treating physician, which in turn are determined by where they trained, who they were trained by, their particular subspecialty, their individual skillsets, and the resources available to them at their hospital.

The mainstay treatment for PAD involves revascularisation to improve limb perfusion. Open surgical bypass has historically been the gold-standard treatment option for occlusive disease of the legs, and is associated with excellent limb salvage rates and clinical durability.

Over the course of the last two decades, endovascular interventions have become more common. Dramatic technologic advances have made this modality applicable to more patients and associated complication rates and morbidity have fallen as technical success has increased and clinical outcomes have improved. However, the steady pace of innovation and the increasing enthusiasm to utilise and adopt new technologies has unfortunately not always been matched or supported by a strong evidence base.

There is a substantial subset of patients who are thought to be appropriate candidates for either surgical or endovascular treatment options, and there persists a lack of consensus as to the best first therapeutic approach for this group. Some physicians and institutions have a strong inclination towards surgical bypass, whereas others have a decided preference to attempt percutaneous revascularisation initially. The end result of this lack of evidence-based standardisation of care is a persistently high degree of clinical equipoise, and a strong desire for high quality data to clarify the current confusion.

How is BEST-CLI set to provide answers? Could you introduce the trial, its design and goals?

The trial, supported fully by the National Institutes of Health, will randomise 2,100 patients at 140 clinical centres. It began focused on the United States and Canada, but has expanded internationally to include sites in Finland, Italy and New Zealand. I am excited to report that we have enrolled 80% of our target sample size to date.

There are three main outcomes of interest: clinical outcomes associated with each treatment arm, quality of life (or how the patients experience the care that they received), and perhaps most importantly, cost and cost-effectiveness. In an era when health care expenses are ballooning and resources are in short supply, it is imperative that we fully understand the short-, intermediate- and long-term cost implications of our treatment decisions.

The trial encompasses two independently-powered randomised cohorts. The largest includes patients who have a good segment of saphenous vein and the second, smaller cohort, includes all of those who do not. This schema allows us to mimic the real-world clinical situations that we routinely see when evaluating CLI patients.

All patients enrolled into the trial have been deemed to be appropriate candidates for both open surgical bypass and for endovascular therapy. The trial has a pragmatic design, which means that each investigator is free to use whatever treatment strategy they prefer. This feature makes for a messier trial with more data variability but guards against the trial results becoming obsolete or less relevant over time, which is particularly important during a time marked by constant technological change.

We chose major adverse limb event (MALE)-free survival as our primary efficacy endpoint. This is a new endpoint that we purposely selected after much deliberation as we thought it was much better at capturing the clinical consequences of the chosen treatment strategy than the more commonly used amputation-free survival (AFS). Accurately assessing limb-related

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morbidity and the need for re-intervention is of paramount importance in a trial comparing revascularisation strategies.

We also have a number of important secondary endpoints. These include AFS, as well as novel endpoints such as freedom from CLI, CLI-free survival (which attempts to mirror tumour-free survival in the cancer world), freedom from re-intervention, number of interventions per limb salvaged, and freedom from haemodynamic failure, which notably captures the durability of the haemodynamic improvement gained with each treatment strategy.

"There is a stark paucity of Level 1 evidence to help vascular specialists decide what treatment strategies are optimal for patients with PAD and CLI."

Matthew T Menard

Two unique features of BEST-CLI are its fully multi-disciplinary nature, and our promotion and propagation of CLI teams. Everyone who is involved in the care of CLI patients at each participating institution, including vascular surgeons, interventional radiologists and interventional cardiologists, was invited to join the trial. There is also a requirement that each patient enrolled must first be reviewed by at least two members of the site-specific multi-specialty CLI team. This has actually changed the way care is delivered at centres that have fully embraced this as a positive model of how to treat what are typically quite complex CLI patients, analogous to the highly successful and now standard multi-disciplinary approach to cancer care.

What have been some of the challenges?

We have encountered a number of challenges throughout the course of the trial, including competing trials which often have more generous enrolment-related payments than the government-sponsored BEST-CLI can afford to pay, the well-recognised hassle factor that comes with the participation in a trial as complex as BEST-CLI, and so-called "trial fatigue" that can come from maintaining a high degree of engagement over the length of the trial, to name a few.

Probably the biggest obstacle, however, has been getting investigators to let go of their pre-conceived treatment biases, and realise that their initial treatment impulses are often not based on solid evidence. We are very grateful to the participating investigators, whose hard work in overcoming the many barriers they have faced is directly responsible for the success we have had to date, and we know will carry us through the approaching finish line.

We do have a carefully thought out credentialing process, and have worked hard to draw the line for inclusion into the trial at the appropriate mark. Our aim was to include everyone who routinely and competently cares for CLI patients, while excluding those who do not have the requisite technical skillset to treat challenging CLI patients or see CLI patients at an appropriate volume. Investigators are approved to provide open surgical revascularisation, endovascular revascularisation or both.

You mention in your presentation title how BEST-CLI will "change our practice". Can you share your take-home message here?

It is my hope, along with that of my fellow Principal Investigators Kenny Rosenfield and Alik Farber, that the data we are collecting in BEST-CLI will truly help each of us better care for the CLI patients we seeing in our clinics and hospitals. There is a real need for information on clinical outcomes that is specific to the treatment strategies that we routinely use, and we can no longer afford to practice without a better sense of what we are getting for the extremely expensive care we are providing to the CLI patient population.

It is also our hope that BEST-CLI will set the stage for a whole new generation of trials that will better hone down on more specific questions that desperately need answers. It has been illuminating and gratifying to see how much engagement and interest there has been in BEST-CLI, which I think speaks to how much work we have to do to reach the goal of truly informed, data-driven evidence-based medicine.

BEST-CLI is part of a growing interest and newly energized dialogue on all things PAD. Helping to raise awareness of the global health care epidemic of CLI has been a consequential secondary benefit of the trial.

References

1. Menard MT, Farber A, Assmann SF, Choudhry NK, Conte MS, Creager MA *et al*. Design and Rationale of the Best Endovascular Versus Best Surgical Therapy for Patients With Critical Limb Ischemia (BEST-CLI) Trial. J Am Heart Assoc. 2016;5:e003219.

DABRA Atherectomy System achieves 98% success

The photochemical DABRA (Destruction of Arteriosclerotic Blockages by laser Radiation Ablation) atherectomy system, (Ra Medical Systems, USA) achieved successful debulking in 98% of lesions in a 52-patient single centre cohort study, the LINC audience heard.

Ashok Kondur, Program Director, Cardiovascular Medicine Fellowship and Chief of Cardiovascular Disease, Garden City Hospital, Michigan, USA, relayed that the new device, launched in 2017, ablates a channel in vascular blockages above- and below-the-knee (ATK/BTK), treating all plaque types, including calcium, thrombus and atheroma. The mechanism of action is non thermal, he added, harnessing photochemical plaque ablation, and producing no unwanted acoustic, mechanical or clinically significant by-products.

The objective of the prospective pilot study was to evaluate the use of the DABRA Atherectomy System in patients with ATK and BTK disease. A total of 52 patients with 111 lesions were treated with DABRA between April and November 2018.

Patient characteristics included older, sicker patients – all of whom had Rutherford 4–6 disease. Furthermore, 54% of the patients had diabetes, 88% were smokers and 69% had coronary artery disease. One third of patients had suffered a heart attack previously.

"Successful debulking with the DABRA Atherectomy System was achieved in 98% of lesions."

Ashok Kondur MD, FACC

The baseline lesion characteristics were very challenging, with 68% of lesions ATK, and a median length of 30 cm. Eighty percent of lesions had moderate to severe calcification, median percent stenosis was 93% and of those 49% were total occlusions. Critical limb ischemia, defined as ABI <0.5, had been diagnosed in 38% of the patients.

Intravascular ultrasound (IVUS) and/or angiography was used pre- and post- treatment to evaluate change in % diameter stenosis. Pre- and post- ankle brachial index (ABI) were also evaluated; post-ABIs were performed four to six weeks after the procedure.

Dr Kondur, summing up the main findings of the research, concluded: "Successful debulking with the DABRA Atherectomy System was achieved in 98% of lesions. The percentage of patients with haemodynamic success – defined as ≥ 0.15 increase in ABI – was 68%."

A significant change in pre- and post- % diameter stenosis was also found, added Dr Kondur, achieving a 98% lesion success rate.

"There was also a very low complication rate; we had just one patient with an arteriovenous fistula and a perforation which was quickly resolved," Dr Kondur relayed.

"Patients were treated with DABRA and percutaneous transluminal angioplasty (PTA) and no adjunctive stenting was performed, so it is an economically viable treatment option."

A prime limitation of the study, Dr Kondur conceded, was its single-centre design.

Speaking to the *LINC Review*, Dr Elias Kassab, President and CEO, Michigan Outpatient Vascular Institute (MOVI), Dearborn, Michigan, USA and Lead Investigator of the study, told *LINC Review*: "We have found that DABRA is very successful in treating a very challenging group of patients – a population with long lesions that were severely calcified, and most of them with both ATK and BTK disease.

"We have found that DABRA is very successful in treating a very challenging group of patients."

Elias Kassab
MD, FACC, FSCAI, FACP, FASA, RPVI, FAHA, FSVM

"DABRA has very good debulking ability because of its design – the catheter delivers a 100% ablative surface and energy is distributed evenly and efficiently to the tissue. Although these findings are from only 52 patients, they are very promising and strengthen the case for proceeding with more extensive case studies. The company has now initiated plans to look at setting up a registry of DABRA cases."

New treatments for varicose veins

During a Deep dive session on endovenous therapies (part II), Anina Lukhaup, an angiologist and specialist in phlebology from Munich, Germany, spoke of her experience in varicose vein treatment. "It's an important issue. Varicose veins are such a widespread disease and can lead to serious complications such as ulcer cruris, a chronic wound of the lower leg with low healing rate," she explained.

The treatment possibilities for varicose veins have changed greatly over the last 20 years, continued Dr Lukhaup. "Currently we already have very safe and efficient minimally invasive treatment options for varicosis. Despite that, in Germany at least, the vast majority of patients undergo surgical crossectomy, or stripping of the vein," she said.

In other countries, however, there has been a shift towards less invasive endovenous treatments. In the UK and US, those alternatives are already recommended as first-line treatments, and are what most patients will receive, she said. Fortunately, said Dr Lukhaup, there have been many technical developments recently. "Within the last few years there's been a progression of laser technologies and the introduction of cyanoacrylate glue," she explained.

That being said, there are still limitations to these particular treatment methods. "Not all vessel anatomies are suitable for endovenous treatment.

"These really are promising new developments and I am positive that some of them will lead to faster, even less invasive and more gentle varicose vein treatments."

Anina Lukhaup

Widespread thermal treatment methods, such as radiofrequency or laser ablation may lead to thermal nerve lesions and therefore require tumescent anaesthesia," she cautioned. "This is why I am so interested in new developments."

Dr Lukhaup discussed three promising new devices in her presentation. Two launched in recent months. The other, though available on the market, is without certification. "I hope they will lead to the further spread of less-invasive methods and enable us to treat more patients safely whilst also making treatments easier and faster for the physician," she said.

The first device is highly-focused ultrasound (HIFU). If it takes off, said Dr Lukhaup, it would be the first time this technique is used in varicose vein treatment. "This device is already used for the treatment of nodes in the thyroid and for the treatment of fibroadenoma, a benign tumour," she explained. "But currently there is no certification for vein treatment."

HIFU is of particular interest because of ongoing research to discover viable methods for treating more challenging varicose veins. Take insufficient perforator veins that often lead to non-healing ulcers, for example. "The technique is especially interesting because it could be a non-invasive alternative treatment when other possibilities are excluded," said Dr Lukhaup.

Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

An invasive treatment is extremely difficult to perform beneath a chronic and sometimes inflamed wound. "It risks progressing the inflammation," she said. "HIFU is an externally non-invasive treatment, so may be used in non-sterile skin conditions."

A second device is the Venclose RF Ablation System (Venclose, USA). "It is a new treatment tool, a more flexible, thinner radiofrequency ablation catheter with a changeable length heating tip that reduces treatment time and leads to more flexibility in terms of which vessel anatomies are suitable," said Dr Lukhaup. "It can be used with smaller sheaths, which makes the intervention less invasive and more flexible."

Perhaps the most interesting development is the Simla 6 1940 nm laser (IMS, Germany), which is the latest version of an existing laser. "It's a new laser with a longer wavelength and has promising study results regarding efficacy and safety," said Dr Lukhaup. "It seems to be less invasive than the existing 1470 nm laser, works with less energy and yet can be more focused, so the heat in the surrounding tissue is lower."

That might make the procedure less painful, she added, allowing laser ablation with much less or even zero tumescent anaesthesia. "This would also save treatment times and eliminate PE and thermal nerve lesions."

The hope is, therefore, that these devices and others like them begin to gain traction in varicose vein treatment. "These really are promising new developments and I am positive that some of them will lead to faster, even less invasive and more gentle varicose vein treatments," concluded Dr Lukhaup.

"Currently we already have very safe and efficient minimally invasive treatment options for varicosis. Despite that ... the vast majority of patients undergo surgical crossectomy, or stripping of the vein."

Anina Lukhaup

Safe, successful and cost effective: Rotarex®S and Aspirex®S

Rotarex®S

Atherectomy with thrombectomy of occluded femoropopliteal arteries using Rotarex®S is safe and effective, minimising the need for stents, and reducing the length of implanted stents to much less than the entire lesion length, according to some of the latest data presented at a Straub-sponsored symposium.

Christian Wissgott (Institute for Diagnostic and Interventional Radiology, Heide, Germany) were initial results from a retrospective analysis of the use of the Rotarex®S atherectomy and thrombectomy device in patients with acute, subacute and chronic lower limb artery occlusion, which he lead. He told *LINC Review*. "Good patency rates after 12 months can be achieved with Rotarex®S especially in combination with a drug-coated balloon (DCB) and/or stent," he said, adding that, "procedure-related complications were rare, and there were no distal embolisations which is especially important as this was done without using distal protection devices."

Other speakers included Bruno Freitas (Leipzig, Germany), and Michael Lichtenberg (Arnsberg Clinic, Germany). Dr Lichtenberg focused on results from the Arnsberg Clinic Registry examining safety and efficacy in patients with thrombotic or thromboembolic occlusions treated with Aspirex®S. He also presented results of a meta-analysis comparing different therapies and outcomes including catheter-directed thrombolysis (CDT) therapy with pharmaco-mechanical and pure mechanical thrombectomy, for the first time.

Straub Medical's endovascular rotational catheter atherectomy and thrombectomy systems, Rotarex®S and Aspirex®S, were discussed for their ability to restore blood flow in occluded blood vessels by mechanically breaking up thrombus and the underlying atheroma, then aspirating and transporting the debris via the catheter into a collecting bag outside of the patients' body. As a strong and rapid mechanical atherectomy and thrombectomy device, Rotarex® S is used in occlusions of native arteries, occluded stents and occluded bypass grafts, whilst the Aspirex®S offers the same effective solution for venous systems. Occlusions can be crossed at a rate of up to 1 cm per second, depending on the composition of the occluding material.

Mechanical atherectomy with thrombectomy reduces hospital stay with fewer complications

"From a health economic point of view, studies on femoropopliteal arteries have shown that the use of mechanical thrombectomy, versus lytics, can reduce the length of a patient's stay in the hospital as well as intervention time," remarked Dr Wissgott, recognising the high importance of cost effectiveness in clinical decision-making today. Referring to the potential benefits of using mechanical atherectomy with thrombectomy, he noted that in a study he published in 2008[1] showed that using Rotarex®S can reduce mean hospital stay to 2.3 days compared to CDT therapy where the mean stay was 8.5 days.

In conversation with *LINC Review*, he explained that the main issue with treatment was the characterisation of the arterial occlusion, including determination of acute versus subacute versus chronic lesion type, short versus long culprit lesion, and embolic versus thrombotic. "Depending on these criteria, you choose the best endovascular tool for the job. This might be angioplasty and/or stenting, or atherectomy with thrombectomy," he said, adding that, "the Rotarex®S is a fit for all."

To provide some evidence to support the decision-making involved, Dr. Wissgott decided to evaluate the safety and effectiveness of the Rotarex®S atherectomy and thrombectomy device for the treatment of acute, subacute and chronic native femoropopliteal artery occlusions in a retrospective analysis of 237 patients treated with Rotarex®S between 2013 and 2018 at his hospital in Heide.

All occlusions treated in the retrospective study were in native femoropopliteal arteries. Of these, 77 were acute, 103 subacute, and 57 chronic. Two-thirds of patients had diabetes mellitus, and four out of five were smokers. In the acute lesions, length averaged 19.6 cm, in the subacute, 15.0 cm, and in the chronic 12.9 cm. Lesions were

"We found no bleeding complications with pure mechanical thrombectomy so it was significantly safer than CDT. With at least similar efficacy compared to CDT, mechanical thrombectomy is a clear step forward for treatment of iliofemoral DVT."

Michael Lichtenberg

long and occluded with one-in-10 being an isolated popliteal artery. In the sub-acute group, 36.9% had chronic limb ischaemia (CLI), while in the chronic group, 40.4% had CLI.

"The analysis showed Rotarex®S delivered a highly successful, rapid procedure avoiding costly thrombolysis and resulted in a significant reduction in the stenting rate," commented Dr Wissgott. "Technical success was 100% in the acute lesions, 99% in the sub-acute, and 96.4% in the chronic. Treatment time varied between 53 to 67 minutes; adjunctive stenting was between 16.8% and 21%; and stent length between 72 mm and 85 mm; and there were only three perforations.

"Twelve-month results, in combination with a drug-coated balloon are good and the complication rate was very low with Rotarex®S," reported Dr Wissgott, adding that, "the typical adjunctive stenting rate in these types of lesions is 40-50% but in this study it was around 20%."

There was a considerable difference between the initial lesion length and the stent length. The mean lesion length for acute lesions was 22.5 cm versus stent length 7.2 cm; the mean lesion length for subacute lesions was 18.9 cm while the stent length was 8.3 cm; and the mean lesion length for chronic lesions was 15.2 cm while the stent length was 8.5 cm. "At 30 days, there were no distal embolisations with Rotarex®S and importantly no distal embolisation filters were used. There was an avoidance of costly thrombolysis, and no major adverse events," he remarked.

"Rotarex®S with adjunctive DCB and/or stenting resulted in high primary patency rates at 12-months," he added. These 12-month rates were 71.4%, 73.6%, and 81.2% for acute, subacute and chronic lesions respectively. Rotarex®S with adjunctive DCB and/or stenting resulted in low clinically-driven target lesion revascularisation (CD-TLR) rates at 12-months of 85.7%, 83.9%, and 93.8% in acute, subacute and chronic lesions respectively.

Arnsberg Clinic Registry of Aspirex®S in acute thrombotic and thromboembolic occlusions

Dr Lichtenberg discussed the treatment of iliofemoral deep vein thrombosis (DVT). He highlighted that this novel thrombectomy device has the potential to perform a one-step approach to treatment.

Explaining the risk of developing post-thrombotic syndrome (PTS) following an acute iliofemoral DVT, he said 25% of patients experienced PTS (ATTRACT 28%), with 5–10% having severe PTS.

In the US, more than 600,000 patients per year develop DVT and despite the use of appropriate medications, around 40% of patients with DVT will go on to develop PTS. PTS is characterised by chronic pain and swelling and has a significant effect on a patient's quality of life, with moderate to severe PTS (in 5–10% of patients) potentially causing major disabilities, including venous claudication and venous ulcers.

ATTRACT [Acute Venous Thrombosis: Thrombus Removal with Adjunctive Catheter-Directed Thrombolysis, an National Institute of Health sponsored trial] was a multi-centre RCT in 692 patients with acute DVT located above the knee. The landmark study was performed in 56 hospitals in the US.

"The ATTRACT randomised trial compared a conservative therapy for DVT and endovascular therapy. At the time of publication, they said there were no advantages to endovascular therapy," remarked Dr Lichtenberg, "but now differences in outcomes in a subgroup have been found, published in December 2018[2], showing a clear benefit in patients who underwent the endovascular approach. This applied to the incidence of PTS, severity of PTS, reflux and persistent swelling. Now we have evidence that endovascular treatment is in favour of preventing PTS especially severe PTS in patients with iliofemoral DVT."

"We now have much better endovascular therapies available like Aspirex®S for treating iliofemoral DVTs," he said, adding that, "the most common therapy is, until recently, local lysis therapy into the vein over one to two days, which can itself cause bleeding complications, and the patient may require intensive care which is labour-intensive and costly. Pure mechanical thrombectomy devices like Aspirex®S just use physical principles to remove the clot."

Dr Lichtenberg reported on a registry of 56 patients from the Arnsberg Clinic where high safety and efficacy were demonstrated with Aspirex®S. Patients were included with acute iliofemoral DVT (pain onset < 14 days), with a follow-up period of 12 months.

He highlighted that the main advantage was that Aspirex®S offered a one-step approach to treatment. A patient does not have to be admitted to the intensive care unit, and they do not need daily monitoring. The patient is placed on the table, the clot is removed with Aspirex®S, and any underlying causes, for example, compression

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Safe, successful and cost effective: Rotarex®S and Aspirex®S

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syndrome, PTS, or May-Thurner syndrome in the iliac vein, are stented" said the angiologist. "The patient usually stays in hospital for only one or two days, which is less than for a patient treated with lytic therapy. Patients also benefit from a much lower risk of bleeding complications," said Dr Lichtenberg.

Patient demographics for the registry included mean age was 55 years, 66% were female, 23% were current or former smokers, 50% had hypertension, 38% used the oral contraceptive. Acute lesions were present in 71%, subacute in 23%, and chronic in 6%. A total of 53% had underlying May-Thurner syndrome. Mean lesion length was 15.7 cm.

The stent rate in the Arnsberg Aspirex Registry was 100% because they found underlying causes for the DVT using intravascular ultrasound in all cases.

The mean patency rate at 12 months, was 87%. Patients were found moderate to severe PTS 12-months after DVT. However, he admitted that longer follow-up was needed.

In terms of safety, there were no device-related complications. Procedure-related complications including puncture site bleeding and haematoma seen in 20% of patients. Procedure-related adverse events occurred in 14% of patients and these included re-hospitalisation, re-occlusion of target vein, and prolonged hospitalisation because of arteriovenous (AV)-fistula operation. No device malfunction was reported. Only 5% of patients spent any time on an intensive care unit.

"The analysis showed Rotarex®S delivered a highly successful, rapid procedure avoiding costly thrombolysis and resulting in a significant reduction in stenting rate. Technical success was 100% in the acute lesions, and procedure-related complications were rare, and there were no distal embolisations especially important as this was without using distal protection devices."

Christian Wissgott

Aspirex®S is a very fast clot-removal system that can be hooked up quickly. "Our experienced team only needs two or three minutes for this. With a 10 F device, which is what we mainly used in the study, we can aspirate up to 130 ml per minute, and this is effected using the Archimedes principle which underpins this catheter."

Dr Lichtenberg conducted a meta-analysis comparing all different therapies and outcomes including CDT therapy with pharmaco-mechanical and pure mechanical thrombectomy. "We found no bleeding complications with pure mechanical thrombectomy so it was significantly safer than CDT, with at least similar efficacy compared to CDT. Mechanical thrombectomy is a clear step forward for treatment of iliofemoral DVT. This meta-analysis was presented at LINC for the first time."

Rotarex®S and Aspirex®S technical details

Rotarex®S: Efficient, quick

and easy to use for arterial occlusions

The Rotarex®S family of catheters are over-the-wire, single use, percutaneous devices for the treatment of occlusions in arterial vasculature. The catheters consist of a flexible outer covering, a rotating head, and a rotating helix, which runs the length of the catheter. A lumen for the passage of the supplied guidewire runs the entire length of the helix and through the head of the catheter. This head is made up of two overlying metal cylinders, with two side openings. The outer cylinder is connected to the rotating helix, and the inner cylinder to the catheter shaft. The helix and the catheter head rotate at approximately 40,000–60,000 rpm depending on the model, by means of a gear box in the catheter housing and a motor contained within the catheter handle driven by the drive system. Available as 6F, 8F or 10F catheters for a range of vessel diameters.

When in operation, both the helix and the outer catheter head rotate and are advanced along the guidewire toward an arterial occlusion. When an occlusion is met, the rotating head, with its small, blunt facets in its forward aspect, breaks down the occlusive material. At the same time, the rotation of the catheter head creates a vortex in the blood, which further erodes occluding material from the vessel lumen. By creating a negative pressure inside the catheter tube, the rotating helix acts as a conveyor screw upon which the ablated material is transported. The detached particles are drawn into the catheter through side windows in the head where they are further broken down and drawn out of the body and into the attached collecting bag under continuous aspiration.

The catheter or rotating head never come into contact with the vessel wall, and the catheter is designed in such a manner that when used as directed, over a guidewire and with adequate proximal blood flow, no wall damage would result if contact with a vessel wall should unintentionally occur.

Aspirex®S catheter for safe and effective removal of thrombus

The Aspirex®S catheter consists of a steel helix with a hydrophobic coating, which has a co-axial, central lumen for the guidewire, rotating inside a single-lumen braided catheter which has a smooth, rounded head, with an aperture fixed to the distal end of the catheter. The catheter is designed to ensure that, when functioning with the guidewire placed inside the lumen and an adequate blood flow, any unintentional contact with the wall will not cause damage to the vessel wall. Contact with the vessel wall is not necessary for the catheter to exert its effect. Available in 6F, 8F and 10F for a range of vessel diameters

Aspirex®S

The Straub Medical Drive System

The drive system, together with a gearbox in the catheter housing, automatically generate the revolution speed appropriate to the particular catheter, ranging between 40,000 and 60,000 rpm depending on the model. The rotating helix guarantees several functions of the catheter: it produces a strong negative pressure and acts as a conveyor screw for the material to be transported out of the body and into the collecting bag. The negative pressure produced is strong enough to aspirate all the fragments of occlusive material reliably into the catheter. The blood that is aspirated along with the fragments helps to cool the helix and catheter. Despite the strong aspiration, the patient's blood loss is limited to 45 ml/min with 6 F catheters, 75 ml/min with 8 F catheters and 130 ml/min with 10 F catheters. The catheter normally opens up to 1 cm of occluded segment per second, which ensures the patient's blood loss usually remains below clinical relevant levels, even in longer occluded segments. The catheters are delivered sterile and are available in usable lengths of 85 cm, 110 cm and 135 cm, depending on the model.

