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Cardiovascular News

EDUCATIONAL SUPPLEMENT

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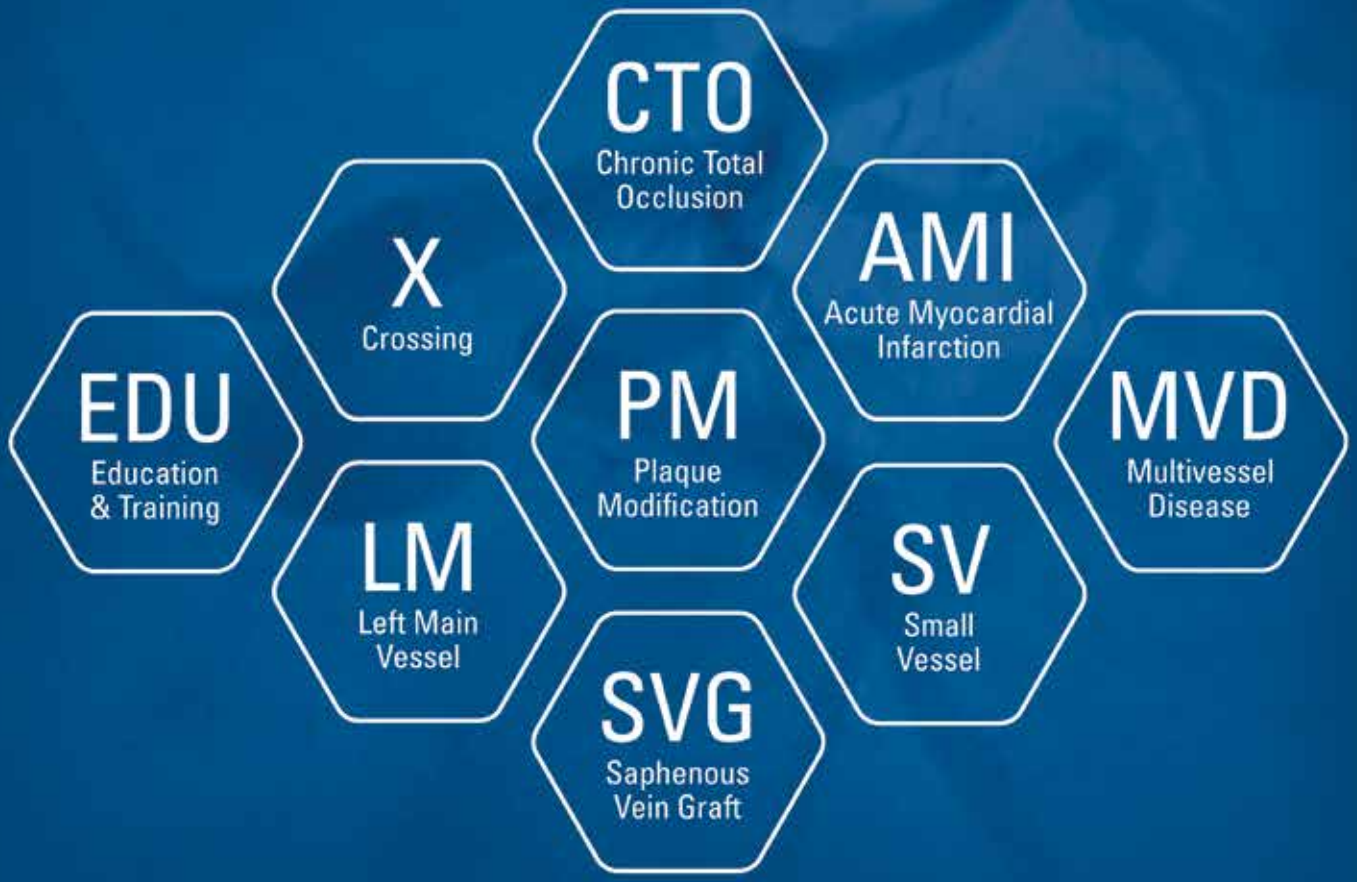

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CONTENTS

The Evidence Base for Complete Revascularisation is Growing

Up to 50% of patients with ST-segment elevation myocardial infarction (STEMI) will have additional stenoses.[1] Until recently, the data for "complete revascularisation" percutaneous coronary intervention (PCI)—ie. treating the non-culprit lesions as well as the culprit lesions—were mixed, which is why current guidelines advocate culprit-only PCI. However, recent studies have suggested that complete revascularisation is beneficial.

Speaking at the Contemporary Issues in Complete Revascularisation meeting* (2 December 2016, Copenhagen, Denmark), Thomas Engstrøm (Rigshospitalet, University of Copenhagen, Copenhagen, Denmark) reported that there were potential "pros and cons" of complete revascularisation in patients with multivessel disease. The pros include immediate complete revascularisation, treatment of remote ischaemia and treatment of secondary unstable lesions, while the cons include increased contrast load, radiation exposure, and possible complications related to treating the additional lesions.