References

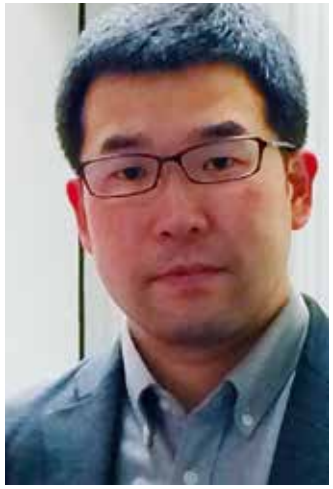
1. Wissgott, C, Kamusella P, *et al*. Treatment of acute femoropopliteal bypass graft occlusion: comparison of mechanical rotational thrombectomy with ultrasound-enhanced lysis. 2008. Rofo. 2008;180(6):547-52.
2. J. CA, Clive K, Chu-Shu G, *et al*. Endovascular Thrombus Removal for Acute Iliofemoral Deep Vein Thrombosis: Analysis from a Stratified Multicenter Randomized Trial. Circulation 2019;0.

JET@LINC explores developments in fem-pop, CLI and CTO

The JET@LINC session featured a range of presentations from Japanese perspectives. The Japan Endovascular Treatment (JET) Conference has become the largest conference on peripheral vascular intervention in Japan, with more than 2,000 delegates participating in recent years.

This year's session was overseen by Giancarlo Biamino (Clinica Montevergine, Mercogliano, Italy), Kazushi Urasawa (Cardiovascular Center, Tokeidai Memorial Hospital, Sapporo, Japan) and Hiroyoshi Yokoi (Fukuoka Sanno Hospital, Fukuoka, Japan). Proceedings began with a presentation by Michinao Tan (Cardiovascular Center, Tokeidai Memorial Hospital, Sapporo, Japan), who provided a review of developments in Japanese revascularisation techniques for femoropopliteal chronic total occlusions (CTO).

In conversation with *LINC Review*, he described recent developments in techniques for the treatment of femoropopliteal segment occlusions. He first discussed a novel anterolateral popliteal puncture technique, developed at the Cardiovascular Center at Tokeidai Memorial Hospital, for retrograde access to CTOs in the femoropopliteal segment. He and others explored the technique in a recent study



of 20 consecutive patients with symptomatic femoropopliteal occlusive disease. The technique was deemed a useful alternative retrograde access study given its success in all patients and absence of complications.[1]

> *"In our study, most patients had ≤ 1 runoff vessel and 45% of cases were Rutherford category ≥ 4."*
>
> **Michinao Tan**

"The anterolateral popliteal puncture technique was performed for the first time by my master, Dr Kazushi Urasawa, who is the president of JET 2019," said Dr Tan, going on to detail the procedure: "In this technique, a retrograde approach via the P3 segment is performed (Figure 1).

"First, an angiogram in an ipsilateral oblique (30–45°) view (i.e. right oblique view for the right popliteal artery) was taken to determine the appropriate puncture site (Figure 2). Under fluoroscopy guidance, a 10-cm-long, 20-G needle (Medikit, Japan) was inserted several cm below the superior tibiofibular joint on the body surface. While advancing the needle, the distance to the popliteal artery was periodically confirmed using fluoroscopy in a contralateral oblique (45–60°) view (Figure 3).

"During these procedures, contrast was injected to visualise the P3 segment; when appropriate, guidance via calcification was useful to reduce the need for contrast. After successful puncture, a 0.014-inch guidewire was advanced into the popliteal artery, and the needle was carefully extracted. Using a sheathless technique, a 2.6-F microcatheter was then introduced to support the 0.014-inch guidewire (Figure 4)."

Describing what the strengths and weaknesses are of various retrograde alternative techniques, Dr Tan noted that, while the conventional transpopliteal approach is one of the techniques that should be considered for retrograde access, it has several shortcomings. Notably, it demands that the patient changes to the prone position during the procedure. In contrast, he

Figure 1. Illustration of the P3 segment.

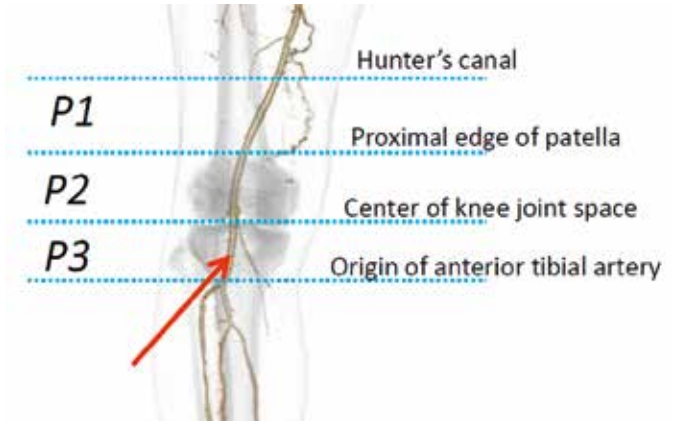
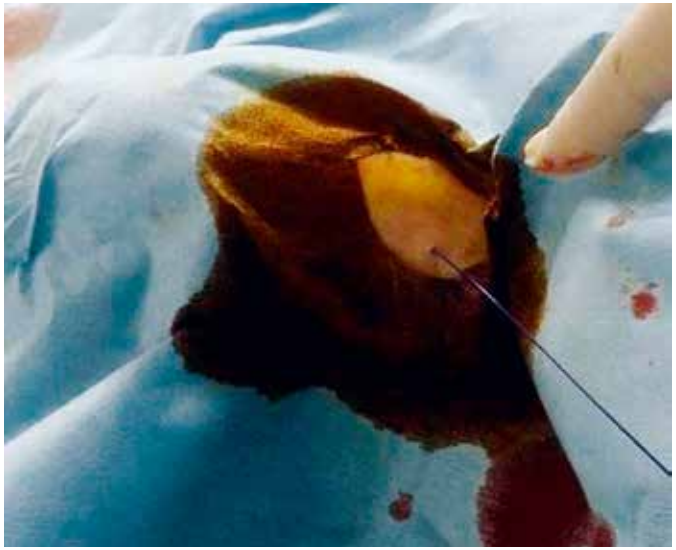


Figure 2. Determining the appropriate puncture site.



said, the anterolateral popliteal puncture technique enables access to the P3 segment of the popliteal artery in the supine position without the need to reposition the patient during the procedure. He continued to highlight important factors that suggest the feasibility of the anterolateral popliteal puncture with respect to other retrograde approaches:

"In the treatment of long occluded femoropopliteal disease, distal below-the- knee (BTK) arteries and the proximal anterior tibial artery are also common puncture sites. "In fact, a high anterior tibial puncture[2] is close to the P3 segment of the popliteal artery. Since conventional retrograde approaches via the BTK arteries require sufficient runoff, they are not feasible in patients with severe BTK lesions. In our study[1], most patients had ≤ 1 runoff vessel and 45% of cases were Rutherford category ≥ 4.

These characteristics discouraged us from performing conventional retrograde approaches via the BTK arteries for fear of blood flow deterioration due to vasospasm or injury to those vessels. Therefore, this technique is one option for retrograde access in patients with severe BTK lesions and with SFA CTOs that extend to the P2 segment. There were no puncture site complications, such as pseudoaneurysms, arteriovenous fistulas, hematomas, embolic complications, and nerve damage in our study."

"Since conventional retrograde approaches via the BTK arteries require sufficient runoff, they are not feasible in patients with severe BTK lesions."

Michinao Tan

Dr Tan then provided an update of device availability on the Japanese market, noting that considerable progress in the application of endovascular therapy for femoropopliteal occlusive disease has yielded initial success rates of greater than 95% in high volume Japanese centres. He noted, however, the enduring issue of long-term clinical outcomes in TransAtlantic Inter-Society Consensus (TASC) II C/D lesions.

"Nowadays, two drug-coated balloons, one drug-coated stent, and a covered stent are available for femoropopliteal lesions in Japan. In addition, one drug-eluting stent will be available soon." He also touched upon the recent much-discussed meta-analysis by Katsanos *et al*. (page 6), saying: "Although these drug technologies have shown superior result compared to standard balloon angioplasty in its patency, it has been reported that there is an increased risk of all-cause death at two and five years following application of paclitaxel-coated balloons and stents.[3] Further clinical research and validation should be performed for patients' safety."

Figure 3. The distance to the popliteal artery was periodically confirmed using fluoroscopy in a contralateral oblique view..

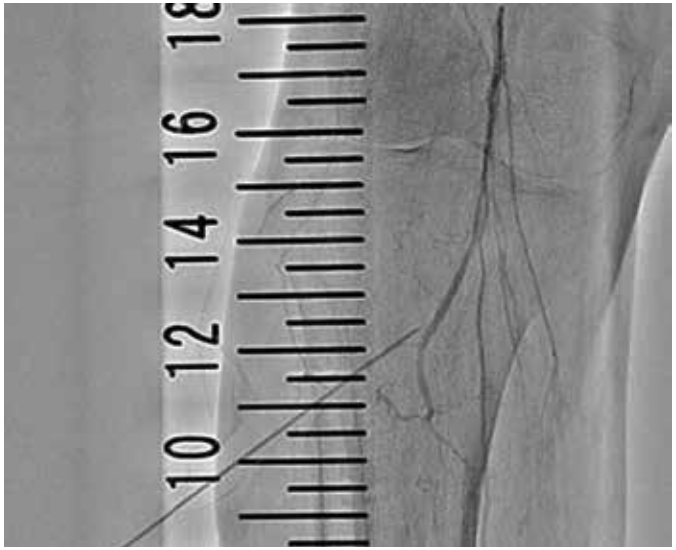
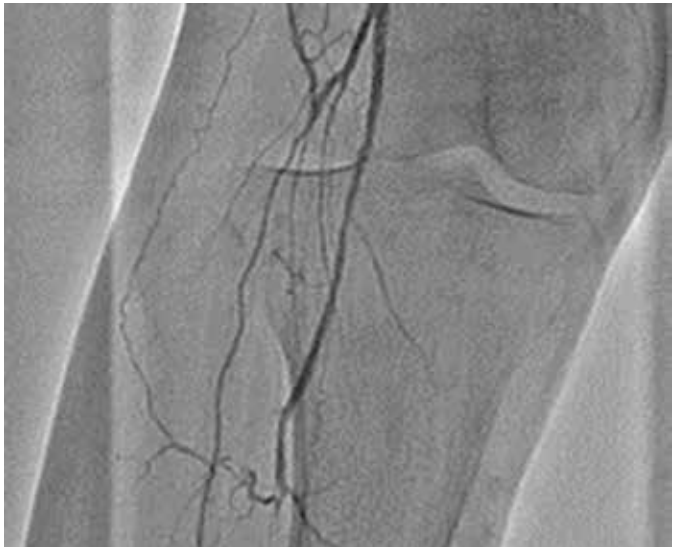


Figure 4. Using a sheathless technique, a 2.6 F microcatheter was then introduced to support the 0.014-inch guidewire.



References

1. Tan M, Urasawa K, *et al*. Anterolateral Popliteal Puncture Technique: A Novel Retrograde Approach for Chronic Femoropopliteal Occlusions. J Endovasc Ther. 2017;24(4):525-530.
2. Iida T, Iida O, Okamoto S, *et al*. Endovascular therapy with novel high anterior tibial artery puncture for limb salvage in a case of critical lower limb ischemia. Cardiovasc Interv Ther. 2014;29:363–367.
3. Katsanos K, Spiliopoulos S, Kitrou P, *et al*. Risk of death following application of paclitaxel-coated balloons and stents in the femoropopliteal artery of the leg: a systematic review and meta-analysis of randomized controlled trials. J Am Heart Assoc. 2018;7:e011245.
4. Iida O, Takahara M, Soga Y, *et al*. Three-Year Outcomes of Surgical Versus Endovascular Revascularization for Critical Limb Ischemia: The SPINACH Study (Surgical Reconstruction Versus Peripheral Intervention in Patients With Critical Limb Ischemia). Circ Cardiovasc Interv. 2017;10(12).

PE, PTS & DVT: optimise treatment with EKOS™

Deciding which patients with acute pulmonary embolism (PE) to treat with ultrasound-assisted catheter-directed thrombolysis using EkoSonic™ Endovascular System Acoustic Pulse Thrombolysis™ (EKOS™), as well as its effect on deep vein thrombosis (DVT) and post-thrombotic syndrome (PTS) provided the focus of this year's BTG (UK) symposium.

Venous thromboembolism (VTE), which includes PE and DVT, is the third most common cardiovascular cause of death globally, totaling approximately three-million deaths annually.[1]

Chairing and speaking at the event, Professor Nils Kucher, Director of Angiology, University Hospital Zurich, Switzerland, discussed how to risk stratify patients with acute PE, and select the optimal patients for catheter intervention. "For each patient with PE, the guidelines say we should estimate the clinical risk based on expertise and a score known as the pulmonary embolism severity index [PESI]. There's a simplified score and an original score. I suggest you use the simplified," he noted.

sPESI is comprised of six variables: cancer, chronic heart failure, chronic pulmonary disease, pulse rate > 110 beats per minute, systolic blood pressure < 100 mmHg, and arterial oxyhaemoglobin saturation < 90%.[2]

"The score is simple because if you have zero points, according to sPESI, then risk of death [30-day mortality] is 1.0%. If the score is greater than one then this risk is 10.9%," he said, adding that, "the question is whether there are further measures with which to assess mortality risk from right ventricular [RV] failure."

"Physicians do not have much faith in systemic thrombolysis anymore. There is greater use now of ultrasound (US)-assisted thrombolysis comprised of a catheter placed in the thrombus."

Nils Kucher

Turning to other echocardiographic signs of adverse outcome in patients with acute PE, Professor Kucher said, "I personally believe one of the easiest ways to determine this is to assess the RV/LV [right ventricular/left ventricular] ratio. We have evidence with data from two prospective cohorts where a RV/LV ratio of greater than one was chosen as a cut off.

"All-cause and PE-related mortality was increased in patients with an RV/LV ratio greater than one," he said. The odds ratio (OR) for all-cause mortality was 35.7 and for PE-related mortality was 8.9 according to one study[3]. The other study had an OR for PE-related mortality or rescue thrombolysis of 3.9[4]. Professor Kucher also referred to RV dysfunction and noted that all-cause mortality is raised in such patients, adding that if the TAPSE score is less than or equal to 16 then all-cause mortality and PE-related mortality are both also increased.[3]

Furthermore, he noted that the McConnell sign is specific for PE because it is a combination of a distinct regional pattern of RV dysfunction, with akinesia of the mid free wall but normal motion at the apex. "This is not normally seen in patients with other causes of hypertension, so it is specific to PE and has been shown to increase the risk of death, with an OR for PE-related mortality of 3.6" he said.

"Not all hospitals have bedside emergency echocardiograms so other ways of determining who is at risk are needed. The chest CT is another way to assess RV dysfunction," said Professor Kucher, referring to evidence from a large meta-analysis of nearly 7,000 patients that showed if the RV/LV ratio is greater than one then the risk of all-cause mortality has an OR of 2.5.

Professor Kucher brought the audience up to date with recently developed combined scores: the BOVA and the FAST scores. These scores combine measures of RV dysfunction or increased troponin levels and haemodynamic parameters, plus syncope in the FAST score.[5,6] "Both scores have been shown to have incremental value as opposed to the single variables alone."

Referring to the 2014 European Society of Cardiology (ESC) Guidelines on the diagnosis and management of acute PE, clinical risk should initially be estimated according to the simplified PESI (sPESI), said Professor Kucher. "If a patient is zero risk based on the sPESI, it is unnecessary to assess biomarkers or right-sided heart size. Anticoagulant treatment alone is sufficient, and patients may even be discharged as an

outpatient with home-care and a novel oral anticoagulant."

With intermediate-risk patients, if either the troponin or RV function is positive then the patient needs hospitalisation and should be administered anticoagulant therapy, he said. "If both tests are positive, then the patient should receive an anticoagulant, and timely rescue reperfusion."

In high-risk patients, heparin 80 IE/kg IV should be given, and in those with low blood pressure, O2 Ringer's (500 ml intravenously) should be given to try and increase blood pressure, along with epinephrine and mechanical ventilation. "If the patient is agitated then tell your anaesthesiologist that by intubating a patient with massive PE and giving fentanyl, or similar, the patient will lose blood pressure and adrenergic drive. Only intubate if the patient is undergoing CPR," he stressed.

A stabilised patient can then go through a standard work up (ECG, lactate level, echo, and CT angiography), followed by catheter therapy, or surgical embolectomy and systemic thrombolysis, said Professor Kucher. However, he added that he does not use systemic thrombolysis for fear of bleeding but prefers to send patients for surgical embolectomy or catheter therapy.

Turning to the PEITHO (pulmonary embolism thrombolysis) trial, the largest randomised controlled trial (RCT) ever performed in patients with acute intermediate risk of PE, Professor Kucher said that tenecteplase (a thrombolytic agent), administered to 506 patients, was associated with 2.6% risk of all-cause mortality and haemodynamic collapse, versus 5.6% in patients who only received heparin.[7] "However, safety was an issue with more bleeding and strokes associated with tenecteplase than with placebo/heparin," he said.

"Ultrasound-assisted catheter-directed thrombolysis is safe, feasible, and shows good patency rates."

Houman Jalaie

He added that it was known that PE thrombolysis is associated with an odds ratio of 2.7 for bleeding complications and the risk of intracranial bleeding has an OR of 4.6.[8] "Physicians do not have much faith in systemic thrombolysis anymore. There is greater use now of ultrasound-assisted thrombolysis comprised of a catheter placed in the thrombus," he said. "Inside the catheter are ultrasound elements which help to force TPA [tissue plasminogen activator] into the thrombus and together with microscopic changes to the fibrin strands force electrons into the thrombus, dissolving it."[9,10]

The only RCT for the technique is the ULTIMA (Ultrasound-Accelerated Thrombolysis of Pulmonary Embolism) trial that confirmed a fixed-dose, ultrasound- assisted catheter-directed thrombolysis using EKOS™ was superior to unfractionated heparin anticoagulation alone in improving RV dysfunction at 24 hours without an increase in bleeding complications.[10]

Patients who received EKOS™ plus heparin showed that the RV/LV ratio significantly improved at 24 hours from 1.28 to 0.99 ($p < 0.001$). With heparin alone the RV/LV ratio reduced from 1.2 to 1.17 ($p = 0.31$). Systolic RV dysfunction significantly improved with EKOS™, and there were no deaths or significant bleeding complications.[10]

"We have evidence for EKOS™ in PE. In most of Europe, the technique is more widely used now but more evidence is needed to show that ultrasound-assisted catheter-directed PE thrombolysis improves clinical outcomes in intermediate- to high-risk patients," he concluded.

Next to speak was Houman Jalaie, Consultant Vascular and Endovascular Surgeon at University Hospital RWTH Aachen, Germany, presenting five-year follow up results for acute DVT treated with EKOS™ at his centre.

Around 20–55% of patients develop PTS after DVT, particularly those who had DVT of the femoral or iliac/caval veins.[11-13]. "Only 20% of thrombosed iliac veins recanalise completely with anticoagulant therapy, and there is 44% claudication five years post-iliac DVT. The presence of residual thrombus in the iliofemoral distribution is a strong predictor of recurrent thrombosis and PTS," said Dr Jalaie.

Patients included in the study[14] had acute iliofemoral and caval DVT without a high risk of bleeding. Ultrasound-assisted catheter-directed thrombolysis using EKOS™ was used along with a recombinant TPA given by bolus of 5 mg, then at 1 mg

Continued on page 42

PE, PTS & DVT: optimise treatment with EKOS™

Continued from page 41

per hour, with heparin partial thromboplastin time (PTT) for 40–60 seconds. A total of 87% of patients had received successful lysis and 88% were stented.[14]

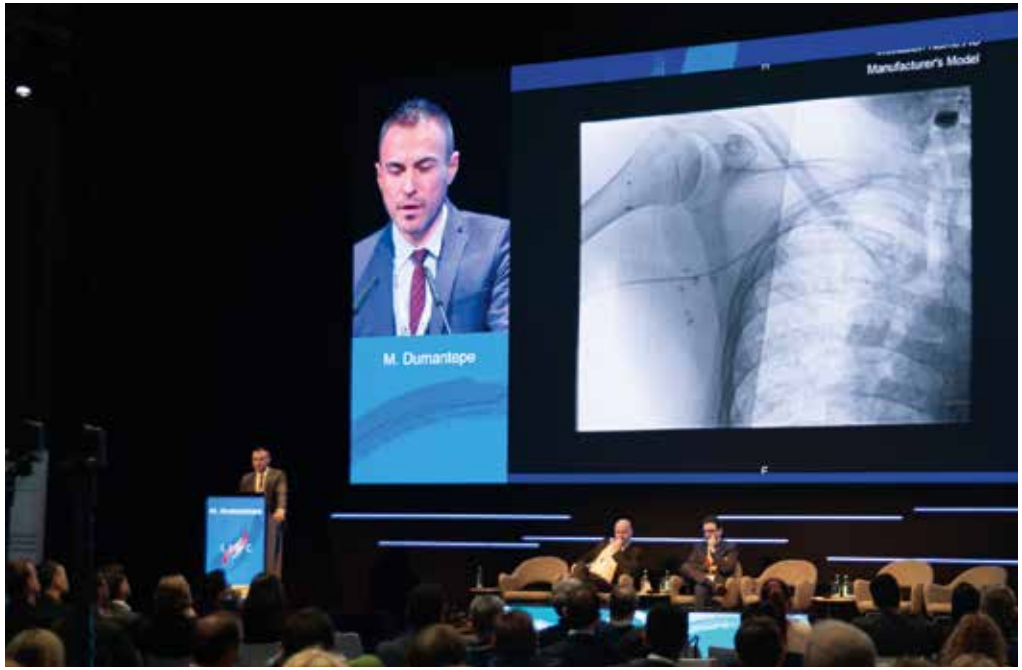
"Primary patency was over 80%, and secondary patency was 94%. Major bleeding events occurred in 1.9% of patients and minor bleeding in 14%," he reported.

"In terms of PTS, 80% of patients were PTS-free in the successful treatment group, while 14% were PTS-free in the unsuccessful treatment group."[14]

He concluded that the study results provided evidence that, "ultrasound-assisted catheter-directed thrombolysis is safe, feasible, and shows good patency rates."[14]

Finally, Mert Dumantepe from Acibadem Altunizade Hospital, Istanbul, Turkey, discussed the treatment of chronic DVT with EKOS™, providing insight on PTS in everyday clinical practice. He explained that he believed there was a solution to PTS as demonstrated by ACCESS PTS Trial (ACCElerated thrombolySiS for Post- Thrombotic Syndrome (PTS) using the Acoustic Pulse Thrombolysis™ EkoSonic™ Endovascular System) PTS trial data.

The study found chronic DVT patients with femoral PTS can be treated safely and a significant improvement of Villalta scores of 34% at 30 days across 77 limbs



treated among the 73 patients with a p-value of < 0.0001. On average, patients treated in the study experienced a symptom reduction from severe to borderline-mild. The study also showed a 21% improvement in patients' quality of life.[15]

Referring to his own practice, Dr Dumantepe explained that he believed the most important step involved proper planning with careful evaluation and examination of the patient. "Review the imaging yourself and decide the access site. The most difficult step is crossing the chronic occlusion, then preparing the vessel with sequential PTA [percutaneous transluminal angioplasty] before using EKOS™ overnight. This improves vein compliance and ability to expand. Then we do further PTA to the expected size of the vessel. Central stenting might be needed."

Patients should be discharged with education about increasing activity levels, using blood thinners (enoxaparin with or without aspirin for a month) and compression, he added.

In his single centre study of 162 chronic fem-pop DVT patients, Dr Dumantepe found that 75%

"It is time to stop saying nothing can be done."

Mert Dumantepe

of patients reached greater than a six-point reduction in Villalta score ($p < 0.001$), with one major bleeding and nine minor bleeding events. "Primary patency was 69.7% at one year, and secondary 82.1%; 88% showed improvement in claudication and 91% freedom from ulceration," he reported.[14].

He concluded that by following a PTS treatment protocol, PTS scores can be reduced, and quality of life improves. "It is time to stop saying nothing can be done," he said.

References

1. Raskob GE, Angchaisuksiri P, Blanco AN, *et al*. Thrombosis: A major contributor to global disease burden. Thromb Haemost 2014; 112: 843–852.
2. ESC 2014 guidelines table 7, page 17
3. J.L. Lobo *et al*. Prognostic significance of tricuspid annular displacement in normotensive patients with acute symptomatic pulmonary embolism, Journal of Thrombosis and Haemostasis, Volume 12, Issue 7, July 2014
4. P.Pruszczyk *et al*., Prognostic value of Echocardiography in Normotensive Patients With Acute Pulmonary Embolism, JACC: Cardiovascular Imaging, Volume 7, Issue 6, June 2014
5. BOVA: Eur Respir J 2014; 44: 694–703
6. FAST: Thrombo Haemost: 2014 May 5;111(5):996-1003
7. G.Meyer *et al*. Fibrinolysis for Patients with Intermediate-Risk Pulmonary Embolism, The *New England Journal of Medicine*, 2014; 370:1402-1411
8. Chatterjee *et al*. Thrombolysis for pulmonary embolism and risk of all-cause mortality, major bleeding, and intracranial hemorrhage: a meta-analysis. JAMA, 2014;311:2414–21.
9. Lin; Vascular, Vol. 17, Suppl 3, pp. S137–S147, 2009.
10. Kucher; Circulation. 2014;129:479-486;
11. Ginsberg JS, Hirsh J, Julian J *et al*. Prevention and treatment of postphlebitic syndrome: results of a 3-part study. Arch Intern Med. 2001; 161:2105-9.
12. Kahn SR, Kearon C, Julian JA *et al*. Predictors of the post-thrombotic syndrome during long-term treatment of proximal deep vein thrombosis. J Thromb Haemost. 2005; 3:718-23.
13. Prandoni P, Lensing AW, Cogo A *et al*. The long-term clinical course of acute deep venous thrombosis. Ann Intern Med. 1996; 125:1-7.
14. Data on file
15. ACCESS PTS Trial, data on file

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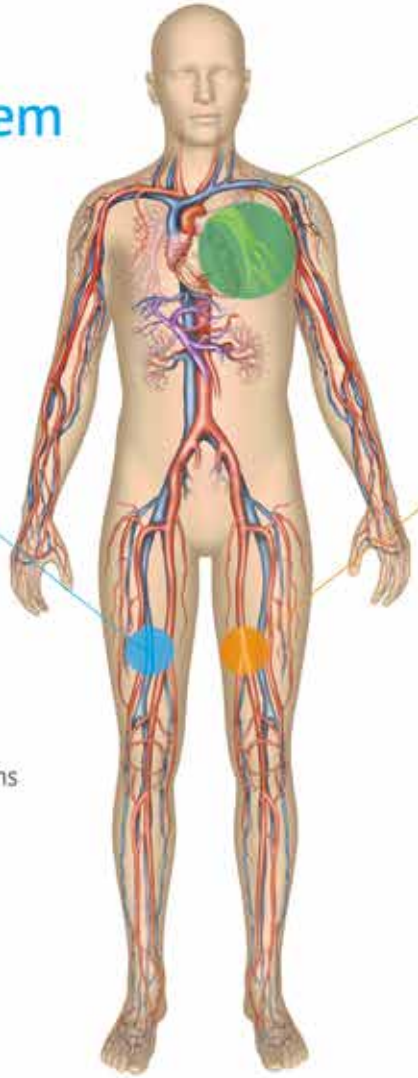

Deep Vein Thrombosis

- 79% of patients presenting with PE have evidence of DVT[11]
- Removes thrombus more completely compared to CDT[7]
- Freedom from PTS of approximately 90% at one year[8]
- Clinically significant improvements in signs and symptoms of PTS out to one year[12]

Pulmonary Embolism

- Reduces RV/LV ratio by 23%-26%[10]
- Reduces PA pressures by 28% (at 48 hours)[2]
- At one year:
  - Mortality 2%[10]
  - Recurrence 2%[10]
  - Major bleeding 3%[10]

Arterial Occlusion

- Lower 30-day amputation rate vs standard CDT in ALI patients[6]
- Lower bleeding rates vs standard CDT in ALI patients[6]
- Higher complete dissolution rate of thrombus in ALI patients[6]

ALI: Acute Limb Ischaemia; **CDT:** Catheter-Directed Thrombolysis; **DVT:** Deep Vein Thrombosis; **PA:** Pulmonary Arterial; **PE:** Pulmonary Embolism; **PTS:** Post-Thrombotic Syndrome; **RV/LV:** Right Ventricular/Left Ventricular

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References: 1. Kucher, N., et al., "Randomized, Controlled Trial of Ultrasound-Assisted Catheter-Directed Thrombolysis for Acute Intermediate-Risk Pulmonary Embolism." Circulation, Vol. 129, No. 4, 2014, 479-486. **2.** Piazza, G., et al., "A Prospective, Single-Arm, Multicenter Trial of Ultrasound-Facilitated, Low-Dose Fibrinolysis for Acute Massive and Submassive Pulmonary Embolism: the Seattle II study." Journal of the American College of Cardiology: Cardiovascular Interventions 2015; 8: 1382-92. **3.** Wissgott C., et al., "Treatment of Critical Limb Ischemia Using Ultrasound-Enhanced Thrombolysis (PARES TRIAL): Final Results." Journal of Endovascular Therapy, 14(4), 2007, 438-443. **4.** Schrijver, A.M., et al., "Dutch Randomized Trial Comparing Standard Catheter-Directed Thrombolysis and Ultrasound-Accelerated Thrombolysis for Arterial Thromboembolic Infrainguinal Disease (DUET)." Journal of Endovascular Therapy 2015, Vol. 22(1): 87-95. **5.** Lin, P., et al., "Comparison of Percutaneous Ultrasound-Accelerated Thrombolysis versus Catheter-Directed Thrombolysis in Patients with Acute Massive Pulmonary Embolism." Vascular, Vol. 17, Suppl. 3, 2009, S137-S147. **6.** Litzendorf, M. E., et al., "Ultrasound-accelerated thrombolysis is superior to catheter-directed thrombolysis for the treatment of acute limb ischemia." Journal of Vascular Surgery, Jun 2011; 53(Suppl. S), p106S-107S. **7.** Parikh, S., et al., "Ultrasound-Accelerated Thrombolysis for the Treatment of Deep Vein Thrombosis: Initial Clinical Experience." Journal of Vascular and Interventional Radiology, Vol. 19, Issue 4, April 2008, 521-528. **8.** Engelberger, R., et al., "Fixed, Low-Dose Ultrasound-Assisted Catheter-Directed Thrombolysis Followed by Routine Stenting of Residual Stenosis for Acute Ilio-Femoral Deep-Vein Thrombosis." Journal of Thrombosis and Haemostasis, 2014, 111.6. **9.** Engelberger RP et al. "Ultrasound-assisted thrombolysis for acute pulmonary embolism: a systematic review." Eur Heart J. 2014 Mar;35(12):758-64. **10.** Tapson, Victor, et al., "A Randomized Trial of the Optimum Duration of Acoustic Pulse Thrombolysis Procedure in Acute Intermediate-Risk Pulmonary Embolism: The OPTALYSE PE Trial." JACC: Cardiovascular Interventions Jul 2018, 11 (14) 1401-10. **11.** Tapson, Victor, et al., "Acute pulmonary embolism." N Engl J Med 2008; 358(10): 1037-52. **12.** Data on file.

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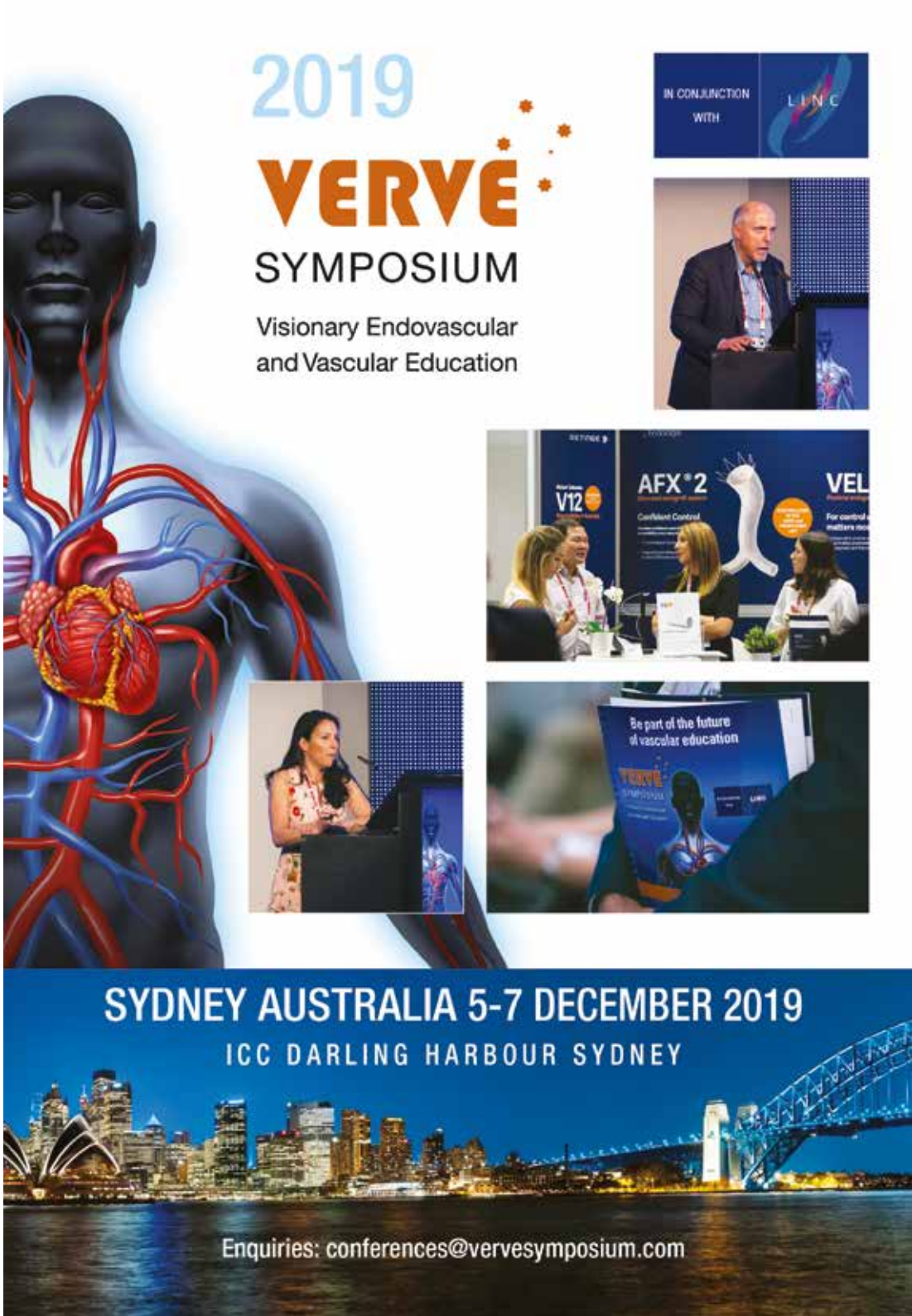
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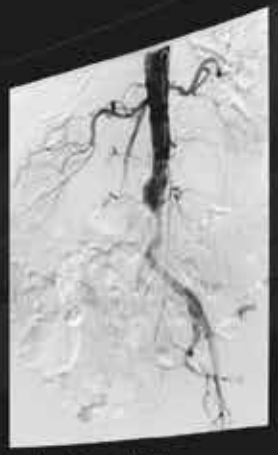
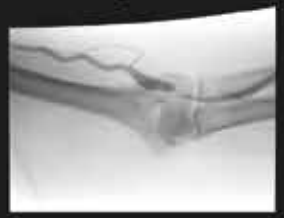
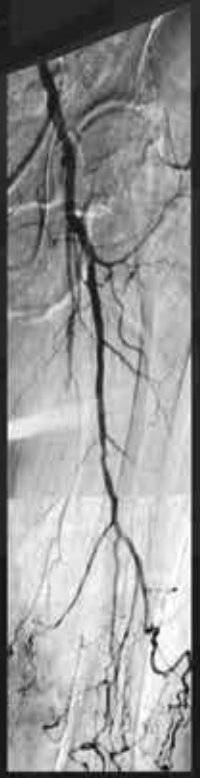


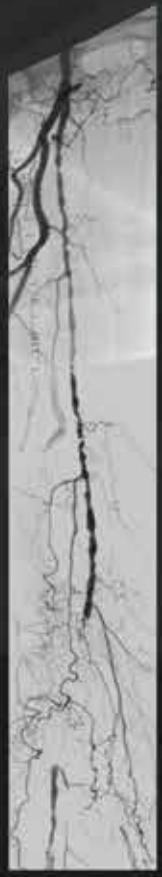
Occluded right iliac



Lesion across the elbow



Left SFA CTO



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*PROPATEN Bioactive Surface is synonymous with the CBAS Heparin Surface.

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Bridging the gap in complex aortic disease

The use of the Viabahn Balloon Expandable (VBX) Endoprosthesis (W. L. Gore & Associates, USA) as a bridging stent in the treatment of complex aortic disease was addressed during a Gore sponsored symposium at LINC.

The treatment of aortic disease has expanded into the realm of fenestrated, branched and chimney endografting for complex disease, where self- and balloon-expandable grafts have worked as bridging stents to connect visceral and renal vessels to the aortic main body.

Bridging stent performance is appreciated as a crucial element in the durability of fenestrated procedures. While they denote procedural complexity, they also introduce vulnerability as potential sites of endoleak, migration, stenosis (possibly caused by kinking, fracture, or tortuosity and thrombosis). Such branch-related complications can result in visceral ischaemia, and demand reintervention.[1,2,3]

The ideal qualities of bridging stents include adequate length options to provide coverage between the main body and the target vessel, as well as diameter and oversizing options. Flexibility, including flexibility after flaring, allows conformation with target vessel angulations. Durability and resistance to migration are also important factors in bridging stent selection, as well as high radial forces and resistance to compression (particularly important in calcified vessels). During implantation and vessel navigation, trackability is also a benefit.[1]

"We have more conformability with this stent inside the target vessels."

Giovanni Torsello

GORE® VIABAHN® VBX Balloon Expandable Endoprosthesis

While no dedicated bridging stent currently exists, a number of devices have been used to date. Self-expanding covered stents, while demonstrating conformability, suffer from low deployment accuracy, poor visibility, and often demand relinement. Balloon-expandable covered stents offer precise deployment and high visibility, but their applicability is limited by stiffness, poorer compliance and foreshortening on overinflation.

The latest iterations of covered stents seek to combine the strengths of both with innovative design in an effort to address unmet needs. The VBX is one such device, set apart from its predecessors with a stent strut design that includes independent stainless-steel rings that confer flexibility and conformability. It

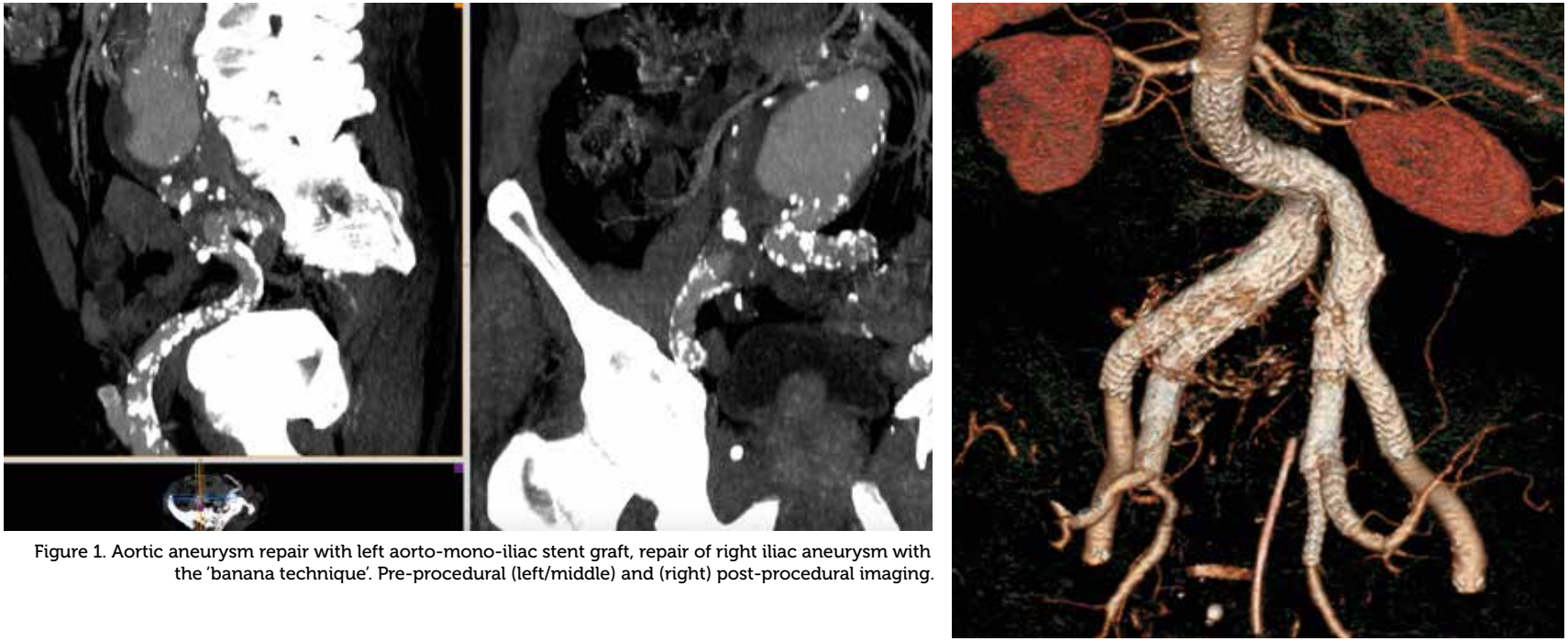

Figure 1. Aortic aneurysm repair with left aorto-mono-iliac stent graft, repair of right iliac aneurysm with the 'banana technique'. Pre-procedural (left/middle) and (right) post-procedural imaging.

also boasts high radial strength with minimal foreshortening and maximal retention alongside diameter customisation, and a highly flexible stent and catheter which enables contralateral deployment.

The VBX stent graft was developed utilising the small diameter, expanded polytetrafluoroethylene (ePTFE) stent graft technology from the Gore Viabahn endoprosthesis. The VBX device is configured in diameters of 5 to 11 mm and lengths of 15, 19, 29, 39, 59, and 79 mm.

In Europe, the post-market registry of the VBX, EXPAND, was initiated in late 2018 with the aim of capturing real-world VBX stent graft use in multiple pathologies and conditions. Enrolment is ongoing, with an anticipated 140 patients who will be followed for 12 months. The estimated study completion date is December 2020.[5]

Investigations are ongoing into the use of the VBX as bridging stents in fenestrated and branched EVAR, with reports limited to case studies and short patient series to date[1,4-7].

In the session, moderated by Dittmar Böckler (Professor of Vascular Surgery at Heidelberg University Hospital, Germany), the technical and clinical value in treating aortic disease with the VBX were discussed by Giovanni Torsello (St. Franziskus Hospital Münster, Germany). Mauro Gargiulo (University of Bologna, Italy) presented on the performance of bridging stents for fenestrated endovascular repair. A selection of recorded cases are then presented by Jorge Fernández Noya (an angiologist and vascular surgeon at the La Rosaleda Hospital in Santiago de Compostela and at the University Hospital of Santiago de Compostela, Spain), followed by a live case transmission from Münster's St. Franziskus Hospital.

Advantages of the Gore Viabahn VBX Balloon Expandable Endoprosthesis: technical and clinical value in treating aortic disease

Ahead of the session, Giovanni Torsello described the features of the VBX in the context of complications associated with fenestrated aortic repair. "We treat many complex aortic aneurysm patients with fenestrated and branched endografts. We need bridging stents to connect the aortic endografts with the renal and visceral arteries. These techniques are very well evaluated. We know that some patients have to be operated on again, because of problems at the level of the bridging stents. We have a series of bridging-stent related complications."

Typical complications are

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Bridging the gap in complex aortic disease

Continued from page 47

fractures of the bridging stent, dislodgement or occlusion, Professor Torsello noted. In the past, bare metal and subsequently covered stents have been used outside their instructions for use (IFU).

He continued: "Now we have a new kid on the block, the VBX. The VBX was firstly introduced in the US and then, 14 months ago, in Europe. The most important feature of this stent is the flexibility. This flexibility is possible because the stent consists of many independent stainless-steel rings with a high radial force. These segments are connected with ePTFE. So we have more conformability with this stent inside the target vessels.

"This is important, because the bridging stents undergo continual stress, secondary to many things – first of all, breathing. The renals move up and down during inspiration and expiration. The second stress factor is the cardiac cycle. The third is the possible migration of the stent grafts inside the aorta. Finally, the modification of the aortic volume: the aneurysm can decrease (hopefully), but it can also increase. These are mechanisms that influence the bridging stent. Our wish is to have a very stable stent, but with high flexibility so that the stent can accommodate the movements of the visceral and renal arteries."

The conformability and flexibility are clear distinguishing features of the VBX. Asked to describe the features of the device that putatively impede the precipitation of complications in fenestrated procedures, Professor Torsello responded: "The stent must be flexible, but must also be stable in place and have resistance to compression with a high radial strength. These are two important features, but we have also other important features of this stent. The VBX is available in a wide range of sizes, up to 79 mm, and a wide range of diameters. So especially in the case of branched endografts, we have to cover very long distances with the bridging stent. In the past, we had to use two or three stents to cover this distance. If we have to use many stents, the probability that we have a problem at this level is higher compared with a one-piece bridging stent. The wide range of lengths and diameters means we can adapt the use of this bridging stent to almost every situation."

The experience at St. Franziskus-Hospital Münster includes 390 stent placements to date, explained Professor Torsello, with the first taking place 14 months ago. These patients are undergoing continual follow-up, and one-year results are anticipated to emerge in the coming months.

"We are more than happy with the results so far," commented Professor Torsello. "Our impression is that both applicability and safety are very good. This study is ongoing. The patients are still under evaluation, so for the mid-term and long-term results, we have to wait."

Before commencing clinical application of the VBX, Professor Torsello and colleagues carried out a variety of bench tests, which he will be presenting today. The team tested the metallic frame and the PTFE fabric, with the aim of assessing the integrity of these two components of the stent. The team assessed the ideal configuration of the device in different sized fenestrations, in terms of manner of flaring and the number of VBX metallic rings extending into the fenestration.[8]

This was achieved with an in-vitro fenestrated model, made using a framed polyester fabric sheet including ten fenestrations with nitinol rings. Fifty VBX devices were inserted into the fenestrations of the test sheet and flared. Using a digital microscope the topology of the flared zone was examined for modification of the fabric or the metallic frame. Radiological analysis was also used to assess for fractures.[8] "We did not see any modification of the fabric, and no fracture at all after flaring," summarised Professor Torsello.

The water permeability of the stent after flaring was also tested, using a standardised model, at 16 kPa of pressure, demonstrating no leakage or flaring of the device. Pull-out forces and shear stress forces were also assessed, in order to simulate the conditions of stent dislodgement that occurs in some patients following the implantation of bridging stents. "We measured the force needed to dislocate the stent," said Professor Torsello. "These pull-out forces were very high, so that the probability that this stent dislocates from the fenestration is very small. Then, we also simulated the migration of the stent graft to see how the stent is modified in its structure. The shear stress which was needed to dislocate the stent from the fenestration in an axial way was very high."

Recorded case presentations showcase elongation, flaring and conformability of VBX

Jorge Fernández Noya presented two case examples that demonstrate the broad applicability of the Viabahn VBX, as well as reinforcing the importance of preservation of perfusion of hypogastric and gluteal vessels, occlusion of which can increase the risk of serious complications such as buttock claudication, erectile dysfunction, and even pelvic and colonic ischaemia[9].

"I selected these cases to show the benefits of the VBX device," he said. "The features of the device infer some advantages in my opinion compared to the other devices that we have in our hands – in terms of conformability of the device in more complex anatomies. Angulation, for example. In the cases I have selected, we can observe better these features of the device in terms of trackability and conformability."

The first case involved a patient who had undergone treatment a number of years ago for a ruptured right iliac aneurysm by ligation of the common iliac artery and fem-fem bypass. More recently he presented with an aortic aneurysm, demanding implantation of an aorto-mono-iliac graft in the left side. In addition to this, a right iliac aneurysm at the level of the iliac bifurcation was diagnosed. As such, together with EVAR of the left side, the right-side aneurysm was treated using the so-called 'banana technique'[10] (Figure 1).

"We treated this with a VBX because we needed good conformability," commented Dr Noya. "In this case the graft is going to be implanted between the internal iliac artery and the external iliac artery so the flow is going to go in a retrograde way, and also the difference between the diameter between the internal and external iliac artery. So we need a device that is not only very

conformable in any anatomy, but we needed that the device could be oversized in one of the sides."

The second case that Dr Noya presented involved the implantation of an iliac branch device for the treatment of an aortoiliac aneurysm. In the absence of adequate landing zone in the hypogastric artery, he explained, stent coverage was extended into the gluteal arteries. "These are small arteries with a lot of elongation. In this case, we needed a good device that could deal with this elongation. We also needed good trackability, because we needed to go with our device from the contralateral side, using different sheaths etc. So maintaining trackability was important as well as the possibility for elongation.

"In other cases we might be able to embolise one of the gluteal arteries, but in this case we had to maintain the patency of both. So we decided to use two VBX stent grafts, due to the complexity of the case and the need to go contralaterally. The other advantage was that we were able to make an oversizing in the proximal part of the VBX device, and this was done to avoid guttering in the hypogastric device."

"We need a device that is not only very conformable in any anatomy, but we needed that the device could be oversized in one of the sides."

Jorge Fernández Noya

With experience of the Viabahn VBX currently limited, Dr Noya offered some comments as to its appeal and applicability: "It is important to say that we are just at the beginning of our practice with this device. We do not know the results in the mid- or long-term follow-up in these more complex situations. But it is important to remark that the features of the device seem to be very good for these more complex situations.

"The length of the device is an important feature. It means that we can treat more lesions – 79 mm is unusual compared to other devices. The possibility of oversizing in some part of the device is also important. With a range of diameters, you can deal with the vast majority of lesions, due to the possibility of making the oversizing of the device."

He concluded: "We are working with this device not only working in complex situations, but also regular cases. Due to the design of the device, we can deal with cases where we would not feel comfortable using other stent grafts."

References

1. Austermann M. 'New GORE® VIABAHN® VBX Balloon Expandable Endoprosthesis: Case experience in aortic disease'. Presented at Leipzig Interventional Course, Leipzig, Germany. 2018 Jan 30-Feb 2.
2. Troisi N, Donas KP, Austermann M, Tessarek J, Umscheid T, Torsello G. Secondary procedures after aortic aneurysm repair with fenestrated and branched endografts. J Endovasc Ther. 2011;18(2):146-53.
3. Panuccio G, Bisdas T, Berekoven B, Torsello G, Austermann M. Performance of Bridging Stent Grafts in Fenestrated and Branched Aortic Endografting. Eur J Vasc Endovasc Surg. 2015;50(1):60-70.
4. Rao A, Beckerman W, Tadros RO, McKinsey J. PC010. Use of a Novel Flexible Covered Stent (GORE VIABAHN VBX) in Fenestrated and Parallel Grafts During Endovascular Treatment of Complex Perivisceral Aortic Aneurysms: Acute Results. J Vasc Surg 2018.;67(6):e175-e176.
5. Tarulli E, Mironov O, Mafeld S, Annamalai G, Tan K. 3:00 PM Abstract No. 386 Viabahn VBX as a novel bridging stent graft (BSG) for fenestrated and branched endovascular abdominal aortic aneurysm repair (FB-EVAR). J Vasc Interv Radiol. 2018;29(4):S164.
6. Png CYM, Lau IH, Marin ML, Faries PL, Tadros RO. Preliminary Outcomes of Fenestrated Endovascular Aneurysm Repair Using Gore Viabahn VBX. Ann Vasc Surg. 2018;48:8-9.
7. Oderich G. Long-term results of bridging stents in fenestrated and branched endovascular repair. Presentation at Aortic Live, Essen, Germany. 2018 29-30 Oct.
8. Torsello G. Aortic challenges, quantitative analysis in fenestrated procedures. Presentation at Leipzig Interventional Course, Leipzig, Germany. 2018 Jan 30-Feb 2.
9. Katsargyris A, Oikonomou K, Klonaris C, Bal A, Yanar F, Verhoeven EL. Common iliac and hypogastric aneurysms: open and endovascular repair. J Cardiovasc Surg. 2015;56(2):249-55.
10. Mosquera Arochena N, Molina Herrero F, Carbalho Fernandez C, Rodriguez Feijoo G, Fernandez Lebrato R, Barrios Castro A *et al*. Hybrid approach to AAA: bilateral "banana" technique to preserve hypogastric artery in complex anatomy aorto-biiliac aneurysm. Rev Port Cir Cardiotorac Vasc. 2011;18(4):225-30.

Lessons from ATTRACT, CAVENT, CAVA and beyond …

During a dedicated acute deep vein thrombosis (DVT) session, Stephen Black (Guys' and St Thomas' Hospital, London, UK) reasoned that we shouldn't be too hard on the ATTRACT trial – an assessment of pharmacomechanical catheter-directed thrombolysis for DVT that needs little introduction.[1] "It's easy to criticise what people have done, but what I think we need to completely understand is that ATTRACT was setup 10 years ago, and was based on the best available knowledge at the time. It has been run by a very good group of people who did their best to advance things forward," Mr Black told *LINC Review* ahead of his presentation.