He added that a 2014 meta-analysis[2] found that while there were no significant differences in hospital mortality overall between complete revascularisation PCI and culprit-only PCI, complete revascularisation was associated with increased hospital mortality when performed during the index procedure and decreased hospital mortality when performed as a staged procedure. Additionally, complete revascularisation was associated with reduced long-term mortality and reduced repeat revascularisation.

According to Engstrøm, the mixed data for complete revascularisation (from studies such as the meta-analysis) led European societies to advise[3] that primary PCI should be limited to the culprit vessel only "with the exception of cardiogenic shock and persistent ischaemia after PCI of the supposed culprit lesion" (Class IIa recommendation; level of evidence B) and that staged revascularisation of non-culprit lesions should be considered in STEMI patients with multivessel disease and symptoms of ischaemia within days to weeks after primary PCI (Class IIa recommendation; level of evidence B). "At this time, many physicians considered it dangerous to perform complete revascularisation during the acute phase. In fact, tempers could flare when people suggested it," he noted.

However, since then, Engstrøm commented, three studies have been published that show complete revascularisation to be beneficial. The first of these—PRAMI (Preventive angioplasty in acute myocardial infarction)—randomised 465 patients with STEMI and non-infarct arteries with more than 50% stenosis to (as it was termed in the trial) preventive PCI (234) or no preventive PCI (231). The authors Wald *et al*[4] report that the revascularisation of the non-infarct arteries was performed immediately after the PCI of the infarct artery, adding that the primary endpoint was a composite of death from cardiac causes, non-fatal myocardial infarction

Thomas Engstrøm

or refractory angina. According the authors, at a mean follow-up of 23 months, preventive PCI was associated with a significant 65% relative risk reduction in the primary endpoint, and that "the effect was similar in magnitude and remained highly significant when the analysis was limited to cardiac death and non-fatal myocardial infarction".

CVLPRIT (Complete versus lesion-only primary PCI trial)[5] also randomised STEMI patients with multivessel disease (with non-infarct arteries defined slightly differently: >70% stenosis single view or

>50% two views) to complete revascularisation—as it was called in this trial—or to culprit-only PCI (150 and 146 patients to the respective arms). Similar to the PRAMI trial, the CVLPRIT trial protocol recommended that complete revascularisation should be performed, if there were no clinical contraindications, during the same sitting as the index procedure. The authors Gershlick *et al* comment that this was to "reduce multiple vascular punctures, avoid prolonged hospitalisation, and attenuate potential patient dropout". However, they add: "If the operator decided for clinical reasons that the procedure be staged it was mandated that the non-infarct artery be treated during the index admission." The rate of the primary endpoint—a composite of all-cause death, recurrent myocardial infarction, heart failure, and ischaemia-driven revascularisation within 12 months—was significantly lower in the complete revascularisation arm: 10% vs. 21.2% for culprit-only PCI (p=0.0009). However, there were no significant differences between groups in the indivual components of the primary outcome.

The third trial, DANAMI3–PRIMULT[6] (the third Danish study of optimal acute treatment of patients with STEMI–primary PCI in multivessel disease), was different from PRAMI and CVLPRIT in that it compared culprit-only PCI with complete revascularisation guided by fractional flow reserve (FFR). Therefore, while all patients in the study had >50% stenosis (>2mm) in their non-infarct arteries, only those with a FFR <0.8 underwent complete revascularisation (if assigned to that arm). The protocol stated that if FFR did indicate that a patient had significant ischaemia in the non-infarct artery, complete revascularisation should be performed before the patient was discharged from hospital. Again, the primary endpoint (a composite of all-cause mortality, non-fatal infarction, and ischaemia-driven revascularisation of non-infarct arteries) was significantly lower in the complete revascularisation group (314 patients): 13% vs. 22% in the culprit-only PCI (p=0.004). Authors Engstrøm *et al* report that this result was "driven by significantly fewer repeat revascularisations, because all-cause mortality and non-fatal reinfarction did not differ between groups," adding that the study showed that "to avoid repeat revascularisation, patients can safely have all their lesions treated during the index admission".

Engstrøm told the delegates at the Complete Revascularisation meeting that based on these data, "we should not exclude the potential need for complete revascularisation to impact hard endpoints".

However, he added that there was a need for further studies—including the need to determine if complete revascularisation was to be performed, "when should it be done: index procedure or postponed?". The ongoing MULTISTARS AMI (Multivessel immediate vs. staged revascularisation in acute myocardial infarction) trial, Engstrøm noted, was comparing the safety and efficacy of immediate complete primary PCI of all target vessels with that of staged PCI of target vessels (within minimal 19 days and maximal 30 days) in acute STEMI patients. Its primary endpoint is any target lesion failure; a composite of cardiac death, target vessel myocardial infarction, or clinically driven target lesion revascularisation at one year.

He said that other questions about complete revascularisation included "what should the guidance be—angiography, FFR or others?" and "should complete revascularisation be performed on an enriched patient population; eg. those with a large ischaemic burden of haemodynamic instability?".

Adrian Banning (Oxford Heart Centre, Oxford University Hospitals, Oxford, UK) also spoke about complete revascularisation at the meeting. He said it was "hugely important" but added that "it is also hugely important that we put our stents in properly. I think this is one of things we have been lazy about in the past when it comes to complete revascularisation.