The difficulty that we have, he added, is that the outcome measures that we rely upon, particularly the Villalta score, have fundamental flaws, making it difficult to judge whether outcomes are genuine. "For me, ATTRACT has big selection bias in the sites," continued Mr Black. "It has become broadly apparent that sites were not randomising [properly] and not even putting people up for randomisation that they felt needed treatment. The number of patients screened compared to the number of patients enrolled turned out to be very disparate."

As such, ATTRACT is a study that represents ~5% of patients with DVT, yet it is being applied to everybody, thus one needs to be careful in terms of over-analysing results, said Mr Black, adding: "But nonetheless the circulation paper that has now come out and various further analyses that have been done are beginning to focus on a group of patients that we thought were going to best target for treatment – iliofemoral DVT alone, and not femoral DVT patients."

"I think all of us, both the critics and supporters of ATTRACT are very clear that we want to do the right thing for our patients … if we can't prove the benefit of lysis, we need to stop. Simple as that."

Stephen Black

The natural instinct for most people treating DVTs, reasoned Mr Black, is that iliofemoral DVTs are the right target. "We've stopped treating femoral DVTs already, so half of ATTRACT represented a practice that had already evolved. That is part of the problem with trials – they take a long time to come out and practice often moves faster than the trials can keep up with."

Another key point Mr Black was keen to make was to explore the detailed nuisance of the data, and not just skim for the answers that seem immediately obvious. "If you look at the continuous data variables in ATTRACT, you do see a significant benefit for patients in terms of symptom improvement at every single timepoint. If you only read the abstract, you miss all the subtleties of the paper."

He added that incremental benefits are also important,

and shooting for a "cure" sets the benchmark too high in some cases: "The outcome we determine … is fundamentally important, and I think that is part of what has caused the controversy around ATTRACT. Villalta set the trial up to be very difficult for anything but the outcome measure it came up with."

Looking forward, Mr Black reasoned that we keep focused on advancing the science with further trials and studies, and refining the questions and answers required to reduce the suffering of this group of patients. Looking at other studies, he began with CAVA, still ongoing, thus with no results yet: "I am not clear whether we are going to get a huge answer from it, because in order to get CAVA through [approval], they have chosen a difficult group of patients, so again you are selecting a cohort of patients through the selection process of the study, making it hard to predict where it will go."

CAVENT, at five years, is starting to become stronger and stronger in favour of clot removal, he added. "We know from the haematology literature that residual thrombus burden predicts PTS, and nobody has found a better way of fixing that," said Mr Black. "There has got to be a better way of getting the clot out."

Establishing standard-of-care therapy in the coronaries took several trials, over a number of years, he went on, during which treatments and selection criteria were refined, and a group of patients were found who benefited most. "That's what we need to do in acute DVT." He added some specific considerations: "Randomising patients between medical therapy and poor surgical technique is no good – it's going to come out badly. But if randomising patients to very effective, modern-day, best-in-class therapy doesn't work then we need to go back to the drawing board. "I think all of us, both the critics and supporters of ATTRACT are very clear that we want to do the right thing for our patients. It is not 'I want to do lysis, come what may' … if we can't prove the benefit of lysis, we need to stop. Simple as that."

"This is about science as an iterative process. You keep refining, and you keep improving."

Stephen Black

Mr Black and colleagues have set up another study, CLEAR DVT (60 patients), which he described. Existing first as a cohort study, but hopefully evolving into an RCT, it will include patients subjected to what are believed to be best-in-class treatments. "We have specifically found six centres with proven track records of treating DVTs with good outcomes, and whose outcomes are completely different to ATTRACT," he said. If the reviewed data shows strongly positive signals when compared to the ATTRACT data then they will go ahead with an RCT.

Another exciting avenue moving forward is the development of new purely mechanical devices for removing clots, without the use of lysis, said Mr Black. "This is about science as an iterative process. You keep refining, and you keep improving."

Adding his concluding remarks, Mr Black commented: "If we keep the patients front-and-centre of what we do, and we keep on focussing on the fact that we have a group of people who at the moment are not served well with what we have, [then we can be] better at treating these patients. It will come from good, collaborative work between physicians, industry, scientists and patients to get this right.

"As long as we keep that focus, and don't get bogged down by the politics, we will keep on advancing things forward."

References

1 Vedantham S, *et al.* Pharmacomechanical Catheter-Directed Thrombolysis for Deep-Vein Thrombosis. N Engl J Med 2017; 377:2240-2252.

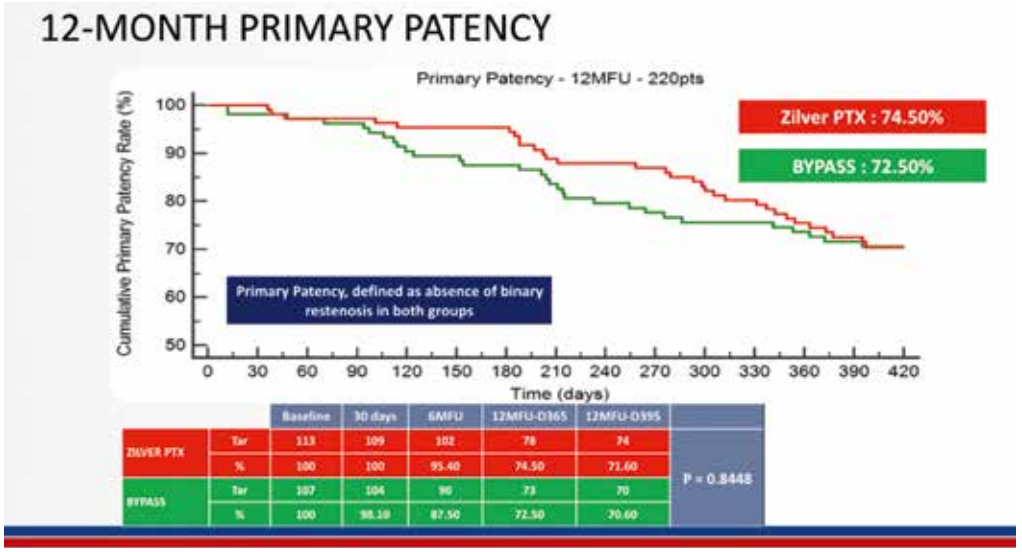
Zilver PTX results non-inferior to prosthetic bypass ATK

The first announcement of the 12-month results of the ZILVERPASS randomised controlled trial (RCT) that looks at the Zilver® PTX (Cook Medical, USA) paclitaxel drug-eluting stent (DES) versus bypass were announced in a presentation by Marc Bosiers, (Vascular surgeon, Belgium).

In a session entitled, "To stent or not to stent?" – the latest data on stentless and stent-based treatment approaches for femoropopliteal lesions, Dr Bosiers provided an overview of the ZILVERPASS results.

Final 12-month results of the physician-initiated study show at least non-inferiority of Cook Medical's Zilver® PTX compared to prosthetic bypass surgery above-the-knee ATK), with similar patency results, shorter hospital stay and less complications.

"Based on these results we can state that this is the first time an endovascular procedure, namely stenting with the Zilver® PTX, yields equivalent or slightly better results compared to what was conceived for many years as being the golden standard for these long complex femoropopliteal lesions: bypass surgery," remarked Dr Bosiers, emphasising the positive impact of the findings.



Source: Cook Medical / Dr Bosiers

"As expected a minimally invasive endovascular procedure yielded less complications than an open surgical procedure."

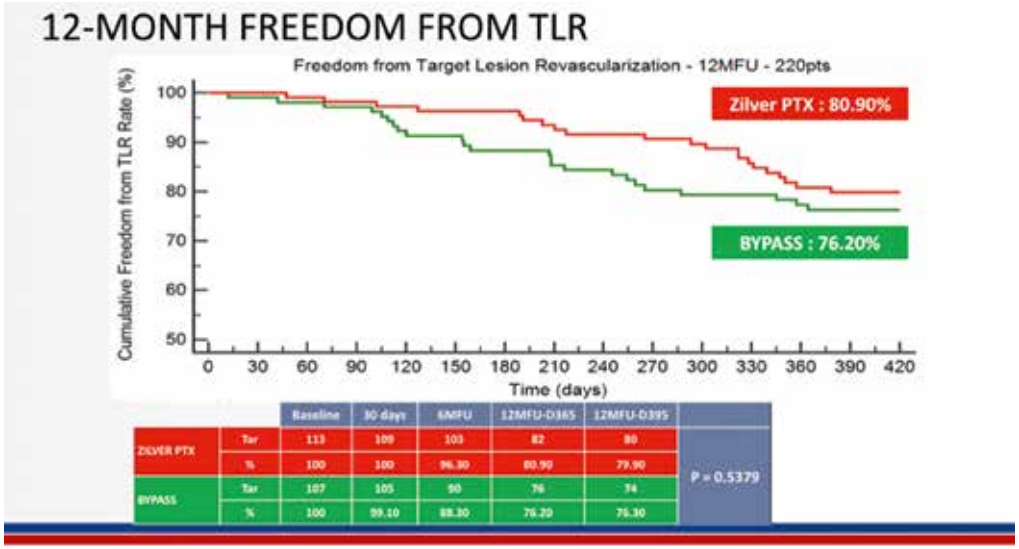
Marc Bosiers

"As expected a minimally invasive endovascular procedure yielded less complications than an open surgical procedure," added Dr Bosiers.

Zilver® PTX, a drug-eluting peripheral stent, is indicated for improving luminal diameter for the treatment of *de novo* or restenotic symptomatic lesions in native peripheral artery disease of the ATK femoropopliteal arteries having reference vessel diameter from 4 mm to 7by mm and total lesion lengths up to 300 mm per patient.

As the first DES in the United States (US) used in the treatment of peripheral artery disease (PAD), Zilver® PTX is currently the only DES for the superficial femoral artery that has five-

Source: Cook Medical / Dr Bosiers



year data to support its use. Previously published data show that Zilver® PTX stent achieves 91% freedom from target lesion revascularisation (TLR) at one year, and 76% at five years, which is higher than that of standard of care endovascular treatment. Five-year data also support the fact that reinterventions are halved with Zilver® PTX compared to both bare metal Zilver® PTX stents and a combination of bare-metal Zilver® PTX stents and percutaneous transluminal angioplasty (PTA).

The study presented was a prospective, randomised, multi-centre study where 220 patients were randomised 1:1 across 13 clinical centres in four countries. The original 24-month study has now been extended to 60 months.

"The ZILVERPASS study is the first international randomised trial comparing – in an objective way, with the same definition of primary patency in both arms – a state of the art endovascular technique (Zilver® PTX) with the golden standard for the treatment of long complex femoropopliteal lesions: bypass surgery," said Dr Bosiers.

Patients could be included if they presented with lifestyle-limiting claudication, rest pain or minor tissue loss (Rutherford Clinical Category 2 to 5); had a stenotic or occlusive *de novo* lesion located in the femoropopliteal arteries, suitable for endovascular therapy and for bypass surgery. The total target lesion length had to be at least 150 mm, and the average lesion length was 247 mm.

Primary patency at 12 months was defined as absence of binary restenosis or occlusion within the treated lesion, and freedom from TLR within 12 months for Zilver® PTX. In patients who underwent bypass, primary patency was defined as absence of binary restenosis or occlusion at proximal and distal anastomoses and over the entire length of the bypass graft, and as being without clinically driven reintervention to restore flow in the bypass.

Patient demographics were similar between groups with notable differences in some risk factors including more patients with hypertension, obesity, hypercholesterolemia, and critical limb ischaemia (CLI) in the bypass patient group. "The lesions however did not differ between both groups, and were very complex with 94.6% occluded and mean lesion length of 247.11 mm. "Occlusions were present in 92% and 97% of Zilver® PTX and bypass groups respectively."

Procedure time was considerably less in the patient group treated with Zilver® PTX, a mean of around 60 minutes in the Zilver® PTX group compared to 123 minutes in the bypass group. "Hospital stay was 2.5 days for Zilver® PTX patients versus 8.2 days for bypass," said Dr Bosiers.

Complication rate preferable in Zilver® PTX over PTX bypass

Turning to 30-day freedom from complication, 95.6% met this endpoint in the Zilver® PTX group (the most common complications were bleeding at puncture site, and haematoma) versus 88.7% in the bypass group (the most common complications were infections and lymphedaema).

> *"Hospital stay was 2.5 days for Zilver® PTX patients versus 8.2 days for bypass."*
>
> **Marc Bosiers**

Twelve-month survival rate was 94.5% in the Zilver® PTX group with most deaths due to cardiac arrest, cerebral infarction, lung cancer, severe bradycardia, acute myocardial infarction, sepsis leading to death, COPD, cardiogenic shock, cardiovascular accident (CVA), or unknown cause; compared to 96.1% in the bypass patients with cause of death as cardiac arrest, gastric bleeding, reason unknown, acute myocardial infarction, pulmonary emphysema, renal failure, acute myocardial infarction, and adenocarcinoma.

"There was no statistical difference in the number nor distribution of causes of death," noted Dr Bosiers.

Primary patency at 12 months was 74.5% in the Zilver® PTX group, and 72.5% in the bypass group. No difference was seen between claudicants or CLI patients in primary patency.

Twelve-month freedom from TLR was 80.9% and 76.2% in the Zilver® PTX and bypass groups; and 12-month secondary patency was 95.1% and 95.9% respectively.

"We now have level one evidence that an endovascular procedure yields results that are as good as open surgery in challenging SFA lesions," said Dr Bosiers, concluding: "There is also the important patient benefits of a shorter hospital stay and a less invasive procedure."

BATTLE for supremacy in femoropopliteal stenting

Yann Gouëffic, from the University Hospital of Nantes, France, stepped up to the podium to outline the latest results from the BATTLE trial. "The objective of the BATTLE trial is to compare a bare metal self-expandable nitinol stent versus a paclitaxel-eluting stent in the treatment of above-the-knee, intermediate length femoropopliteal lesions," he explained.

"The objective of the BATTLE trial is to compare a bare metal self-expandable nitinol stent versus a paclitaxel-eluting stent in the treatment of above-the-knee, intermediate length femoropopliteal lesions."

Yann Gouëffic

The trial pits Misago RX (Terumo, Japan), a nitinol peripheral stent delivered via a rapid exchange (RX) monorail delivery catheter, against Zilver PTX (Cook Medical, USA), a paclitaxel-eluting, polymer-free nitinol stent. "Misago is bare nitinol stent which uses moderate radial force through the RX system," said Professor Gouëffic. "The Zilver PTX stent is self-expandable and delivered via an over-the-wire system." Specifically, the objective of this trial was to demonstrate the clinical superiority of primary stenting using Zilver PTX stent system versus Misago in patients with symptomatic peripheral arterial disease.

The BATTLE trial is a French, multicentre randomised clinical trial which ran between February 2014 and September 2018. It was carried out at 10 centres in France and Switzerland, said Professor Gouëffic, including Clinique d'Antony under Jean Marc Pernes and CHU de Bordeaux under Eric Ducasse.

"The BATTLE protocol has been in evolution since 2014," added Professor Gouëffic. The investigative study follow-up includes 1-, 6-, 12-, and 24-month clinical assessment, he said. "In addition, we have 1-, 12- and 24-month X-rays to detect stent fracture," he added. The main endpoint of the BATTLE trial was freedom from in-stent restenosis at one year assessed by Duplex ultrasound.

Professor Gouëffic outlined the main inclusion criteria: patients with the Rutherford stages 2–5, *de novo* atherosclerotic lesions, stenosis and/or occlusion of the SFA, the proximal popliteal artery (P1), or both. "The target lesion should be between 2 and 14 cm in length and the reference vessel diameter (RVD) between 4 and 7 mm," he explained. "We excluded from the trial patients with asymptomatic lesions, restenosis and no atheromatous disease."

The original group enrolled 186 patients, of which 78 completed the one-year follow in the Misago group, and 82 completed one-year follow-up of Zilver PTX. Demographic data showed the mean age was 68 in the Misago group and 71 in the Zilver PTX group. Symptomatology included intermittent claudication at levels of 82% in the MISAGO co-group and 79% in the Zilver PTX, he added.

Professor Gouëffic displayed baseline lesion characteristics during the session. "They were similar in terms of length and diameter, and we mainly have two or three distal vessels patent," he said, adding: "We achieved a technical success of 100% in both groups."

Regarding the safety outcomes through the first year, there were two deaths in the Misago group and one death in the Zilver PTX group. "These deaths were not related to the procedure or the devices. The re-hospitalisation rate was similar in both groups," he explained.

With respect to clinical outcomes, Professor Gouëffic commented: "We have an improvement in two groups after one year in comparison to baseline, but without any difference. Also, in terms of haemodynamic outcomes we have no difference at one year between both groups."

Patency at 12 months for Misago was 81.6% and for Zilver PTX was 84.2%. "With regards to TLR, we have no difference at one year [Misago 8.9% and Zilver PTX 8.8%] and we notice that the rate of TLR is pretty similar to the PTX trial."

Freedom from in-stent restenosis, the primary endpoint, Professor Gouëffic noted no difference at one year despite a difference in both groups during the period of 6–12 months.

Offering his conclusions, Professor Gouëffic said: "In the BATTLE trial, the Zilver PTX polymer-free paclitaxel-eluting stent failed to show superiority in comparison to Misago, a bare metal stent. What the advantages of drug eluting therapy compared to bare metal stents [might be] is still required to define the strategy for the treatment of intermediate length femoropopliteal lesions."

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Lutonix BTK IDE is the only **Level 1 Randomised Control Trial** to show improved 6-Month efficacy and equivalent safety to PTA for the treatment of infra-popliteal disease.

LUTONIX® 014
Drug Coated Balloon PTA Catheter

6 Month Safety

DCB **97.8%**

PTA 95.3%

6 Month Efficacy

DCB **85.3%**

PTA 70.7%

Lutonix BTK IDE Clinical Data on File. Primary Efficacy is defined as freedom from composite of above-ankle amputation, target lesion occlusion, and clinically-driven target lesion revascularization. At 6 months, treatment with LUTONIX® 014 DCB resulted in a primary efficacy rate of 73.7% (190/266) versus 63.5% with PTA alone (87/137). The primary effectiveness analysis for superiority of DCB vs. PTA was not met with a p-value of 0.0273. At 30 days, treatment with LUTONIX® 014 DCB resulted in a freedom from primary safety event rate of 99.3% (283/285) versus 99.4% (154/155) for PTA alone. Primary Safety is defined as freedom from composite of all-cause death, above-ankle (index) amputation or major reintervention (new bypass graft, jump/interposition graft revision, or thrombectomy/thrombolysis) of the index limb involving a below-the-knee. The primary safety analysis for non-inferiority for DCB vs. PTA was met with a p-value of <0.001. Percentages reported are derived from Kaplan-Meier analyses.

Please consult product labels and instructions for indications, contraindications, hazards, warnings, and precautions. Rx_{only}

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BD BARD has joined BD

Latest findings on Lutonix DCBs

Data shows consistent safety and efficacy in BTK patients

The success and safety of the Lutonix® (BD, USA) paclitaxel drug-coated balloon (DCB) for below-the-knee (BTK) patients and high-risk subgroups came under expert scrutiny at LINC.

Headline topics up for in-depth examination and analysis included: keenly awaited data from a comparison of overall Lutonix BTK investigational device exemption (IDE) trial 6-month outcomes to a global registry (GLOBAL REGISTRY); analysis of the rates of downstream embolisation between different DCBs; and a subgroup analysis from the Lutonix randomised controlled trial.

Dr Patrick Geraghty, a vascular surgeon at the Washington University School of Medicine, St Louis, Missouri, USA, gave an update comparing the results of the Lutonix BTK DCB trial with the GLOBAL REGISTRY, announcing similar 30-day safety of the Lutonix DCB, with freedom from primary safety events of 99.3% (233/285) and 98.3% (354/360) in the GLOBAL REGISTRY. Safety events were defined as target vessel revascularisation (TVR), major index limb amputation and device- and all-cause death. Both sets of data also show a low amputation rate at 6 months: 1.5% in the IDE DCB arm and 4.4% in the GLOBAL REGISTRY.

"In light of the recent meta-analysis by Katsanos *et al.*, we looked at all-cause death within the IDE trial. A current snapshot of the IDE study shows no statistical difference in all-cause death to date: 13.9% in the DCB arm and 12.9% in the PTA arm. At the time of that snapshot, over 30% of subjects had reached 36 months of follow-up."

The GLOBAL REGISTRY results were consistent with the IDE DCB trial's findings, including a similar safety profile at 6 months, strong patency and freedom from target lesion revascularisation (TLR) results.

"The results signal Lutonix DCB as an efficacious and safe treatment for patients with complex BTK peripheral arterial disease [PAD]," Dr Geraghty told *LINC Review*. "The promising safety findings of the IDE RCT have been confirmed in the GLOBAL REGISTRY. Both studies involve complex patient groups – with a high percentage of Rutherford 4 and 5 classifications, and other comorbid conditions such as diabetes and hypertension – and reflect the sort of patients clinicians are treating in the real world."

"Whenever DCBs are used by clinicians, the potential for downstream emboli should be understood and products which minimise this occurrence should be selected, especially when multiple DCBs are used."

Aloke Finn

One third of patients with PAD will progress to critical limb ischaemia (CLI) and 27% will have one or more re-amputations. CLI is now a global epidemic affecting between 300 and 1,000 persons per million per year.[1]

There have also been two previous failed clinical studies on DCBs in the past. These include the IN.PACT DEEP study trial, which in November 2013 reported that after 12 months of follow-up, there was no difference between the active Amphirion™ DEB (Medtronic, USA) treatment and the standard balloon angioplasty in any of the study's three main outcome measures. The study also identified a potential safety signal with a trend towards an increased

rate of major amputations in the DEB study arm. [2] The product was recalled due to safety concerns in November 2013.

Another study, BIOLUX P-11, using the Passeo Lux DCB (Biotronik, Germany) enrolled 27 patients with CLI, randomised 1:1 to receive either a DCB or POBA. The trial failed to show any clinical or technical benefit at one year, although no difference in the major amputation rate was found.[3]

The DCB IDE trial is the first and only DCB RCT to date to prove safety and efficacy in this indication, including 442 randomised subjects in the US, EU, Japan, and Canada. Separate from the IDE enrollment, 371 patients were also enrolled in the GLOBAL REGISTRY in the EU. The IDE trial ran between June 2013 and December 2017 and the GLOBAL REGISTRY enrollment study period was between September 2015 and November 2017.

The key overlapping eligibility criteria included: being a male or non-pregnant female ≥ 18 years of age, a Rutherford classification of between 3 and 5, life expectancy ≥ 1 year and significant stenosis of ≥ 70%, a patent inflow artery, target vessels of between 2 and 4 mm and target vessels reconstituted at or above the ankle.

In the BTK IDE trial, 9.1% of patients had a baseline Rutherford 3 classification, 34.8% class 4 and 56.1% class 5, compared to 24.1% class 3, 10.5% class 4 and 65.4% class 5 in the BTK GLOBAL REGISTRY. A key finding in the GLOBAL REGISTRY study was that 80% of patients improved by ≥ 1 Rutherford class and 61% improved by ≥ 3 Rutherford classes.

In the BTK GLOBAL REGISTRY, freedom from TLR was 81.6%, with a low amputation rate of 5.4% and diabetics had no difference in freedom from TLR at 6 months. All-cause mortality was 12% after one year of follow-up, with 99.7% freedom from reintervention for distal embolisation.

Both the IDE and the GLOBAL REGISTRY studies treated patients with challenging health conditions, reflecting the types of patients that clinicians see in the real world. For example, in the BTK IDE trial, 92% had hypertension, 78.4% had dyslipidaemia, 59.3% were current or previous smokers, 71.1% had diabetes, 72.8% had undergone previous cardiovascular interventions and 53.7% had undergone previous peripheral vascular interventions. The figures were broadly similar in in the GLOBAL REGISTRY population, where 86.8% of subjects had hypertension, 62.5% dyslipidaemia, 51.4% were previous smokers, 63.9% had diabetes, and 74.8% had previous cardiovascular interventions. However, previous peripheral vascular interventions were lower, at 14.3%.

"The promising safety findings and low amputation rates of the IDE RCT of Lutonix DCBs have been confirmed in the GLOBAL REGISTRY in a challenging group of patients."

Patrick Geraghty

The mean age for the BTK IDE study was 72.9 years, versus 73.5 in the BTK Registry. Both studies treated around 70% men (70.4% in IDE and 72.2% in GLOBAL REGISTRY) and 30% women (29.6% in IDE and 27.8% in GLOBAL REGISTRY). In the BTK IDE study 90% of patients had CLI, versus 75.9% in the GLOBAL REGISTRY.

Not all DCBs have the same risk of downstream embolisation – that was the clear message from Professor Aloke Finn, Medical Director of the CVPath Institute and Associate Professor of Medicine at the University of Maryland School of Medicine, Baltimore, USA. Speaking to *LINC Review*, Professor Finn made the important point that whilst it's tempting to think of DCBs in terms of their class effects, differences in performance do clearly exist between products.

Professor Finn explained: "In contrast to drug-eluting stents (DES) which contain a polymer-drug reservoir to control drug release over months, drug transfer by DCBs takes place during the period of balloon inflation (1–3 minutes typically). Drug transfer is relatively inefficient with the majority of loaded drug never being fully transmitted to the target treatment site compared to DES.

During balloon inflation the

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Latest findings on Lutonix DCBs

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drug-excipient coating delivers particulate paclitaxel, which ensures the persistence of the drug at the site of the target tissue where it is needed to help prevent restenosis. Paclitaxel has lipophilic properties, allowing passive absorption into the arterial wall and sustained anti-restenotic drug effect.

"However, it is clear from preclinical animal studies that excipient and drug may embolise non-target organs. The potential consequences of these emboli remain uncertain, but it seems logical that this is an unwanted side-effect given the known tissue-damaging effects of paclitaxel. "

Professor Finn said the various DCB technologies differ in their design with regards to excipient coatings and drug form (amorphous versus crystalline, including the size of the crystals). Drug delivery to the luminal surface is facilitated by different carrier excipients such as iopromide, urea, or polysorbate/sorbitol.

He stressed: Each DCB technology should be evaluated separately based upon their individual components to understand effects not only on target tissues but also non-target tissues.

"Overall, the IN.PACT Admiral [Medtronic] balloon contains the highest drug dose (3.5 µg/mm^2) with a urea-based excipient while Lutonix 035 DCB contains a lower dose (2 µg/mm^2) and a polysorbate/sorbitol carrier," said Professor Finn.

"More recently, the Stellarex DCB (Spectranetics, USA) was approved by the US FDA for clinical use. This product has a lower dose of paclitaxel (2 µg/mm^2) with a polyethylene glycol carrier. The Ranger DCB (Boston Scientific, USA) also contains the same dose of paclitaxel with an acetyl-tributyl citrate carrier and is currently in clinical trials for FDA approval."

Professor Finn said that the ideal DCB should effectively deliver the drug to the target (e.g. the superficial femoral artery, SFA) while minimising the occurrence of downstream emboli. He pointed out that particulate emboli after DCB delivery are difficult to detect in the clinic especially because clinical tests used to assess patient outcome are unable to discern whether such emboli have occurred. "Thus, reliance on clinical data alone might not be enough to ensure the safety of these products. Our understanding of the performance of different products continues to evolve as we do more investigation of embolic effects. "

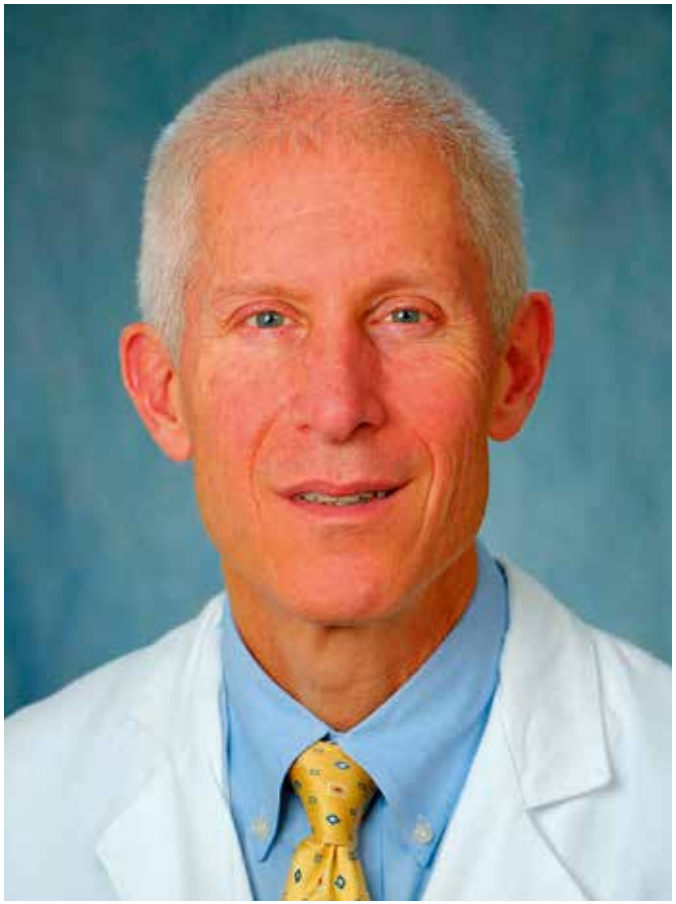
Professor Finn added that a porcine preclinical study was the first to demonstrate at the preclinical level differential downstream effects of different DCBs.[4] This study highlighted important safety considerations for DCB technology.

"We previously reported a study in which the Lutonix 035 and the IN.PACT Admiral were tested for target vessel changes and downstream embolic events in the porcine femoral artery model.[5].Femoral artery target tissue drug effects such as medial proteoglycan score and smooth muscle cell loss score were statistically and significantly Global Registryeater in the IN.PACT DCB at 90 days follow-up after overlapping balloons, and were accompanied by more downstream embolic debris for IN.PACT versus Lutonix.

"However, it remains unclear what the optimal dose and duration of drug should be to have sustained clinical effect."

Earlier this year, Professor Finn *et al*. published the results of another head-to-head preclinical study examining IN.PACT, Stellarex, and Ranger at triple doses in the same model at 28 days[4]. For all DCBs tested, a similar drug vasculature effect was seen at the target treatment site.

"The percentage of sections with downstream vascular changes in arteriolar beds was highest for IN.PACT, followed by Stellarex and was the least for Ranger," revealed Professor Finn. Embolic crystalline material was also observed in all cohorts and followed a similar trend. Drug



analysis however, showed similar paclitaxel concentrations in non-target coronary band tissue but higher levels in downstream skeletal muscle for IN.PACT versus the other two DCBs.

Commenting on the results, Professor Finn said: "Our understanding of the significance of downstream emboli after DCB treatment continues to evolve. While patients in clinical trials tend to be highly selected, those undergoing treatment in the clinic may have more significant disease with limited flow reserve and lower ischaemic thresholds. These patients might be the ones more susceptible to embolic debris and yet our knowledge of

"Lutonix DCB appears to work equivalently across subgroups. There was not a statistically significant difference in results when reviewing subgroups including: patients on anti-platelets, fistula age, diabetics, recurrent vs. de novo lesions, fistula location, or lesion location."

Scott Trerotola

how they do after DCB treatment is limited. Whenever DCBs are used by clinicians, the potential for downstream emboli should be understood and products which minimise this occurrence should be selected, especially when multiple DCBs are used.

"The goal is to cause target vessel changes without damaging downstream muscle beds. The focus of my research currently is to understand more about how these emboli affect vascular function. It remains likely that crystalline paclitaxel might have damaging effects on the endothelium of skeletal muscle beds which could potentially affect its function, causing local tissue oedema. This type of research will help us better understand the risks of using these devices and better guide their use in the clinic."

Scott Trerotola, Stanley Baum Professor of Radiology and Professor of Surgery at Perelman School of Medicine, University of Pennsylvania, Philadelphia, USA, spoke to *LINC Review* about the 24-month results of the Lutonix AV IDE Clinical Trial – the first, large multi-centre randomised trial using DCBs in dysfunctional fistulae. Safety and efficacy of the technology were the primary endpoints.

Professor Trerotola said: "The Lutonix AV IDE Clinical trial demonstrated continued safety and comparable mortality and is the only multicenter RCT with 24-month reported results in dysfunctional fistulae.

"The Lutonix DCB proved to be safe at both the primary endpoint of 30 days, as well as through the 24-month endpoint. Furthermore, there was no statistically significant difference in mortality between DCB and the control arm. The DCB did not meet the primary efficacy endpoint at 180 days, yet the study showed a sustained improvement trend beginning at two months and continuing through two years.

"In addition, there was a four-month average benefit in prolongation of time to the next intervention for those experiencing an event. The subgroup analysis was performed to better understand if we could identify specific patient populations where the DCB had varying effects."

He added: "The Lutonix DCB appears to work equivalently across subgroups. There was not a statistical difference in results when reviewing subgroups including: patients on anti-platelets, fistula age, diabetics, recurrent versus *de novo* lesions, fistula location, or lesion location."

He continued: "There are trends in some areas. Some have asked if there should be targeted use of DCBs in specific patient groups; we have not been able to make any definitive conclusion based on these results. I will add that these are post-hoc analyses and the study was not powered for subgroups, so additional research is needed for a definitive answer."

Professor Trerotola said he was personally very interested in seeing the results of patients who were taking antiplatelet therapy. "I'm often asked if I recommend use of antiplatelets after DCB. In the trial, it was up to the individual physician to determine use. Approximately 45% of subjects were taking antiplatelet agents at 6 months. Although previous studies have shown that their use can protect against loss of patency after PTA, there was not a statistically significant patency benefit afforded by antiplatelet use after DCB in this trial."

The good news to emerge from the 24-month results was that there was no negative safety signal for subjects with dysfunctional AV fistula; mortality results were comparable over two years. "One concern from the Katsanos meta-analysis was an increase in cardiovascular-related mortality. I've personally reviewed the individual patient data from the Lutonix AV IDE Clinical Trial and the cardiovascular deaths were the same in the control arm and with Lutonix. In addition, 2 year mortality in both arms of the study is well below that published the USRDS." The results were adjudicated by an independent Clinical Events Committee (CEC) as well as an independent Data Safety and Monitoring Board (DSMB), Professor Trerotola emphasised. "In addition, to date, this is the only DCB which has gone through the rigours of receiving FDA approval in AV".

Professor Trerotola said he was "excited" to see the amount of ongoing research with DCBs in AV. "We are now enrolling in the Lutonix AV Post Approval Study, which adds another 213 subjects, so I look forward to seeing subgroup data from that trial. The Lutonix balloon has more than 800 subjects under protocol and Medtronic has a large study that will soon have results. The amount of subject data from these trials is unprecedented, so I look forward to learning more about how to best treat dysfunctional access."

References

1. The TransAtlantic Inter-Society Consensus (TASC) Working Global Registry Group
2. Zeller T, Baumgartner I, Scheinert D, Brodmann M, Bosiers M. Drug -Eluting Balloons v Standard Balloon Angioplasty for the Infrapopliteal Arterial Revascularisation in Critical Limb Ischaemia: 12-month results from the IN.PACT DEEP randomised trial. J Am Coll 214 Oct 14;64(15): 1586-76
3. Zeller T, Beschorner U, Pilger E, Bosiers N, Deloose K, Peeter P. Paclitaxel-Coated Balloon on Infrapopliteal Arteries; 12 Months Results from The BIOLUX P-11 Randomised Trial (BIOTRONIK's First in Man Study of the PASSEO-18 LUX Drug-Releasing PTA Balloon Catheter in Subjects Receiving Revascularisation of Infrapopliteal Arteries. JACC Cardiovasc Interv 2015. Oct; 8 (12): 1614-22
4. Torii S, Jinnouchi H, Sakamoto A, Romero M, Kolodgie FD.Comparison of Biologic Effect and Particulate Embolisation after Femoral Artery Treatment With Three Drug-Coated Balloons in Healthy Swine Model. J. Vasc Interv Radiol.2019 Jan;30(1):103-109).
5. Kolodgie FD, Pacheco E, Yahaq K, Mori H, Ladiche E. Comparison of Particulate Embolisation after Femoral Artery Treatment with IN. PACT Admiral versus Lutonix 035 Paclitaxel- Coated Balloons in Healthy Swine. J Vasc Interv Radiol 2016 Nov; 27(11); 1676-1685

GoBack™ Crossing Catheter case studies

Andrej Schmidt, MD
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Figure 1: The GoBack™ Crossing Catheter

Device description

The GoBack™ Crossing Catheter is a 4 Fr single-lumen crossing catheter which features a curved nitinol needle that serves as an effective crossing tool. The needle protrudes from the catheter's distal end. The pre-shaped needle's protrusion length can be selected by the clinician using the device's handle.

The options are a straight 3 mm needle protrusion, a partially curved 7 mm protrusion and a fully curved 11 mm protrusion. This way, the catheter can be used as a crossing device for lesions that are difficult to pass, as well as a re-entry device. A radio-opaque marker on the needle's distal section provides guidance as to the needle tip's axial and radial positioning. This facilitates easy steering of the instrument in the desired direction. The GoBack Crossing Catheter is intended for use with 0.018" guidewires (Figure 1).

Case 1: Crossing in-stent restenosis

A 62-year-old male patient admitted for severe claudication presented a long reocclusion of the left SFA and popliteal artery after stent implantation a few years prior. The first stent crossing was performed using a guidewire supported by a balloon catheter. The subsequent stent's proximal cap was impossible to penetrate using a guidewire, and the wire deflected into the subintimal space instead of remaining intraluminal (Figures 2a & 2b).

The GoBack Crossing Catheter was inserted and advanced to the desired location. I extended the needle to its maximal length and then aimed and pushed against the hard, proximal cap within the stent (Figure 2c). The needle was able to penetrate the cap, and a 0.018" guidewire was able to cross through the entire stent's length (Figure 2d).

Case 2: True lumen re-entry

A 59-year-old male patient admitted for severe claudication presented a severely calcified, long SFA occlusion in the left leg. A large block of calcium prevented the guidewire from crossing the lesion, and deflected the guidewire into the subintimal space. Re-entering the distal true lumen was not possible.

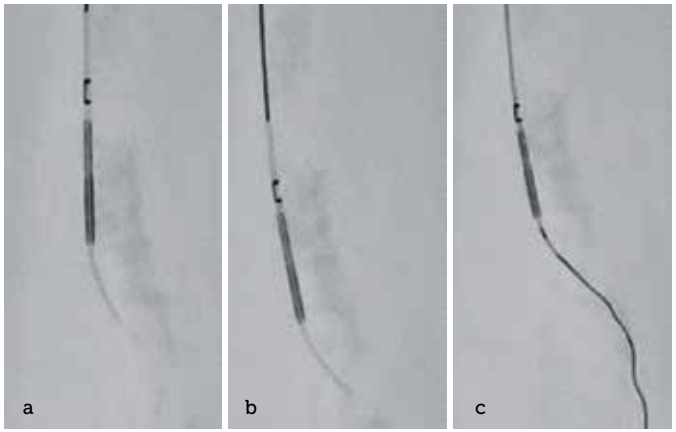


Figure 3

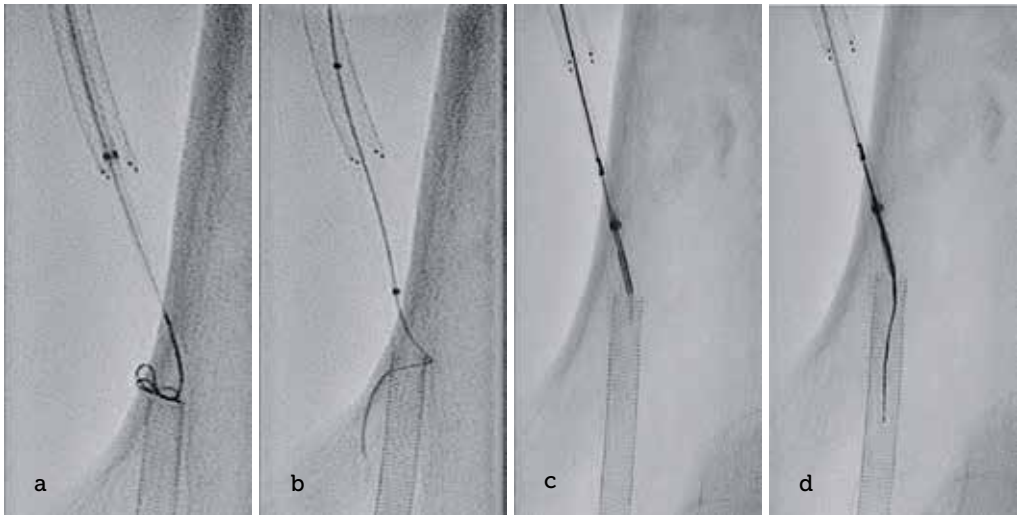


Figure 2

I decided to use the GoBack Crossing Catheter as a re-entry device. The GoBack Crossing Catheter was able to push through the lesion and reach the distal section of the calcium, proximal to the true lumen. Due to the large gap between the GoBack Crossing Catheter and the true lumen, the fully protruded needle was unable to reach the true lumen (Figure 3a). This large gap was crossed by advancing the GoBack Crossing Catheter forward with the fully protruded needle. The GoBack Crossing Catheter's distal section followed the needle's direction, closed the gap, and allowed the needle to penetrate into the true lumen (Figure 3b). The 0.018" guidewire was then advanced through the curved needle into the true lumen (Figure 3c).

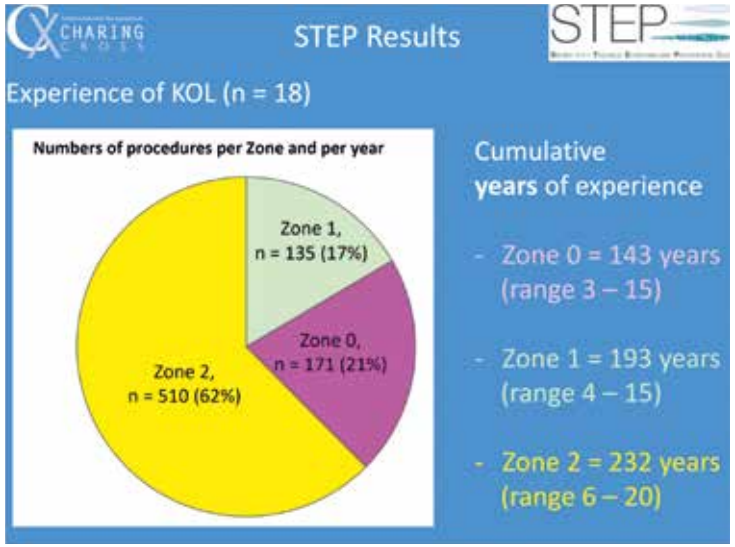
CX@LINC: Stroke prevention in TEVAR; what the experts say

The CX@LINC session brought together LINC and the Charing Cross Symposium, covering a range of endovascular aortic controversies, featuring presentations on new NICE aortic guidelines and whether EVAR procedures should be done under local anaesthetic.

Tilo Kölbel (University Heart Centre, Hamburg, Germany) presented the first phase results of the Stroke from Thoracic Endovascular Procedures (STEP) initiative to improve outcomes for patients undergoing TEVAR. "I'm sure we all agree that stroke is still the main issue in TEVAR," he said. "We see, in larger multicentre studies and meta-analyses, strokes happen in about 4 to 5% of all TEVAR procedures, and that figure has not changed considerably over the past 10 years."

STEP is the brainchild of several colleagues at Imperial College, London including Fiona Rohlffs and Charing Cross Symposium Chairman Roger Greenhalgh. It aims to gather examples of best practice from around the world by questioning 18 key opinion leaders in TEVAR. Their methods might go some way to prevent something that is still not well understood, said Professor Kölbel.

"The mechanism of stroke is not yet clear, and we consider all these potential factors – air, thrombus and particles – as mechanisms for stroke in



Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

"Strokes happen in about 4 to 5% of all TEVAR procedures, and that figure has not changed considerably over the past 10 years."

Tilo Kölbel

TEVAR," he explained. "There is significant research to be done to understand better what happens when a patient has a stroke in TEVAR."

STEP has consulted opinion leaders from Frank Arko, Carlos Bechara and Adam Beck, to Dittmar Böckler. The initiative has also worked in close collaboration with the manufacturers, although Professor Kölbel stressed it is neither a manufacturer-led nor sponsored initiative. "We use manufacturers to define key opinion leaders all over the world and they participated as collaborators in the study," explained Professor Kölbel. "We want to learn from their experience and define future steps towards TEVAR with lower stroke rates."

As well as maintaining independence from industry, STEP will investigate all potential mechanisms and sources of stroke and aim to be interdisciplinary, learning from colleagues to improve the safety of patient treatments, said Professor Kölbel.

The first step, he said, was to characterise current practice in centres of excellence all over the world, and analyse the pre-, intra- and post-procedural aspects of TEVAR. "Firstly, we looked at yearly practice – which a very significant number – not only for the key area of TEVAR, which is zone two, but also to further proximal areas – zones one and zero," he explained. "That amounts to around 800 patients per year."

With regards to the results of the study, there was a broad consensus that an interdisciplinary team decision is necessary for any kind of treatment performed within zone zero. However, opinion leaders made less strong statements towards interdisciplinary team decisions when discussing procedures performed in zone one and zone two. "That reflects my personal practice very much," said Professor Kölbel.

Then there was also strong consensus about the advantages of TEVAR not just in elective but also emergency cases, he said. In addition, CT angiography was the imaging technique of choice for these cases, according to opinion leaders.

No consensus was reached on the maximum age of CT scans acceptable in planning an endovascular procedure, although the most frequent answer was three months or less.

There was consensus on anticoagulation, however, noted as having a central role in preventing a stroke or cerebral damage in TEVAR. "The procedure should be done under antiplatelet therapy with heparinisation and an activated clotting time (ACT) of between 250 and 350 seconds," said Professor Kölbel.

Amongst the opinion leaders, there was no consensus about the need for revascularisation of the left subclavian artery (LSA). "About half of the key opinion leaders said LSA revascularisation should be done selectively under certain circumstances," he explained. Those circumstances include preventing spinal cord

Continued on page 62

CX@LINC: Stroke prevention in TEVAR; what the experts say

Continued from page 61

ischaemia, AV-Fistula or left internal mammary artery bypass for example. Conversely, half the opinion leaders said performing LSA revascularisation should be routine in all elective TEVAR cases.

On the subject of cardiac output reduction, continued Professor Kölbel, there was a consensus to avoid lowering blood pressure when deploying stent grafts in zone zero. "But there were less strong statements on the need for cardiac output reductions in zones further distally," he added. Opinion leaders also varied in techniques of cardiac output reduction. The majority of them opted for rapid ventricular pacing, while a small minority chose inferior vena cava occlusion (IVCO) or adenosine.

A technique highlighted to prevent cerebral embolisation was carotid artery clamping, added Professor Kölbel. "In cases where the chronic artery is dissected, [nobody] stated that they deliberately dissected the artery to clamp it during TEVAR," he said, adding that he was surprised to see so many opt for the CO_2 flushing technique. In just one year this has become a technique of choice in a significant number of centres, he added.

Professor Kölbel also touched upon several adjunctive techniques in his presentation. "The CT fusion technique is used very frequently but may not have an impact on cerebral protection, and cone beam CT is already in use within half of the centres," he said. "Intraoperative monitoring of brain function is done in the majority of cases using these techniques."

> *"There is significant research to be done to understand better what happens when a patient has a stroke in TEVAR."*
>
> **Tilo Kölbel**

There was also consensus that post-operative CT angiography is the follow-up method of choice for TEVAR, said Professor Kölbel. What's less clear is when angiography should be done, he added, although most opinion leaders thought that sooner rather than later is better. "The majority aim for CT angiography directly post-procedurally during hospitalisation of the patients," he said.

On the question of how neurological function is evaluated in the centres, Professor Kölbel relayed that STEP received quite mixed feedback. "It was different between zones, but the majority of centres agreed that neurological evaluation by MRI is only performed when needed, depending on the symptoms of the patients," he said.

Although the first phase of STEP has been extremely interesting, Professor Kölbel said the goal of the next phase is to evaluate cerebral damage in patients treated with TEVAR in the aortic arch. "We will look, with our collaborators, at the number, size and distribution of silent brain infarctions defined by diffusion-weighted MRI imaging," he explained. "The protocol has been developed and implemented and we will look at these factors and the association they have with the degree of cerebral damage."

Those factors also include the association between patient and procedural factors, the landing zone, type of device (tubular, fenestrated, branched) and protective techniques.

"TEVAR is in our view still plagued by a high frequency of stroke and cerebral damage. We will report the initial results of phase 2 of the Step initiative showing cerebral damage after TEVAR at the Charing Cross Symposium in London," concluded Professor Kölbel.

EFFECTIVE LOW DOSE AND SAFE

Not all DCBs are equal. The LUTONIX® 035 Drug Coated Balloon PTA Catheter is designed to be both safe and effective. While the LUTONIX® DCB delivers an impressive **85.4% primary patency at 12 months***, it also distinguishes itself from high-dose DCBs in important characteristics ensuring that you'll get both the results you demand and the peace of mind you deserve.

LUTONIX® 035
Drug Coated Balloon PTA Catheter

CLINICAL	LUTONIX® DCB
Low Drug Dose	2.0 µg/mm²
Carrier	Polysorbate & Sorbitol
Plasma Half-Life	6.88 Hours**
PRE-CLINICAL†	
Downstream Necrosis	0%
Downstream Crystalline Material	0%

* Lutonix Global SFA Real-World Registry. Primary Patency of the target lesion is by investigator assessment based on presenting symptoms and clinical exam and by absence of CEC adjudicated TLR event. Total of 614 subjects were evaluable for primary patency at 12 months. The primary patency success rate at 12 months as determined by subject counts was 83.1%. The primary patency rate for all subjects as measured by Kaplan-Meier estimates resulted in 85.4% for 12 months.

** PK1400100 Rev. 2 04/18

† Virmani et al. Comparison of Particulate Embolization after Femoral Artery Treatment with In Pact Admiral versus Lutonix 035 Paclitaxel-Coated Balloons in Healthy Swine. J Vasc Interv Radiol. 2016 Nov;27(11):1676-1685.e2. doi: 10.1016/j.jvir.2016.06.036.

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BARD has joined BD

New endovascular options for creating AV fistulas

Leading endovascular specialists gave LINC an update on the latest research findings on the success, safety and patency outcomes of a new minimally invasive device dedicated to the creation of endovascular arteriovenous (AV) fistulas (endoAVF).

Use of endoAVFs via the proximal forearm offers an additional option for end stage renal disease haemodialysis patients, delegates heard. The device showcased was the WavelinQ™ 4F EndoAVF System (Becton, Dickinson and Company), the latest version of the endovascular AV fistula technology that builds on the previous 6 French (Fr) device. The 4 Fr system has only been in use in the EU for less than two years, but early adopters are already reporting positive results, with good safety and efficacy, according to the latest global pooled data from the EASE, EASE2 and the endoAVF EU study announced at LINC.

Globally, there are two million people on haemodialysis, with the majority relying on surgical fistulas as their lifeline for continuing dialysis therapy. Surgical fistulas were first described more than 50 years ago, but the procedure is still fraught with challenges, including mean maturation times ranging from 4 to 9 months, and failed maturation rates of 20–60%. They also have high rates of failure and primary reintervention, with intimal hyperplasia, stenosis and vessel manipulation during AV fistula creation being contributory factors. [1] The loss of patency is associated with significant morbidity, and subsequently patients become reliant on a central dialysis catheter which carries a risk of increased mortality.

The latest endovascular technologies such as the WavelinQ™ 4F EndoAVF System device (previously known as everlinQ™ 4 endoAVF System) allow endoAVF formation with minimal vessel trauma. The system uses two, thin, flexible, magnetic catheters that are inserted into the artery and the deep vein in the arm through a small puncture. Multiple access points in the arm (described below) can be used allowing adaptability to anatomical variations. When directed to the site of anastomosis in the forearm, the adjacent magnets in each catheter attract, coapting the vessels together. After confirming alignment, an electrode from the venous catheter delivers radiofrequency energy to create a connection between the artery and vein. Embolisation of one of the brachial veins is then recommended to direct blood flow from deep to superficial venous systems via the forearm perforator vein. The fistula is confirmed with an angiogram to show that arterial blood is flowing to the low-pressure venous system.

The procedure minimises the amount of vessel and skin trauma compared to traditional fistula creation using open surgery, and initial results with the original 6 Fr device have demonstrated encouraging outcomes in terms of high technical success rates, low reintervention rates and usability for haemodialysis at 12 months.

Dr Rob Jones, a consultant interventional radiologist from Queen Elizabeth Hospital, Birmingham, UK, presented new data to demonstrate the acceptable safety and effectiveness profile of the WavelinQ™ 4F EndoAVF System. Speaking ahead of LINC, Dr Jones told *LINC Review* that the new pooled global data from the three studies has shown that the WavelinQ™ 4F EndoAVF System has a similar success rate to the 6 Fr design, but with lower complication rates at 6 months. "Because the 4Fr device is of a smaller calibre, we can therefore use the wrist vessels which we couldn't with the 6Fr predecessor," explained Dr Jones. "It's minimally invasive – there is no incision scar – which is particularly important for some patients; endovascular fistulas are not unsightly in the same way as a surgical fistula can be.

"The key to achieving success with this device is to have a good multidisciplinary team relationship with your radiologists, surgeons and dialysis unit."

Rob Jones

"Patients who have surgical fistulas end up having on average three to four interventions a year, but with the 4 Fr trial data it's less than one intervention per year, and there is also improved longevity, with durable patency results at 6 months."

However, he emphasised the results were in a clinical trial setting, so whether this success rate can be replicated outside of specialist trial centres is left to be seen.

"One of the key messages I will be trying to get across at LINC is that this is a procedure for a clinician with the necessary endovascular skills, and with a baseline understanding of the technology," Dr Jones continued. "To get a good level of competency, and maintain it, you need to be performing a regular volume of procedures – you can't just do one a year.

The key to achieving success with this device is to have a good multidisciplinary team relationship with your radiologists, surgeons and dialysis unit.

"The advantage of a multidisciplinary team is that you have your colleagues to support you. We all bring something different to the table and we each have our own expertise and opinions."

Dr Jones works alongside his colleague Nicholas Inston, a consultant renal surgeon, as well as his vascular access expert, Dr Khawaja who screens patients and assesses anatomy. "The patients are then followed up by the surgeon and our renal access nurse specialist who carries out cannulation," he said.

Mr Inston added his perspectives on the WavelinQ™ 4F EndoAVF System: "Patient selection is absolutely key – and we don't know yet which patients are best suited to this or a surgical procedure," he said.

Indeed, Mr Inston reasoned that when setting up an endoAVF programme, it is important to work with patients that have every chance of success in order to boost confidence in the procedure. "You need patients with good, suitable, anatomy, ideally that is patients with reasonably sized vessels (particularly the target cannulation vessels) and a perforator draining into a superficial system, predominately a cephalic vein drainage. That all comes from the ultrasound mapping and patient selection."

As Mr Inston detailed, the site where this fistula is formed is completely new, and the vascular drainage is different to standard fistulas. "If you select a patient with a cephalic vein that is small, and the other veins are large, the fistula is more likely to drain by the other veins," he said. "That's not a deal-breaker, but it just needs consideration as people will think of it as a non-successful procedure, when actually it followed a predictable path" adding that "in time this procedure may provide a valuable approach to perform the first stage of a basilic or brachial vein fistula,"

Framing the advantages of procedures using the WavelinQ™ 4F EndoAVF System, Mr Inston continued: "Obviously it's less invasive – it just needs two needle holes in the arm. There is an argument that this is less traumatic for the blood vessels, which helps with better maturation of the fistula. Causes of failure to mature in surgical fistulas include trauma when mobilising the vein and the unfavourable angle of the anastomosis. This procedure avoids both. This device works deep in the mid forearm – it's a completely novel site for a fistula to be chosen, one that is really not an option surgically."

"This device works deep in the mid forearm – it's a completely novel site for a fistula to be chosen."

Nick Inston

Mr Inston also stressed that the flow through the fistula is different to a standard surgical fistula, in that it comes through multiple vessels. This, he added, likely helps reduce the turbulent flow through each vessel, and may lower the chance of neointimal hyperplasia," he said.

One minor implication of the reduced flow rates through the fistula is that the nurse undertaking cannulation may not feel a fistula that seems to be as "strong", said Mr Inston. "That's why we have a specialist access nurse involved. They have been able to cannulate nearly all these fistulas with good flow by just using slightly modified cannulation techniques," he said.

In terms of failure rates, Mr Inston shared that outcomes compare favourably to surgical fistulas. "While there isn't yet an abundance of evidence to be certain that these last longer than surgical fistulas, they appear to not require as many interventions within six months."

Summing up his experience with using the WavelinQ™ 4F EndoAVF System, Mr Inston relayed the excitement surrounding this device size. "It is a welcome advance in the field of fistula formation. I think there are certain considerations needed in terms of using it – I don't think it's a case of completely moving from surgical fistulas to this. For example, there will be an element of patient selection, and an element of how much expertise is involved, but if the results achieved so far are maintained, I think this is the direction fistula formation should go; either as a primary procedure, or for slightly more challenging fistulas.

"I say this because it's minimally invasive. If we can do this procedure with minimal morbidity on marginal blood vessels, and these mature it improves the possibilities of what we can do in the future.

"When you look at the people with the right anatomy, there are probably 75–80% we assess who would be suitable, and with the right skillset there is a good probability of successful fistula creation. This has been demonstrated in multiple centres now. It's still too early to say what the optimal application is, but it's certainly promising."

Different approaches in WavelinQ endovascular access

Robert Shahverdyan, a vascular

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New endovascular options for creating AV fistulas

Continued from page 65

and endovascular surgeon who is Head of the Vascular Access Center at the Asklepios Clinic, Barmbek in Hamburg, Germany, discussed the different groups of patients who could potentially benefit from the 4 Fr procedure, based on his clinical experience using the device. Dr Shahverdyan currently performs more than 600 AV fistulas a year and has performed 26 endoAVF with the 4 Fr device outside of the clinical trial. "The WavelinQ™ 4F EndoAVF System is currently being used both for patients who have had a failed surgical fistula and as a primary option; also, in patients who just want a minimally invasive procedure without incisions and scarring," Dr Shahverdyan told *LINC Review* about the use of the device within in his practice.

Speaking more generally to begin with, he underlined a key advantage of the endoAVF procedure: "During open AV surgery you have to dissect and clamp the vessels, so it is traumatic and there is a risk of stenosis or damage developing, leading to intimal hyperplasia. As such, this leads to damage to the vessel wall and, ultimately, higher risk of juxta-anastomotic stenosis. Therefore, this could be seen as an advantage for the endovascular procedure."

Building on the perspectives of Dr Jones and Mr Inston, Dr Shahverdyan added his own input as the advantages of the WavelinQ™ 4F EndoAVF System sizing in particular. "The 4 Fr device extends the options when creating fistulas in patients," he said. "It really is a major improvement on the 6 Fr design because it's smaller, and so is suitable for the anatomy of many more patients.

"Overall, feedback from patients is that if it works, they don't have scarring typically seen with surgery and they are very happy."

Robert Shahverdyan

"A disadvantage of the 6 Fr device is that you access the brachial vein from the upper arm, i.e. you work against the valves which can make it tricky to reach the exact vein you are intending to use for the fistula operation. Moreover, the haemostasis of the brachial artery is much more difficult than that of the wrist arteries."

Returning to the 26 cases he has performed using the 4 Fr device within the last year, he outlined the outcomes thus far. "The technical success rate was very high – for 26 cases I had only one case where I couldn't create a fistula. In terms of how long they will last, this question will only really be answered with time and a higher volume of patients," he said.

Underlining his overarching message, he continued: "This procedure doesn't take away the chance to create a surgical fistula at a later date, nor does it replace surgical fistulas. Rather it adds a new option. If it fails after one month, one year, or 10 years, the key message is that those patients will have gained that period of dialysis success. It gives them that extra option and extra time for dialysis."

He added: "There are still a lot of things we have to figure out about this technique, including which vessels are best for it – radial or ulnar vessels – and where the anastomosis connection should be with relation to the perforating vein."

Study results laid bare

Daniela Branzan, head of the Department of Vascular Surgery, University Hospital, Leipzig has gained extensive experience using the WavelinQ™ EndoAVF System during the EndoAVF European Post-Marketing Study.

As she told *LINC Review*, the pilot FLEX Study[1], completed in 2014, demonstrated the feasibility and safety of using the 6 Fr System. Specifically, an endoAVF was successfully created in 32 of 33 patients, with cumulative patency at 6 months of 97%, and the mean time to maturation (58 days) compares favourably to published results of surgical techniques.

The NEAT Study[2] in 2016 demonstrated safety and effectiveness of using the 6 Fr device in nine centres in Canada, Australia, and New Zealand. In total, 80 patients were enrolled. AV fistulas were created in 98% of participants, with 12-month primary and cumulative patencies of 69% and 84%, respectively. NEAT concluded that the WavelinQ™ 6F EndoAVF System may be a viable alternative option for achieving AV fistulas in haemodialysis patients in need of vascular access.

Future publications of the WavelinQ™ 4F EndoAVF System clinical data will build upon the foundation defined by the earlier WavelinQ™ 6F EndoAVF System experience. Data is being pooled from three studies: EASE, EASE-2 and the endoAVF EU study which is ongoing. She also stressed that one of the main advantages of endoAVF formation compared with traditional surgical methods was that patients who received the former underwent significantly fewer additional procedures for maturation and/or maintenance of patency. "This could be related to the lack of surgical trauma to the vessels, maintenance of the vasa vasorum of the vessels, and improved haemodynamics with a consistent side-to-side anastomosis," said Dr Branzan.

"This overall reduction in post-

"This [fewer first year intervention rates] could be related to the lack of surgical trauma to the vessels, maintenance of the vasa vasorum of the vessels, and improved haemodynamics with a consistent side-to-side anastomosis."

Daniella Branzan

creation procedures in the first year was associated with lower total procedural costs."[3]

Dr Branzan echoed that patient selection is key for creation of an effective endoAVF. "I start by looking at the forearm perforator vein. If this vessel is very small or partially thrombosed the patient is not a good candidate. Besides a good arterial inflow and a good venous outflow, which is standard for every AV creation, we need suitable access vessels for the introduction of the catheters. They need to be at least 2 mm in diameter, as well as target vessels at the creation sites larger than 2 mm in diameter."

She went on to note that one disadvantage of the endoAVF technique is that the area of the lower arm below the perforator cannot be used for cannulation. What's more, the WavelinQ™ 6F System only allows for retrograde puncture of the vein and the navigation of the guidewire against the vein valves is technically somewhat challenging. "However, this disadvantage can be eliminated by using the 4 Fr system and puncturing a wrist vein," she said, which will allow for antegrade wire navigation with the valves.

Dr Branzan concluded: "With the WavelinQ™ 4F EndoAVF System the procedure becomes straightforward and easier to perform. By reducing the complexity and the time of the procedure, this could become the first choice for creating an AV access in patients with a good perforator vein."

WAVELINQ™ 4F EndoAVF System has been previously referred to as the everlinQ™ endoAVF System

DISCLAIMER: The WAVELINQ™ 4F EndoAVF System is not available for sale or distribution in the United States of America.

References

1. Rajan DK, Ebner A, Desai SB, Rios JM, Cohn WE. Percutaneous creation of an arteriovenous fistula for hemodialysis access. Journal of Vascular and Interventional Radiology. 2015;26(4):484-90.
2. Lok CE, Rajan DK, Clement J, Kiaii M, Sidhu R, Thomson K, *et al*. Endovascular Proximal Forearm Arteriovenous Fistula for Hemodialysis Access: Results of the Prospective, Multicenter Novel Endovascular Access Trial (NEAT). American Journal of Kidney Diseases. 2017;70(4):486-97.
3. Yang S, Lok C, Arnold R, Rajan D, Glickman M. Comparison of post-creation procedures and costs between surgical and an endovascular approach to arteriovenous fistula creation. Journal of Vascular Access. 2017;18(Suppl. 2):8-14. BPV/ENDO/0119/0099

everlinQ™ 4 endoAVF System

INDICATIONS The everlinQ 4 endoAVF System is intended for the cutting and coagulation of blood vessel tissue in the peripheral vasculature for the creation of an arteriovenous fistula used for hemodialysis.

CONTRAINDICATIONS Known central venous stenosis or upper extremity venous occlusion on the same side as the planned AVF creation. • Known allergy or reaction to any drugs/fluids used in this procedure. • Known adverse effects to moderate sedation and/or anesthesia. •Distance between target artery and vein > 1.5 mm. • Target vessels < 2 mm in diameter.

WARNINGS, CAUTIONS, PRECAUTIONS

WARNINGS The everlinQ 4 System is only to be used with the approved commercially available devices specified in instructions for use. Do not attempt to substitute non-approved devices or use any component of this system with any other medical device system. • The everlinQ 4 System catheters are single use devices. DO NOT re-sterilize or re-use either catheter. Potential hazards of reuse include infection, device mechanical failure, or electrical failure potentially resulting in serious injury or death. • Use caution when performing electrosurgery in the presence of pacemakers. • Improper use could damage insulation that may result in injury to the patient or operating room personnel. • Do not plug device into the electrosurgical pencil with ESU on. • Keep active accessories away from patient when not in use. • Do not permit cable to be parallel to and/or in close proximity to leads of other devices. • Do not wrap cable around handles of metallic objects such as hemostats. • Consult the ESU User's Guide on its proper operation prior to use. • Do not use closure devices not indicated to close the artery used for access.

CAUTIONS Only physicians trained and experienced in endovascular techniques should use the device. • Adhere to universal precautions when utilizing the device. • Do not kink, pinch, cut, bend, twist, or pull excessively or with excessive force on any portion of the devices. Damage to the catheter body may cause the device to become inoperable. • Avoid sharp bends. This may cause the device to become inoperable. • Do not pinch or grasp the catheter with excessive force or with other instruments. This may cause the device to become inoperable. • Do not bend the rigid portion of the catheter near the electrode or backstop. • Do not touch or handle the active electrode. Electrode dislodgement may occur. • Always use the hemostasis valve crosser to assist insertion of the venous catheter through the introducer sheath. Insertion into introducer sheath without hemostasis valve crosser may damage electrode. • Do not attempt to remove the hemostasis valve crosser located on the venous device. Device damage or fracture may occur.

PRECAUTIONS Care should be taken to avoid the presence of fluid on the ESU. • Care should be taken during handling of the arterial and venous catheters in patients with implantable cardiac defibrillators or cardiac pacemakers to keep the distal 3 inches of the catheters at least 2 inches from the implanted defibrillator or pacemaker. • Care should be taken to avoid attempting fistula creation in a heavily calcified location of a vessel as fistula may not be adequately formed. • If the device does not perform properly during the creation of the endovascular fistula it is possible that a fistula will not be created or there may be some vessel injury. • Keep magnetic ends of catheters away from other metallic objects which may become attracted and collide with devices.

CCT@LINC

Vessel preparation might be the most important issue in the DCB era

The Complex Cardiovascular Therapeutics (CCT) meeting was founded in 2001 to explore new techniques in the field of cardiovascular intervention. The spirit of CCT is "challenge and innovation", and has grown to be the biggest live courses in Asia at present.

At LINC 2019, two CCT@LINC sessions were featured, offering the chance to merge international perspectives, share challenging case *stories* and collaborative on innovative solutions. *LINC Review* caught up with CCT Co-Director Kazushi Urasawa for some of his insights.

Kazushi Urasawa, MD, PhD, FJCC
Vice President, Tokeidai Memorial Hospital, Sapporo, Japan

Last year, two drug-coated balloons (DCB) were finally approved for femoropopliteal endovascular therapy in Japan. One-year outcomes of the IN.PACT Japan clinical trial far exceeded our expectations. The primary patency of the DCB group was 93.9%, versus 46.9% in the conventional balloon group. Freedom from clinically driven target lesion revascularisation (CDTLR) was 97.1% and 81.3%, respectively.[1]

Now we can use various devices to treat femoropopliteal lesions, such as conventional balloons, DCBs, self-expandable nitinol stents, drug-eluting stents (DES) and graft stents. Furthermore, atherectomy devices are expected to join this group within a couple of years. Bare nitinol stent implantation has been a standard treatment for femoropopliteal disease for a long time. However, long-term primary patency was usually very poor in TASC II C/D patients.

Suzuki *et al*. (2011) reported four-year results of the SMART Control stent for superficial femoral artery (SFA) lesions. In their report, primary patency of the TASC II A/B group at four years was 81%, and 51% in the TASC II C/D group.[2] Although we can obtain secondary patency by repeated intervention in those patients, we should aware that a part of the TASC II C/D patients fall into the repeated re-stenosis / re-occlusion cycle. Based on these results, we have discussed the "leave nothing behind" strategy or "leave the right thing behind" strategy using DCB for last several years. I totally agree with the concept of leaving nothing behind because a no-stent or fewer-stent strategy can provide more options when reintervention is required in the future.

There are two events which require provisional stenting during the endovascular treatment of femoropopliteal artery disease.

"A no-stent or fewer-stent strategy can provide more options when reintervention is required in the future."

Kazushi Urasawa

One is dissection, and the other is acute recoil. Fujihara *et al*. reported that the severe dissection group showed a significantly lower patency rate and higher CD-TLR rate compared to the non-severe group.[3] In order to minimise vessel dissection and prevent provisional bailout stenting, we are using very long balloons for femoropopliteal lesions. In our recent single-centre study, multivariate analysis identified long balloon (length ≥ 220 mm) usage as an independent negative predictor of severe vessel dissection.[4]

Recently, Horie *et al*. reported that prolonged inflation time (longer than 3 min) during balloon angioplasty significantly reduces the frequency of severe vessel dissection.[5] Based on these works, we can expect that prolonged inflation using a very long balloon minimises vessel dissection and provides better long-term outcomes. This type of optimised balloon angioplasty could be

the base for DCB treatment. The guidewire route is another issue which has not yet been answered properly.

Personally, I believe that intraplaque wiring is better than subintimal wiring in terms of long-term outcome. At this point, we still do not have a strong evidence as to whether guidewire route affects the outcome of femoropopliteal interventions or not. Clinical studies using intravascular ultrasound should be conducted to answer this question.

References

1. Iida O, Soga Y, Urasawa K, Saito S, Jaff MR, Wang H *et al*; MDT-2113 SFA Japan Investigators. Drug-Coated Balloon vs Standard Percutaneous Transluminal Angioplasty for the Treatment of Atherosclerotic Lesions in the Superficial Femoral and Proximal Popliteal Arteries: One-Year Results of the MDT-2113 SFA Japan Randomized Trial. J Endovasc Ther. 2018;25(1):109-117.
2. Suzuki K, Iida O, Soga Y, Hirano K, Inoue N, Uematsu M *et al*. Long-term results of the S.M.A.R.T. Control(TM) stent for superficial femoral artery lesions, J-SMART registry. Circ J. 2011;75(4):939-44.
3. Fujihara M, Takahara M, Sasaki S, Nanto K, Utsunomiya M, Iida O *et al*. Angiographic Dissection Patterns and Patency Outcomes After Balloon Angioplasty for Superficial Femoral Artery Disease. J Endovasc Ther. 2017;24(3):367-375.
4. Tan, Urasawa K, Koshida R, Haraguchi T, Kitani S, Igarashi Y *et al*. Comparison of Angiographic Dissection Patterns Caused by Long vs Short Balloons During Balloon Angioplasty of Chronic Femoropopliteal Occlusions. J Endovasc Ther. 2018;25(2):192-200.
5. Horie K, Tanaka A, Taguri M, Kato S, Inoue N. Impact of Prolonged Inflation Times During Plain Balloon Angioplasty on Angiographic Dissection in Femoropopliteal Lesions. J Endovasc Ther. 2018;25(6):683-691.

SITE@LINC

Vicente Riambau
SITE Chairman

SITE (www.sitesymposium.com) has become one of the most important endovascular meetings for Iberian and Latin American endovascular practitioners and one of the most prestigious endovascular events in southern Europe.

The SITE symposium is a medium-sized meeting held every other year. During two and a half days, all attendees can interchange their experiences and concerns with a very select group of international guest speakers and experts. In comparison with other larger international meetings, SITE extracts and concentrates the most selected topics and issues – those directly applied in daily clinical and research practices. The attendee can use all their time, [without] walking around, attending different rooms and [having to choose between] relevant simultaneous sessions. Discussion periods are strictly respected at the end of every session.

SITE is mostly focused on practical solutions for everyday endovascular practice, gives the latest updated knowledge, and stimulates research for the development, consolidation and sustainability of endovascular therapies. In the end, SITE contributes to the improvement of endovascular care for our patients.

In 2014, due to the identification of a great number of unmet needs in every endovascular sector, the SITE directors decided to introduce a new concept: SITEupdate. Also following the biennial model, SITEupdate takes place in the years between the regular SITE symposia.

SITEupdate has a fresh formula, and is a useful expert event. Over a single day, the international faculty in conjunction with a limited international expert audience (including physicians, engineers and industry managers), review the unmet needs of one or two "hot", mainstream endovascular fields.

For the SITE@LINC session, 'Aortic disaster cases: what can we learn from the expert's nightmares?', we selected, in accordance with the LINC organisers, a one-hour session focused on aortic disaster cases. Expert faculty presenters shared – with the audience and the rest of the panellists – the worst-case nightmares in their experience.

It was a very interesting session, where the audience realised that the 'big names' can also get into trouble – and learn how they managed it. This format is very much appreciated by the audience of SITE Symposium for its high teaching value. We hope that the SITE@LINC session reached the level of success that the LINC meeting deserves!

"We hope that the SITE@LINC session reached the level of success that the LINC meeting deserves!"

Vicente Riambau

Are DCBs an effective treatment for SFA and BTK lesions?

Luminor results from EffPac and TINTIN laid bare

The Discussion Forum played host to 12-month results from the EffPac trial, a multicentre, randomised controlled trial to assessing the Effectiveness (vessel restenosis or reocclusion) of the Paclitaxel-coated Luminor (iVascular, Spain) drug-coated balloon (DCB) versus an uncoated balloon catheter in the superficial femoral artery (SFA) and popliteal arteries.

As presenter and study PI Ulf Teichgräber (Interventional Radiologist, Jena, Germany) described, the Luminor DCB features a unique nanotechnology coating, TransferTech, iVascular's proprietary technology for drug release. "This makes this device special," he said. "It is a spray technology which allows a uniform layer of nanodrops on the surface."

He added that TransferTech facilitates better adhesion of paclitaxel on the balloon, reducing loss of drug during manipulation and navigation to the target lesion, while still providing effective transfer to the vessel wall.

Describing the EffPac study design, Professor Teichgräber first noted that randomisation was performed after predilatation. "This was to ensure that all patients are really treated in the same manner."

The primary efficacy endpoint was late lumen loss (LLL), with secondary efficacy endpoints set as freedom from target lesion revascularisation (TLR), patency, and change in ankle brachial index (ABI), Rutherford class, quality of life (QoL) and walking impairment questionnaire (WIQ). The primary safety endpoint was major and minor amputation rate in the index limb, and mortality (independent of cause).

"We as investigators believe that we have a very good, efficient and safe DCB."

Ulf Teichgräber

A total of 172 patients were enrolled, randomised to Luminor DCB (n = 85) or plain old balloon angioplasty (POBA; n = 86).

Baseline patient characteristics in the Luminor/POBA groups were well balanced in terms of age, sex, diabetes (36.5% vs 40.7%), hypertension and hyperlipidaemia. The majority of patients were severe claudicants (more than 80% in both groups). The lesion characteristics were also well balanced, continued Professor Teichgräber, with mean DCB/POBA lesion lengths of 5.9/5.6 cm, as were the rates of dissection (37.6/40.7%) and stent rates (15.3%/18.8%).

Diving into the results, Professor Teichgräber relayed the LLL outcomes for both groups at six months. "They were astonishing results," he said, noting 0.14 mm in the Luminor group versus 1.06 mm in the POBA group; a difference of -0.92 mm. This result was comparable to other leading DCBs, he added, indicating a very promising outlook going forward.

"What we also observed was a negative remodelling effect," he continued, detailing that the relative chance for negative

remodelling is increased by 91% in the Luminor group, when compared to POBA.

In terms of TLR rates, there was only one case (1/76; 1.3%) in the Luminor group at both 6 and 12 months, compared to 13 (13/76; 17.1%) and 14 (14/75; 18.7%) at 6/12 months in the POBA group. "This is really a very good result," he said. "Even the POBA group is strong due to the predilatation step."

He added that a relative risk reduction of 91.8% calculated for the Luminor DCB at 12 months showed "clinically effective avoidance of TLR."

Compared to other trials, Professor Teichgräber stressed that the EffPac TLR results were class-leading. "It is by far the best balloon right now, but we have to say that the other trials are performed under [somewhat] differing conditions."

Moving on to primary patency – i.e. freedom from restenosis as determined by duplex ultrasound and freedom from TLR – Professor Teichgräber revealed 94.7% and 90.3% patency at 6 and 12 months – again the highest values obtained in clinical trials. He added that the number needed to treat (NNT) was low, at four patients.

"iVascular and ourselves also want to take the enthusiasm that we have for the Luminor DCB in the SFA and transfer it to the below-the-knee (BTK) arena."

Koen Deloose

"For us as investigators, what was very astonishing was that we also saw an improvement in Rutherford class in our patients, up to three stages," said Professor Teichgräber.

Concluding with safety outcomes at one year, he shared mortality rates of 1.2% and 2.3% for Luminor and POBA, respectively, noting that all deaths were not related to device or procedure. There were no amputations in the Luminor group, he added.

"For now, we as investigators believe that we have a very good, efficient and safe DCB," Professor Teichgräber said in closing.

Preliminary six-month results from TINTIN unveiled

Also speaking during the session was Koen Deloose (Dendermonde, Belgium), principle investigator of the TINTIN trial – a prospective, investigator-initiated, nonrandomised, multicentre trial that will investigate the 12-month safety and efficacy of combined Luminor DCB and iVolution self-expanding stent (iVascular) in TASC C and D femoropopliteal atherosclerotic lesions.

Speaking to *LINC Review*, Dr Deloose underlined that the excellent results from Luminor in the EffPac RCT and iVolution in the EVOLUTION trial, were focussed on relatively short TASC A/B lesions. With that in mind, Dr Deloose had his sights set on evaluating both technologies, in combination, in more complex lesions. "My question was could 1 + 1 = 3?" he said.

"In TASC C and D lesions – the daily reality in our vascular surgery department – can we [repeat] these kinds of results or even improve on them by combining the two devices? That is the rationale for the TINTIN trial."

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Are DCBs an effective treatment for SFA and BTK lesions?

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Full enrolment of 100 patients was completed towards the end of 2018, and during the LINC session he was able to present some preliminary 6-month results from 65 patients.

Describing the patient demographics, Dr Deloose relayed that 72% of the patients were claudicants, 28% had CLI, and 37% were diabetic. The mean lesion length was 24.2 cm, therefore much longer lesions than EffPac/EVOLUTION lesions, with 60% being CTOs. Specifically, lesions were split between TASC C (62%) and TASC D (38%). "It is quite a challenging population to treat," he said.

Procedurally, predilatation in accordance with the study protocol was performed using a regular balloon, after which a 0.018" or 0.035" guidewire-compatible Luminor DCB was used, depending on the physician's preference for either platform size. "Both were allowed according to the study protocol, and both were made available; 58% worked with an 18 system, and 42% worked with the 35 system," explained Dr Deloose.

After a three-minute inflation with the Luminor, the full lesion length was covered with an iVolution stent – an important point, he added: "It is not a study using bailout stenting, because you would not be able to judge the real [impact] of the combination therapy ... even when results after the DCB were good, it was mandatory to implant an iVolution stent."

Dr Deloose shared the preliminary 6-month results from a cohort of 65 patients, beginning with the primary patency of 96.6%. "That is tremendously good," he stressed, adding that a six-month analysis of freedom from TLR was also impressive at 98.2%.

Dr Deloose also spoke of the safety outcomes at 30 days: "There were no device- or procedure-related deaths in 100 patients, there was no clinically driven TLR, and no target limb major amputations."

Major adverse events data at 180 days was also available: "We have had five deaths, one CD-TLR, no major amputation, and one thrombus."

Remarking on the "tremendous" results, Dr Deloose stressed that it is no longer common practice to stent for full lesion coverage, rather bailout or provisional stenting is preferred. "However, if we know coming out of this TINTIN trial that the combination of Luminor and iVolution works ... if we need to do bailout stenting in these complex lesions, we can [be confident with] this combination of devices."

Looking ahead, Dr Deloose noted that the next crucial step will be to explore the definitive and full cohort at one year, and then extend out to 24 months: "As we know, the restenotic cascade in the SFA occurs more between let's say 12 and 18 months, compared to the coronaries where it occurs around six months."

He concluded: "iVascular and ourselves also want to take the enthusiasm that we have for the Luminor DCB in the SFA and transfer it to the below-the-knee (BTK) arena. That is why together with the company we have set up another physician-initiated trial, BIBLIOS."

BIBLIOS is a Belgian-Italian prospective, single-arm, multicentre study to evaluate the efficacy and safety of BTK treatment with Luminor Paclitaxel coated Percutaneous Transluminal Angioplasty Balloon catheter of iVascular with Critical Limb Ischemia.

The trial was approved by the Ethics Committee (EC) on the 17 December 2018. In total, 150 patients will be enrolled from six Italian and Belgian centres.

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SIRCCA: Room for interventional radiology in oncology

The important SIRCCA trial[1] was the focus of a presentation by Tim-Ole Petersen from the Department of Diagnostic and Interventional Radiology, University Hospital, Leipzig – a centre rich with experience in interventional oncology (IO) and minimally invasive cancer therapy. "We are one of the major sites for selective internal radiotherapy in Germany. In the past 20 years, our hospital has established nearly all procedures used in IO," he said in an interview with *LINC Review*.

His presentation looked at selective internal radiotherapy (SIRT), a standard tool in IO for the treatment of primary and secondary liver cancer. "Most patients treated with SIRT suffer from hepatocellular carcinoma or metastasis," he explained.

It's an intervention that is under-researched, however. "Since interventional radiology is a relatively small discipline, there is a lack of prospective and randomised trials, especially for rarer tumours like cholangiocellular carcinoma (CCC)," said Dr Petersen. "There is an urgent need for strong trials and their resulting evidence in order to establish interventional radiology therapies in the guidelines."

Traditionally, patients with CCC have been treated with surgery, chemotherapy or

minimally invasive interventional procedures such as transarterial chemoembolisation or radiofrequency ablation, noted Dr Petersen. SIRT is a part of the interventional toolbox, and has also been used in CCC patients for more than a decade, he stressed, but there have been no randomised controlled trials supporting its use.

That's why the SIRCCA trial is important – a randomised trial evaluating SIRT followed by standard cisplatin and gemcitabine chemotherapy (CIS-GEM) versus CIS-GEM alone in patients with unresectable intrahepatic cholangiocarcinoma. After a long postponement, the trial is now underway in Germany. "The SIRCCA trial will hopefully show the usefulness of SIRT in combination with the standard of care, chemotherapy," said Dr Petersen. "I hope the results will be a longer progression-free survival and also a longer overall survival."

"Quality of life has long been ignored by physicians. Most of the trials have objectives like overall survival or time to progression."

Tim-Ole Petersen

The greatest challenge in Germany, he added, has been the approach of some doctors. "Convincing the medical oncologists to participate in interventional trials has not been easy," he said. Ironically, without trials like SIRCCA, it is not possible to drive the wider uptake of IO techniques and convince other specialties to accept them, he stressed.

Important too is a debate on measures of success within these trials. As Dr Petersen puts it: "Quality of life has long been ignored by physicians. Most of the trials have objectives like overall survival or time to progression."

Take palliative tumour treatment, for example. "I think for many patients with little time left, it is more important for them to have a good last year than it is to suffer the side-effects of therapies that may only give them up to two months more to live," he reasoned. "We need to think more deeply about what is meant by an 'excellent result' in our studies."

Looking forward, Dr Petersen hopes that there will be more trials like SIRCCA in the pipeline. "Certainly, participants at LINC know that interventional procedures are the future," he said. "We can see the improvements in techniques and devices every year. But we all need the proof that our therapies are not only feasible, but also helpful for the patients."

That's especially important when convincing other specialists, he concluded: "In interventional oncology where we are in competition with surgery, medical oncology and radiotherapy, we have a great need for good trials which can support a fair discussion in multidisciplinary tumour boards."

References

1. SIRT Followed by CIS-GEM Chemotherapy Versus CIS-GEM Chemotherapy Alone as 1st Line Treatment of Patients With Unresectable Intrahepatic Cholangiocarcinoma (SIRCCA). Available at clinicaltrials.gov/ct2/show/study/NCT02807181

FORS: Fiber Optic RealShape technology sheds new light

LINC 2019 played host to a session dedicated to innovations in daily practice, including advanced technologies that could offer new gold-standards for image guidance.

During the session, Joost van Herwaarden (Department of Vascular Surgery, University Medical Center Utrecht, The Netherlands) presented new data from a novel guidance technology. Speaking to *LINC Review*, he first described the limitations of traditional guidance. "All procedures nowadays are done with X-rays, and of course

Continued on page 76

"The tip of [FORS] catheter and the wire are marked with a white dot; this enables me to see exactly if the dot comes towards me, or away from me. That is a big advantage."

Joost van Herwaarden

Figure 1. View in the hybrid OR, where Dr Joost van Herwaarden is using the FORS technology to treat a patient in the FORS First study.

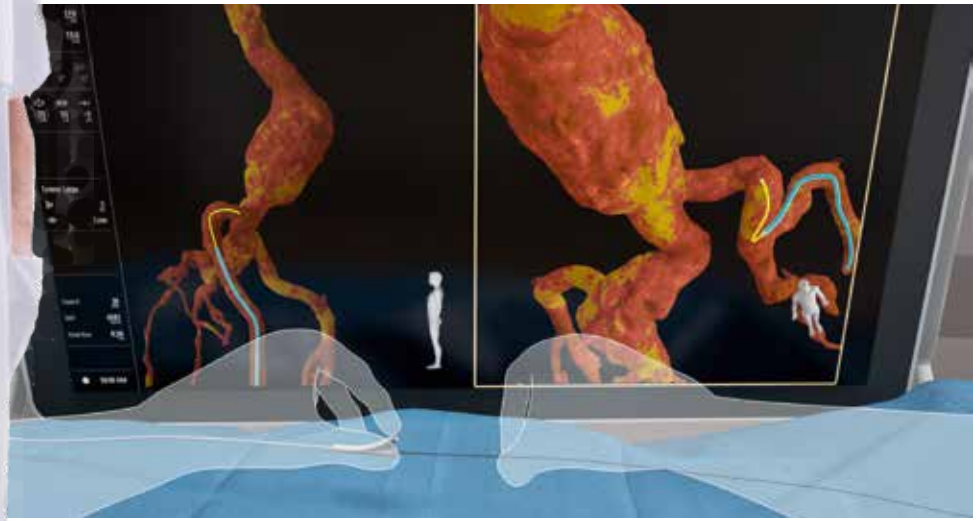


Figure 2. Graphical illustration of the navigation of a FORS-enabled guidewire (in yellow) and a FORS-enabled catheter (blue), with respect to a CT scan. Two simultaneous views from different angles help to navigate the wires through the tortuous iliac artery.

FORS: Fiber Optic RealShape technology sheds new light

Continued from page 75

there are huge drawbacks," he said.

There are two crucial concerns, the first being the exposure to radiation, the other being the reliance on 2D visualisation, forcing the operator to decipher the directional movements with a degree of blind faith. "Currently, we have a grey catheter and a grey wire; beyond left and right, it is difficult to see in which direction they are pointing," he said. "We may think we know in which direction they are going, but we simply cannot see that. That is the problem with 2D."

As such, Dr van Herwaarden outlined a novel guidance solution, Fiber Optic RealShape (FORS) technology (Philips, the Netherlands) – a ground-breaking platform that pulses light through devices to provide real-time 3D visualisation, without the need for fluoroscopy. Transmitted through optical fibres, the light signal is translated into distinct coloured devices that are visualised in 3D – greatly enhancing the detailand clarity of endovascular procedures when compared to fluoroscopy.

> [FORS] is a ground-breaking platform that pulses light through devices to provide realtime 3D visualisation, without the need for fluoroscopy.

"The visibility is so much better," said Dr van Herwaarden, noting that it allows much more precise directional control. "The tip of the catheter and the wire are marked with a white dot; this enables me to see exactly if the dot comes towards me, or away from me. That is a big advantage."

In addition, FORS simplifies the use of roadmaps, as Dr van Herwaarden explained. "If we do a PTA, we have a stenosis and we treat it, we will take an angiogram. With FORS you can simply use your angiogram and benefit from all the angiographic details in order to navigate your devices, which are visualised in distinctive colours."

An added benefit of the FORS-enabled devices is their normal visibility under X-ray, allowing flexibility in the adaption of procedures: "For instance if I start with a FORS wire and put in a Cobra catheter, and then I want to change the wire for a stiff wire, I can simply use a normal stiff wire in X-ray, and still see the FORS catheter in the X-ray," said Dr van Herwaarden.

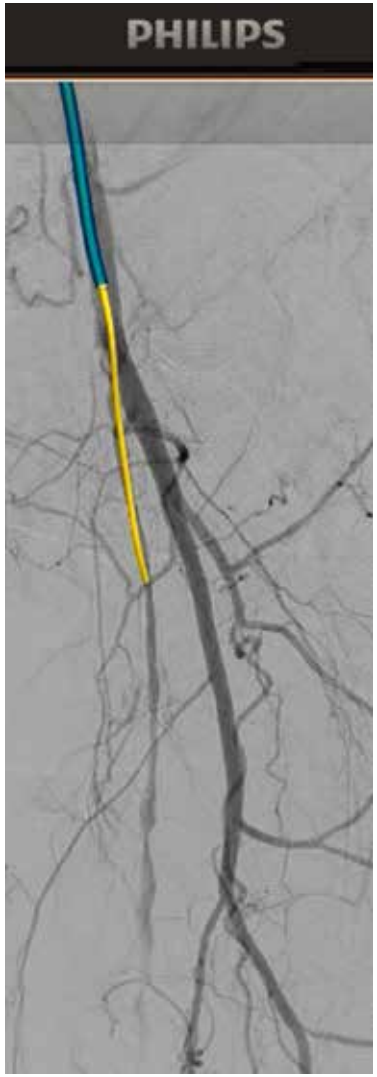


Figure 3. Image from a case in the FORS First study. A FORS-enabled guidewire (in yellow) and a FORS enabled catheter (blue) are navigated with an angiographic image as a roadmap.

During his presentation, Dr van Herwaarden shared the results from the first in-human FORS study. The objective of the study was to test the feasibility of using the FORS technology in endovascular aortic and peripheral procedures. The study included consecutive patients scheduled for standard or complex (fenestrated/ branched) EVAR or for iliac or superficial femoral artery (SFA) PTA between July and December 2018 in his centre. In total, 21 patients were enrolled, comprising 13 endovascular aortic repair (AR) cases, and 8 PTA.

Dr van Herwaarden shared information about three "remarkable moments" he observed during the study. All three examples demonstrate the power of the FORS technology for navigating challenging anatomies using 3D visualisation and all without the use of fluoroscopy.

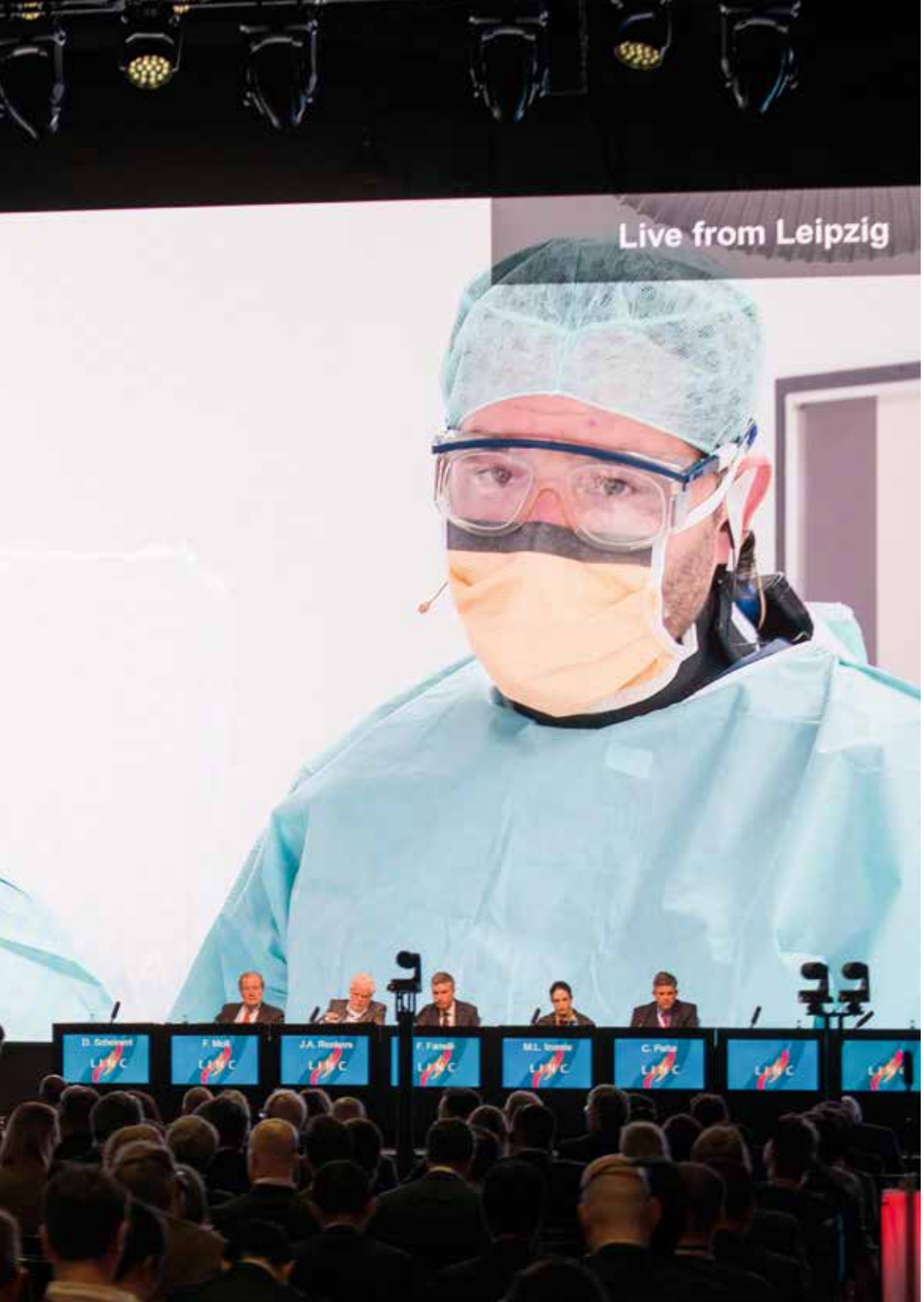
The first case was a tortuous iliac artery: "The visualization of the extreme angulation of the iliac artery is not feasible with the C-arm, simply because the ability to see that extreme angle would mean angulating the C-arm beyond its limits," said Dr van Herwaarden.

With FORS you can use multiple, unrestricted viewing angles. "You can see any extreme of angulation, and with excellent clarity," he said.

"The second case was a cannulation of the contralateral limb in EVAR," continued Dr van Herwaarden. "Important to note that we were able to use bi-plane functionality, making the cannulation much easier because you can see from two directions at the same time. It is a particularly nice video because not only is it an example of the beneficial effect of bi-plane visualisation, but it also demonstrates that you can use any X-ray you want as an overlay."

The third and final patient, he added, was a PTA case which neatly showcases the excellent clarity of the coloured devices over the black angiogram during FORS guidance.

In his closing remarks, Dr van Herwaarden spoke of a bright future for FORS. In close collaboration with Philips, he will be involved in the next steps of developing more devices, as well as assisting in building the experience-base to more patients and more centres by conducting multi-centre studies.



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Active Control and conformability: A new portfolio paradigm

A Gore sponsored session explored the themes of active control and conformability, which are emerging as central tenets of interventional practices today. The session combined a selection of presentations with a live case from Münster's St. Franziskus Hospital (Germany) showcasing the performance of the Excluder Iliac Branch Endoprosthesis (IBE) (W. L. Gore & Associates, Flagstaff, AZ, USA), and well as a recorded case from Catharina Hospital Eindhoven (the Netherlands) including for the first time ever the Excluder Conformable AAA Endoprosthesis (W. L. Gore & Associates).

Session moderator, Giovanni Torsello (St. Franziskus Hospital Münster, Germany), shared his thoughts on the importance of active control and conformability. "The aim of our intervention should be that the stent graft should accommodate to the anatomy, and not vice-versa," he said. "This is an extremely important message, and I think Gore is on the right track to doing this."

He also spoke of Gore's Active Control System, which enhances conformability by allowing the optimal graft positioning inside the vessel: "It is a feature which is absolutely fascinating," he commented. "16 months ago, we had the opportunity in Münster to perform the first thoracic endografting with the Active Control System. And, since a few months ago, it is possible to do it in the abdominal aorta.

"The session addressed this specific feature of the new generation devices, which is also based on trusted and well-known performance of the Excluder and the Conformable TAG Thoracic Endoprosthesis (CTAG), which are both very well evaluated."

The broad portfolio of devices from Gore, he added, has expanded the range of endovascularly-treatable anatomies. "Nowadays we know that, especially in patients with strong angulation and with unfavourable anatomy, they are the best candidates for less invasive therapy methods. In my eyes, it is extremely important to have a wide portfolio to adapt our technique to the specific anatomies of these patients."

He highlighted the importance of this in, for example, young patients with traumatic rupture of the aorta, who often possess a 'gothic' aortic arch, as well as patients with type B aortic dissection. In the aging abdominal aortic aneurysm (AAA) population, angulation increases the risk of type IA endoleak and as such demands optimal anatomical stent graft adaptation. In addition, in cases of wide common iliac arteries, he cited the Excluder IBE as a means of preserving the pelvic circulation. "We have a really wide range of anatomies that can be covered with all of these solutions," he concluded.

"The aim of our intervention should be that the stent graft should accommodate to the anatomy, and not vice-versa."

Giovanni Torsello

Gore is now introducing

GORE® TAG®
Conformable Thoracic Stent Graft with ACTIVE CONTROL System

reduced profiles for the most commonly used diameters of the Gore TAG Conformable Thoracic Stent Graft with Active Control System. The reduced profile allows physicians to perform TEVAR in patients with smaller vessels where access is challenging and aortic anatomy is tortuous, expanding the availability of Gore's thoracic stent graft to a greater population of patients.

Dittmar Böckler (Heidelberg University Hospital, Germany) opened the session with a presentation on the benefits of the Gore Active Control System for achieving optimal outcomes in complex TEVAR procedures, discussing his first experience with the new reduced profile device. Speaking to *LINC Review*, he commented: "As the market for TEVAR has continued to expand and evolve, lower profile devices have rapidly emerged with a goal of increased patient applicability, accessibility, trackability and finally reducing access complications for patients with smaller vessels.

"It's reassuring that the new reduced profile sizes of the Gore TAG Conformable Thoracic Stent Graft was achieved without changes to the stent graft. Gore's device is known for its conformability, and the Gore Active Control System enables me to take full advantage of the conformability by allowing precise placement during TEVAR procedures. The combination of controlled delivery with the trusted stent graft, and now reduced profile for the device, is a significant advancement and approaches unmet needs performing TEVAR in my daily practice."

"It's reassuring that the new reduced profile sizes of the Gore TAG Conformable Thoracic Stent Graft was achieved without changes to the stent graft."

Dittmar Böckler

Controlled conformability to make it possible: European clinical experience with the Gore Excluder Conformable AAA Endoprosthesis

Marc van Sambeek (Cardiovascular Biomechanics research group of the department of Biomedical Engineering at Eindhoven University of Technology, and Catharina Hospital Eindhoven) discussed the evolution of endografts, the most recent leap being conformability, precision of delivery and hence apposition, with some case examples to illustrate these concepts.

Dr van Sambeek is Principal Investigator of the post-market EXCeL registry, evaluating the Gore Excluder Conformable AAA Endoprosthesis in the treatment of AAA within Europe. The registry, which is currently in the early stages of recruitment, includes patients who meet the instructions for use (IFU) anatomic criteria (≥15 mm proximal neck length and ≤90° proximal neck angulation; and ≥10 mm proximal neck length and ≤60° proximal neck angulation) as well as those with challenging anatomic presentation outside the IFU. It will enroll an estimated 150 patients, with a three-year duration of follow-up.[1]

"At this time, in Europe, there is only relatively little experience,"

"Physicians in 2019...will make a choice between the C3 and Excluder Conformable, based on the anatomy of their patients."

Marc van Sambeek

he told *LINC Review*. "The largest experience at this time is at the Catharina Hospital in Eindhoven and Rijnstate Hospital (Arnhem) in the Netherlands. Together, we have included 19 patients now."

Dr van Sambeek, who treated the first patient enrolled in the EXCeL registry, presented early experience with the Gore Excluder Conformable AAA Endoprosthesis. "We have used it in nine patients now, of which four had challenging anatomies, and of which two would have been rejected by virtually every other device company, because of their very tough and severe angulation – a double angulation, [each] of almost-90 degrees. We treated these patients with very good results.

"What we have learned so far is that the ability to angulate the delivery system works very well in angulated necks, specifically if you want the endograft to be deployed perpendicularly to the central lumen line. This is what most of the devices don't do.

"When we treat these patients we see that, when we introduce the device, it is actually similar in trackability to other devices. We can see the positioning and how the position would be if we were to deploy it [along the central lumen line]. At this point, because the device is conformable we already see some adaptation to the angulation. Then, with the Active Control, we can fine-tune the angulation, so that we can deploy the device in the ideal way for that particular complex anatomy.

"So far, I have been very satisfied with the device. Of course, even for this device there

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Active Control and conformability: A new portfolio paradigm

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are some limitations. But that is in extreme anatomy."

Asked how the features of conformability and control are important in his practice, he responded: "There are two points. There is a discussion worldwide about treating patients outside of IFUs. There is another trend going on where the IFUs, with newer generations, are extended. Both initiatives are happening because we want to treat more patients with a regular endograft even if the anatomy is complex.

"We believe that if you only use the regular EVAR device, it has an added durability and creates less complications than doing open surgery or a fenestrated or branched procedure. That is the idea: to keep it simple and treat the patients with a device that we have already been using for more than 20 years."

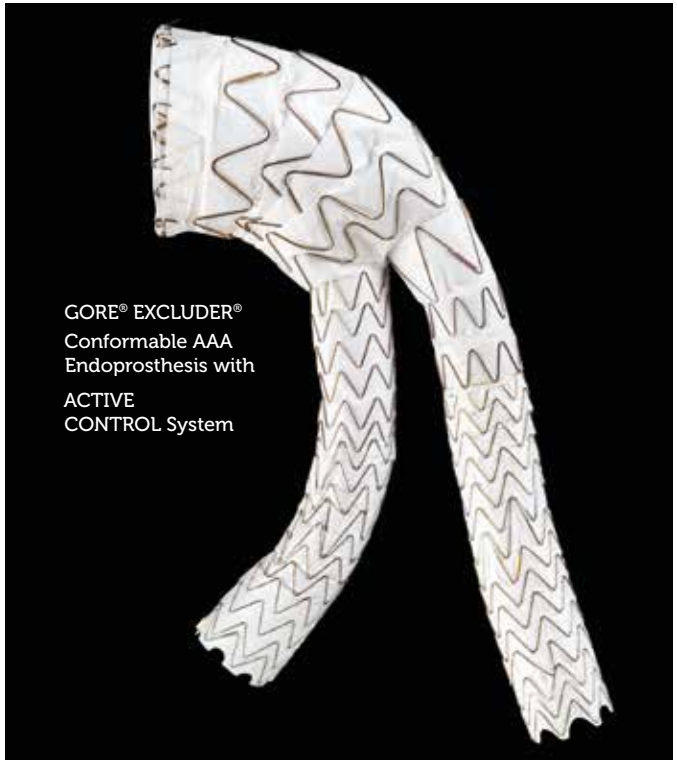
Older devices, he added, were too rigid to be able to achieve these aims, failing where newer generations are succeeding: "Fixation is relatively good now in all the devices that we use currently on the market. The migration of the endograft has almost disappeared.

"The only thing is that if the anatomy is more challenging, so far most of the devices have a limitation of 60 degrees of angulation. Only a few endografts allow for angulations between 60 and 90 degrees that makes it possible to treat more patients with a regular endograft.

"And by adapting the delivery system and fine-tuning the position of the endograft so that you can create a maximal seal that will help in getting better results and fewer type I endoleaks. These innovations are a natural evolution, but with each step it is improving the quality of EVAR treatment significantly."

In his concluding remarks, Dr van Sambeek added: "Gore has Excluder C3 which is in my opinion is the workhorse to treat the majority of aneurysm patients. Now they also have Excluder Conformable that is tailored towards more complex anatomy. So I can imagine that physicians in 2019, if they treat a patient with an aneurysm, will make a choice between the C3 and Excluder Conformable, based on the anatomy of their patients.

"Then of course if there is an extension needed in the iliac tract Gore has the IBE system for iliac branching. That is extending the indications for aneurysm treatment. In that perspective, Gore has a very nice portfolio of different devices for infrarenal aortoiliac aneurysm."



Expand the indication for iliac branching: key clinical and technical learning in the bilateral treatment

Nilo Mosquera is Head of the Department of Vascular Surgery at Complexo Hospitalario Universitario de Ourense, Spain. Last year he published, as part of the Gore bilateral IBE study investigators, on the use of this endoprosthesis the setting of bilateral common iliac artery (CIA) aneurysm treatment.[2]

The retrospective study examined real-world international multicentre experience of cases of bilateral treatment using the Gore IBE since CE mark and FDA approval were gained (2013 and 2016, respectively). Data pertaining to 47 patients were analysed, including six symptomatic patients, 12 treated primarily for CIA aneurysm, and four with aneurysmal internal iliac arteries. The investigators reported excellent technical success and short-term patency rates. Limb and branch occlusions were reportedly rare, usually due to kinking, and in most cases were treated successfully with stenting.[2]

A key driver of the study, Dr Mosquera explained to *LINC Review*, stems from a growing acknowledgement of the importance of hypogastric preservation: "The idea was somehow to analyse, in two different directions, the performance of this technical approach. On one side, we wanted to analyse the technical feasibility and how bilateral treatment can affect the length of procedure and complications. What we found was that there is not much significant difference between unilateral and bilateral cases, in technical success and patency rate in the follow-up.

"The other analysis was the economical impact, and also the procedural impact. We found that it is of course more expensive, if you analyse the cost of the materials. But on the other side it is also efficient, because we have found (and this is supported by other data coming from other registries) that complications and reinterventions are much lower. So in the end, it is effective and safe to preserve both hypogastrics. Also from the clinical point of view, it is always much better to preserve than to occlude."

Dr Mosquera's department at the Complexo Hospitalario Universitario de Ourense have collaborated with the University Clinical Hospital of Santiago de Compostela, pooling their combined experience with the IBE device. This analysis (currently

being prepared for publication) includes almost 60 cases, 20 of which include bilateral treatment.

Elaborating on the importance of hypogastric preservation, Dr Mosquera explained: "There are three main reasons why this should be the standard of care. The first reason is just the basic logic of a vascular surgeon, that to preserve is much better than to lose.

"The second very important thing is that we have data that supports preservation, from a reintervention point of view. We know that preservation with IBE is more effective than bell-bottom or coil-and-cover strategies, in terms of avoiding reinterventions – that has been clearly demonstrated.

"The third aspect is the economical point of view, which might seem like a contradiction. It is not: we know that the bilateral approach only increments the cost of the procedure by around 9%. And if we look at the overall cost of the treatment, including follow-up, reintervention, etc., it is effective."

Dr Mosquera cited the recently published 2019 European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms, in which a Class 1, Level C recommendation is given for the preservation of patency of at least one of the hypogastric arteries in AAA repair, in order to reduce the risk of buttock claudication and colonic ischaemia[3]. "This is a step

forward," he commented.

"Now, we need to collect more evidence to support bilateral preservation. I am truly convinced that in the future it is going to be in the guidelines that bilateral preservation of the hypogastrics should be done if feasible."

Turning to the technical aspects of IBE procedures for the preservation of the hypogastric arteries, Dr Mosquera explained: "When we are treating the hypogastrics and the common and external iliacs, all these cases are much more tortuous than normal aortic aneurysms. So in the past this was a big limitation to preserving the iliacs. It also had an impact on long-term follow-up and patency. What we found with the Gore IBE is that we have a really flexible and conformable graft that allows us to treat, I would say, almost any kind of tortuosity and angulation of the iliacs.

"The patient is a patient for life, so we need to keep the possibilities open."

Nilo Mosquera

"The only limitation that we can find is the fact of having a short distance coverage between the renal and hypogastric, which is not that common. So in the end when you analyse the case for going bilateral, tortuosity is normally not an issue and the length is much more important."

He noted that, during initial experiences with bilateral IBE procedures, there were concerns that there would be issues in introducing the second IBE device from the contralateral common femoral access site after the first had been implanted. He noted the performance of the Gore Dryseal Flex introducer sheath, much more flexible than its predecessors, allowing the stable introduction of the second sheath where otherwise additional brachial access would need to be considered.

He added: "Sometimes, when the origin of the hypogastric is not healthy and you need to land more distally into the vessel, the combination of the proper internal iliac component that has been designed for use in the hypogastric together with other devices such as the Viabahn and the new VBX, are useful."

Summarising his long-term experience with the Gore portfolio, Dr Mosquera said: "The Excluder family has been on the market for many years. Having this long-term experience, with long-term results, is very important. Today, there are a lot of questions in the air about long-term effectiveness of the treatments etc. So using a proven platform family is important."

He commented that the conceptual thread of flexibility, conformability and control runs through the latest iteration of this family of products. "From the first Excluder to the current Conformable, what we have is the same graft, same concept, same product, but the delivery system has evolved for a more controlled procedure that allows us as surgeons to be more precise, to reposition the graft if needed, and to have a very good approach in complex, tortuous anatomies. Also the profile reduction came hand in hand with this delivery system, which didn't change the material features, just the thickness of the sheath. When you go for an organ like the aorta, it is very good to have not only a graft but a platform."

Dr Mosquera concluded with his thoughts on the notion of preservation of perfusion where possible, in keeping with the idea of leaving the door open for future interventions: "When we are treating AAA, we are sometimes also treating the iliacs and the thoracic aorta. Here, the preservation concept may be secondary, but it is very important.

"When you have a patient with an infrarenal AAA, you don't know if they will, in time, also need thoracic repair or even thoracoabdominal repair. In that kind of situation, you need to have both hypogastric arteries patent as much as possible, because neurological damage is clearly related to the patency of the collateral vessels of the aorta. The patient is a patient for life, so we need to keep the possibilities open."

References

1. Assessment of the GORE® EXCLUDER® Conformable AAA Endoprosthesis In the Treatment of Abdominal Aortic Aneurysms (EXCeL). ClinicalTrials.gov. https://clinicaltrials.gov/ct2/show/NCT03743142 (accessed Jan 2019).
2. Maldonado TS, Mosquera NJ, Lin P, Bellosta R, Barfield M, Moussa A *et al*; Gore Bilateral IBE Study Group. Gore Iliac Branch Endoprosthesis for treatment of bilateral common iliac artery aneurysms. J Vasc Surg. 2018 Jul;68(1):100-108.e3.
3. Wanhainen A, Verzini F, Van Herzeele I, Allaire E, Bown M, Cohnert T *et al*. European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms. Eur J Vasc Endovasc Surg. 2018 Dec 5. pii: S1078-5884(18)30698-1.

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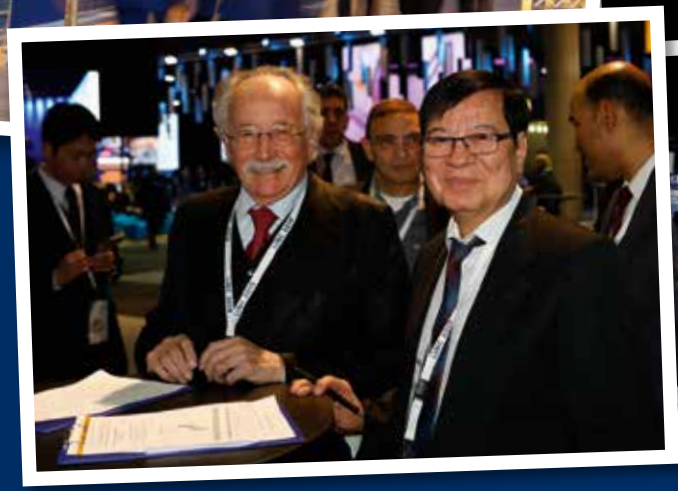

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with the 22nd CCVVC-Course
Mount Sinai Hospital, *New York, USA*

LINC@CCT 2019
24–26 October 2019, Kobe International
Exhibition Hall and Portpia Hotel, *Kobe, Japan*

LINC@CEC 2019
31 October – 3 November 2019,
Beijing, China

LINC@VIVA 2019
4–7 November 2019, Wynn Las Vegas,
Las Vegas, USA

LINC@VEITHsymposium
19–23 November 2019,
New York Hilton-Midtown, *New York, USA*

LINC Australia/VERVE Symposium
5 –7 December 2019, International Convention
Centre (ICC), *Sydney, Australia*

LINC 2020
28–31 January 2020,
Trade Fair Leipzig, Hall 2, *Leipzig, Germany*

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March 2020, AsiaWorld-Expo,
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VIVA@LINC: Carotid revascularisation redux

Recent advancements in carotid revascularisation were explored during a VIVA@LINC session, accompanied by live case transmissions from the OhioHealth Research Institute (Columbus, OH, USA).

Vascular Career Advancement Award 2018

The session was opened with the announcement of the 2018 Vascular Career Advancement Award winners, introduced by Peter Schneider (Hawaii Permanente Medical Group, Kaiser Foundation Hospital, Honolulu, HI, USA): "We are so passionate about what we are doing, but at the same time there is a whole next generation who are making huge contributions as they get into their careers. They are the ones who are going to be taking care of us.

"Each year, the VIVA and LINC groups get together and select nominees from around the world from a variety of specialties, who we would recognise as future leaders of our field. From 2013 to the present, these people have already shined in so many ways, in vascular surgery, cardiology, interventional radiology and vascular medicine."

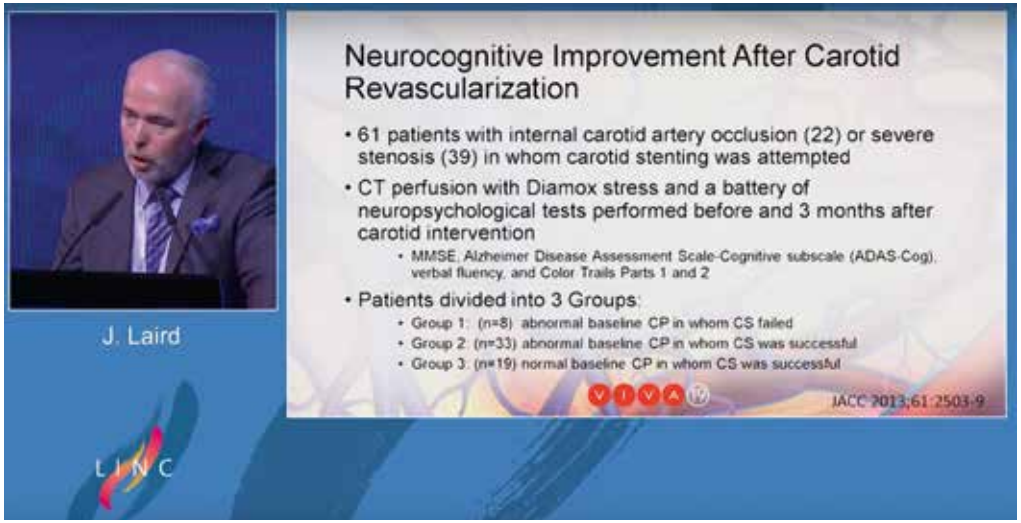
This year's recipients of the Vascular Career Advancement Award were Sabine Steiner (University Hospital Leipzig, Germany) and Osamu Iida (Kansai Rosai Hospital, Amagasaki, Japan).

"Sabine Steiner has regularly published large series from the Leipzig group, whether it is on nitinol stents, woven nitinol or drug-coated balloons," said Dr Schneider. "Osamu Iida is an interventional cardiologist from Kobe, and he has really contributed so much to the literature. Hopefully they both will think fondly of this portion of their career, where they identified themselves as future leaders and impressed a lot of people."

Is cognitive decline related to untreated carotid lesions?

Later during the session, John Laird (Adventist Heart and Vascular Institute, St. Helena, CA, USA) questioned whether the observed cognitive improvement in patients who have undergone carotid revascularisation is due to improved cerebral perfusion or placebo.

"There has been shown to be a strong link between stroke and cognitive decline," he began. "Studies have shown that many stroke survivors suffer dementia later in life. But there continues to be controversy as to whether asymptomatic carotid stenosis is an independent risk factor for cognitive decline. It is an important issue because, if it is, revascularisation earlier in the course of disease might prevent that cognitive decline and development of dementia."



Source: LINC 2019 presentation archive (www.leipzig-interventional-course.com)

One of the first important publications on this topic, he said, came from Johnston *et al*. (2004)[1], who conducted a cross-sectional cohort study of 4,000 patients with carotid stenosis and no history of stroke, transient ischaemic attack or carotid endarterectomy. They performed a Mini Mental Status Examination (MMSE) at baseline and annually for five years, evaluating patients for cognitive impairment (defined as MMSE score < 80) and cognitive decline over time. They discovered that for patients with asymptomatic stenosis of ≥ 75%, there was an association with cognitive impairment and decline during that five-year period.

More recently, Chang *et al*. (2013)[2] assessed the association between asymptomatic carotid stenosis and cognitive function by conducting a meta-analysis of eight cross-sectional studies and two community-based cohort studies. They found that all but one study supported the association. In a further pooled analysis, they identified older age (in two studies) and cerebral hypoperfusion (in two studies) as additional factors that may linked to cognitive decline in patients with asymptomatic carotid stenosis.

> *"There is a whole next generation who are making huge contributions as they get into their careers."*
>
> **Peter Schneider**

Dr Laird commented on this meta-analysis: "There are a number of limitations. These were small studies. There was a lot of heterogeneity of subjects and methods. Cognitive function was assessed in a variety of different ways; in some of the studies, the only test that was performed was the MMSE, which is not a very sophisticated test of cognitive function. Some of the studies did not have blinded assessment of cognitive function."

In terms of what might be causing cognitive decline in these patients, Dr Laird explained that the two most likely explanations are silent embolisation and cerebral hypoperfusion. "There have been publications that have identified white matter lesions on MRI as being associated with an increased risk of cognitive decline. But in a large preponderance of these studies there are no MRI lesions identified. So there has to be something else going on. What is likely going on is cerebral hypoperfusion.

"As carotid stenosis becomes severe, we know that patients with inadequate collateralisation compensate by progressive dilation of the intracranial arteries and arterioles in that ipsilateral hemisphere. This maintains cerebral blood flow but a point arises when vessels cannot dilate any more. They enter a state of impaired or exhausted cerebrovascular reserve. It is thought that these patients with impaired cerebrovascular reserve may be at increased risk for cognitive decline."

Dr Laird then turned to investigations of the effect of carotid revascularisation on cognitive performance. "I have been watching with great interest work from a group in Taiwan led by Hsien-Li (Paul) Kao [National Taiwan University Hospital, Taipei, Taiwan], who has been doing carotid artery stenting for treatment of chronic occlusion of the internal carotid artery in patients with demonstrable cerebral hypoperfusion. They have been able to show significant improvement in cognitive function."[3]

In an editorial accompanying this work (Siddiqui and Hopkins, 2013), the authors review this topic over the years, including a literature review of 22 studies, of which eight demonstrated improvement of cognitive function and 11 finding mixed results, with a further three finding cognitive decline following revascularisation.[4]

Discussing the numerous factors possibly contributing to these inconsistencies, Dr Laird noted that the diversity of patient populations and differences in baseline perfusion status may play a role, particularly given that it may be only those with cerebral hypoperfusion that will see a benefit. Furthermore, revascularisation techniques differ between studies and continue to evolve with time, with the possibility of peri-procedural embolism impacting cerebral perfusion and hence cognitive function. Neuropsychological testing methodology, too, may have an impact on results, in terms of its nature and timing post-procedure, as well as the possibility of a learning effect of repeated testing (or indeed a placebo effect).

Dr Laird concluded: "There is strong evidence to support the notion that asymptomatic severe carotid stenosis can lead to cognitive decline. The most important factor appears to be cerebral hypoperfusion. There is inconsistent data regarding the benefits of carotid revascularisation for reversal or prevention of cognitive decline. At the present time, revascularisation has a Class III, Level C recommendation in the guidelines.

"If we are going to attempt revascularisation to prevent cognitive decline, the benefits need to outweigh the detrimental effects of the procedure, including periprocedural embolic events."

References

1. Johnston SC, O'Meara ES, Manolio TA, Lefkowitz D, O'Leary DH, Goldstein S *et al*. Cognitive impairment and decline are associated with carotid artery disease in patients without clinically evident cerebrovascular disease. Ann Intern Med. 2004;140(4):237–47.
2. Chang XL, Zhou HQ, Lei CY, Wu B, Chen YC, Hao ZL *et al*. Association between asymptomatic carotid stenosis and cognitive function: a systematic review. Neurosci Biobehav Rev. 2013;37(8):1493–9.
3. Huang CC, Chen YH, Lin MS, Lin CH, Li HY, Chiu MJ *et al*. Association of the recovery of objective abnormal cerebral perfusion with neurocognitive improvement after carotid revascularization. J Am Coll Cardiol. 2013;61(25):2503–9.
4. Siddiqui AH, Hopkins LN. Asymptomatic carotid stenosis: the not-so-silent disease: changing perspectives from thromboembolism to cognition. J Am Coll Cardiol. 2013;61(25):2510–3.

Not all covered stents are the same

Evidence strongly suggests that patients with severe aorto-iliac disease should be treated with covered stents, according to an expert who spoke at the Getinge-sponsored lunchtime symposium. With over 500,000 global sales, Advanta V12 leads the pack in covered stent technology.

Patrice Mwipatayi, vascular surgeon from Royal Perth Hospital, Australia, commented: "In particular, the reliable and durable results seen with the long-established Advanta V12 covered stent in the COBEST trial clearly demonstrate superiority over bare metal stents." In addition, reflecting robust cost effectiveness, he emphasised that the immediate expense of the covered stent was offset in the long-term compared to bare metal stents.

Professor Mwipatayi's talk provided an overview of 15 years of evolution of the covered stent: 'Choosing the best stent for aortoiliac arterial disease. Is COBEST strong evidence for Advanta V12 as the choice of a covered stent?'

The professor shared his extensive experience with the V12 as the principal investigator of the Covered Versus Balloon Expandable Stent Trial (COBEST) that now has five years of follow-up data. Professor Mwipatayi has been using the Advanta V12 since it was first available in the trial setting in 2004.

At the symposium, he was joined by Professor Eric Verhoeven (Nuremberg, Germany) who discussed the Reliable performance of Advanta V12 in complex aortic cases as a renal stent; and Professor Giovanni Torsello (Muenster, Germany) who addressed the Long-term Munster experience with Advanta V12 and the latest in-vitro evidence.

Advanta V12 has an enviable history having touched over 500,000 lives and is supported by over 300 publications providing clinical evidence of its use. Of particular note, evidence from the COBEST trial comparing Advanta V12 to bare metal stents showed superior patency with a reduction in re-intervention rates at five years.[1]

"I was very impressed by these results. Initially, I didn't think we would see results as good as this. I was amazed."

Patrice Mwipatayi

COBEST is the first and only prospective, multicenter, randomised controlled trial (RCT) to date to compare the efficacy of covered stents vs bare metal stents for aorto-iliac occlusive disease. The five-year follow up data presented by Professor Mwipatayi featured 77 of the 125 patients (61.6%; 119 limbs) assessed at 60 months for primary and secondary endpoints. Particular attention was paid to the outcomes stratified according to TASC lesion severity. The primary endpoint was freedom from binary stenosis as determined by ultrasound imaging or quantitative visual angiography.

The five-year analysis showed that covered stents had lower binary restenosis and lower target vessel revascularization (TVR) than bare metal stents in TASC B, C, & D lesions. Of note, the results demonstrate that for patients with TASC C & D aortoiliac arterial occlusive disease, there were significantly lower restenosis rates and lower occlusion rates with covered stents compared with bare metal stents at 18 months and five-years follow-up.

Published in the Journal of Vascular Surgery, COBEST trial provides a strong basis for the use of the Advanta V12 balloon expandable covered stent in complex aortoiliac lesions, with a definite and enduring patency benefit observed in long-term follow-up compared with the balloon expandable bare metal stent. The benefit of covered stents was seen in more complex TASC C & D lesions, as demonstrated in the initial COBEST RCT; for TASC B lesions, both balloon-expandable covered stents and bare metal stents achieved comparable results.

"In severe disease, the Advanta V12 is only stent that is reliable with good results, according to the COBEST trial," said Professor Mwipatayi. "Five-year patency showed that the covered stent had primary patency of 74.7% versus 62.5% with the bare metal stent [P = 0.01]."

Moreover, the results showed that 18-month patency was 95.1% in the Advanta V12 versus 73.9% in the bare metal stent. "I was very impressed by these results. Initially, I didn't think we would see results as good as this. I was amazed. When we look at the effect of Advanta V12 in severe disease, TASC C and D lesions, we had outstanding results with the covered stent. The patency benefit was exceptionally high with an odds ratio of 8.639, p-value = 0.003."

The Advanta V12 is known for being trusted, reliable and proven. In a conversation with *LINC Review*, Professor Mwipatayi was asked why Advanta V12 was considered so. He said: "In real terms, we have over 10 papers published looking at the use of the Advanta V12 in the 15 years since

it has been available. We have also worked on the only randomized controlled trial comparing Advanta V12 with a bare metal stent. This showed enormous superiority of Advanta V12 versus the bare metal stent. So it is certainly reliable and proven."

He explained why he believed the Advanta V12 stood apart from other covered stents. "First, this product was specifically designed for aortoiliac disease; secondly, it is a covered stent and has an open cell design encapsulated by polytetrafluoroethylene (PTFE). The 316L stainless steel struts are completely covered protecting both the flow lumen as well as the struts from contacting the luminal wall. The stent is also designed to expand uniformly and prevent tissue from prolapsing through the expanded stent."

In addition, the Advanta V12 can be post-dilated to match each patient's individual anatomy. "The bare metal in the Advanta V12 stent does not touch the vessel wall nor the flow surface and this makes a significant difference. This is unique with Advanta V12 in that the stent is fully encapsulated within the ePTFE as one piece. Following the success of the Advanta V12, many companies have developed covered stents but the Advanta V12 was the pioneer and the design is unique from other companies," he added.

The Advanta V12 has unique covering technology and three times higher radial strength than physically needed; these attributes allow the stent to be post dilated and provide customized solutions for physicians and patients.

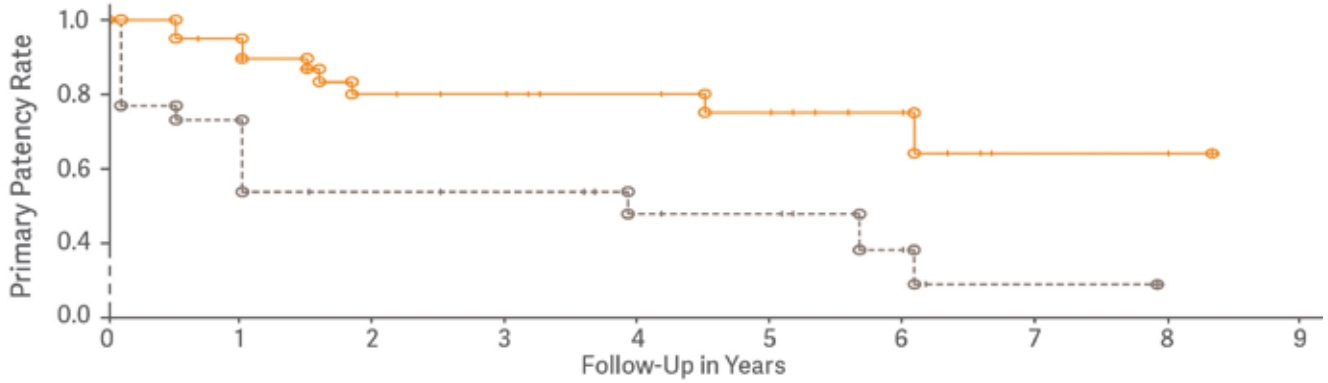
"All covered stents are not the same," stressed Professor Mwipatayi. He drew an analogy to racing cars. "If you take Formula One cars, they all have similar engines but they do not perform the same way. Only one wins the race because there is something different about it. With Advanta V12 the research team moved from a closed cell to an open cell stent design, which is flexible while maintaining radial force. The stent graft material's low porosity provides a blood-tight surface but allows the stent to be incorporated into the vessel wall.

Each covered stent has a different design and technology; as such, each needs to be proven efficacious and safe in its own trial. Results of the Advanta V12 in the COBEST trial have changed clinical practice tremendously, according to Professor Mwipatayi. "Since it was shown that there is a great advantage in using a balloon expandable stent in patients with severe occlusive disease of the aortoiliac segment, then the vast majority of the community agrees that severe disease should be treated with balloon expandable stents".

Turning to issues of cost and value associated with using the covered stent, Professor Mwipatayi noted that the immediate cost of the covered stent was more than the bare metal stent. However, when the benefits are considered including the extremely low re-intervention rate at five-years compared to bare metal stents, the higher initial cost is justified. "This is also less frustrating and inconvenient for the patient."

A physician-initiated meta-analysis is also underway and being led by Professor Mwipatayi. Eventually, the analysis aims to generate a propensity matching score to simulate a clinical study. "Currently, the results seem to be promising," he said in closing.

Primary Patency TASC C/D Lesions



References

1. Mwipatayi BP, *et al*. Durability of the balloon-expandable covered versus bare-metal stents in the Covered versus Balloon Expandable Stent Trial (COBEST) for the treatment of aortoiliac occlusive disease. J Vasc Surg. 2016; 64(1):83-94.

Faculty @ LINC 2019

We would like to thank sincerely the outstanding faculty for their collaboration and commitment.

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Frank Vermassen Vascular Surgeon *Gent Belgium*
Fabio Verzini Vascular Surgeon *Perugia Italy*
Vincent Vidal Interventional Radiologist *Marseille France*
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Martin Werner Angiologist *Vienna Austria*
Philipp Wiggermann Radiologist *Braunschweig Germany*
Christian Wissgott Interventional Radiologist *Heide Germany*
Tim Wittig Angiologist *Leipzig Germany*
Walter Wohlgemuth Interventional Radiologist *Halle Germany*
Hany Zayed Vascular Surgeon *London UK*
Clark Zeebregts Vascular Surgeon *Groningen Netherlands*

ASSOCIATED FACULTY

Mohammad Ansari Interventional Cardiologist *Lubbock USA*
Lee Chang Hoon Interventional Cardiologist *Seoul Republic of Korea*
George Chrysant Interventional Cardiologist *Oklahoma City USA*
Yutaka Dannoura Cardiologist *Sapporo Japan*
Brian DeRubertis Vascular Surgeon *Los Angeles USA*
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Robert Heidepriem Vascular Surgeon *Birmingham Alabama USA*
Yang Jiao Vascular Surgeon *Beijing China*
Jin-Hyun Joh Vascular Surgeon *Seoul Republic of Korea*
Zaza Alexandrovich Kavteladze Interventional Cardiologist *Moscow Russian Federation*
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Taeseung Lee Vascular Surgeon *Seonam-si Republic of Korea*
Jun Li Interventional Cardiologist *Parma USA*
Kumar Madassery Interventional Radiologist *Glenview USA*
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Johnathon Rollo Vascular Surgeon *Seattle USA*
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Ammar Safar Interventional Cardiologist *Dayton USA*
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Myung Gyu Song Interventional Radiologist *Seoul Republic of Korea*
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Jordan Stern Vascular Surgeon *Palo Alto USA*
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Hideyuki Takimura Interventional Cardiologist *Tokyo Japan*
Michinao Tan Cardiologist *Sapporo Japan*
Yoshinori Tsubakimoto Interventional Cardiologist *Kyoto Japan*
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Mathew Wooster Vascular Surgeon *Charleston USA*
Dongming Zhang Vascular Surgeon *Dalian China*

Industry support

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