"Ultimately, we do have to be accurate; we do have to cover the lesion completely. The benefit of revascularisation depends on the amount of ischaemia that patient has; if they have not got much ischaemia, then they will not get much benefit from revascularisation."

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The Potential Benefits of Drug-eluting Stents with Biodegradable Polymers for Complex Disease

Biodegradable polymer drug-eluting stents have the potential to improve outcomes, compared with second-generation drug-eluting stents, because they offer the antiproliferative drug benefits of drug-eluting stents, and act as bare metal stents after the polymer has biodegraded. In this interview, Giovanna Sarno (Department of Medical Sciences, Cardiology and Uppsala University, Uppsala, Sweden) outlines the available data for these stents and reviews the different properties of the currently available devices.

Giovanna Sarno

What are the potential benefits of a stent with a biodegradable polymer?

It has been suggested that the polymers used in drug-eluting stent technology exacerbate the inflammatory reaction after stent implantation, and impair endothelialisation and endothelial function—leading to neoatherosclerosis and late adverse events such as very late stent thrombosis and delayed in-stent restenosis, even one year after stent implantation.

Data from SCAAR (Swedish Coronary Angiography and Angioplasty Registry)[1] show that, among patients with ST-segment elevation myocardial infarction (STEMI), new-generation drug-eluting stents are associated with a significant reduction in early and late stent thrombosis compared with older generation drug-eluting stents and bare metal stents. However, these data also indicate that the rates of stent thrombosis after one year continued to increase—with a 0.5% increase of very late stent thrombosis between the one and two years of follow-up in the new drug-eluting stent arm and a 0.2% increase in the bare metal stent arm.

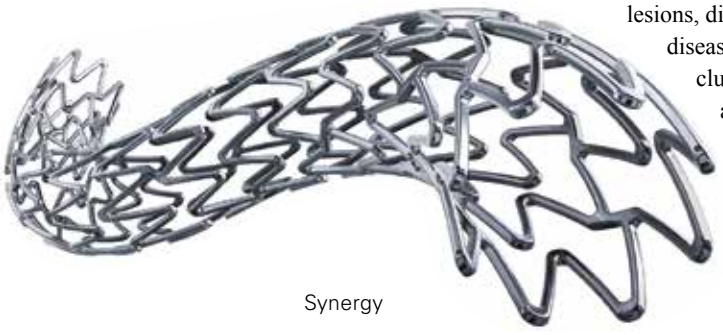
Stents with biodegradable polymers have the potential benefits of both drug-eluting stents and bare metal stents. With a controlled release of an antiproliferative drug during the first months after stent implantation (when reactive intimal proliferation is known to be more accentuated), they could reduce the risk of in-stent restenosis; and, once the polymer is resorbed, they act as bare metal stents with the associated potential to reduce risk of late and very late stent thrombosis.

If these benefits are shown, a revision of the current guidelines for dual antiplatelet therapy (DAPT) might be required so that the duration of DAPT after implantation of a stent with a biodegradable polymer is reduced. Therefore, the results of ongoing studies looking at short DAPT and biodegradable polymer drug-eluting stents will be crucial.

Is the time it takes for a polymer to biodegrade important?

I would say that **more important than the time it takes for a polymer to biodegrade is the synchrony between the drug release and the polymer degradation, which intuitively should be complete when its function is accomplished.** The available drug-eluting stents with biodegradable polymers have different characteristics and distribution: abluminal uniform (Synergy, Boston Scientific; Biomatrix, Biosensors); abluminal sparing at some points of stress in the stent (Ultimaster, Terumo); and circumferential asymmetric with lower thickness on the luminal side (Orsiro, Biotronik).

The Synergy and Ultimaster stents have a synchronous degradation of the polymer within three to four months, while the Orsiro stent has a longer polymer degradation time (within 14 months) with the persistence of the polymer nine to 10 months after the drug release is accomplished. To date, the only randomised trial (BIORESORT)[2] comparing two different biodegradable polymer stents—Orsiro and Synergy—did not show any relevant differences between these stents at one year. Further studies with longer follow-up may allow detection of any potential differences. *[N.B: BIORESORT was a non-inferiority trial that compared Synergy and Orsiro with a permanent polymer drug-eluting stent. It was not powered to show a difference between Orsiro and Synergy.]*



Synergy

There is a drive towards thinner struts. Why is this?

Polymers are only one of the components of the drug-eluting stent technology. The stent design affects the elastic recoil and rigidity properties, and it may influence the healing process and neo-intimal proliferation. The use of stents with thinner struts has been associated with a significant reduction of angiographic and clinical restenosis. Thinner struts lead to a faster endothelialisation, this could mean a faster recovery of the endothelial function and a decreased risk of neoatherosclerosis that is advocated to be one of the main causes of very late stent thrombosis. The excellent performance of new drug-eluting stent technologies is due to a synergic effect of the improvement in all the single drug-eluting stent components: the stent design with innovative material and thinner struts; more biocompatible and biodegradable polymers; and a proven efficacious antiproliferative drug, such as everolimus, that shares the same antiproliferative and immunosuppressive effects as earlier drugs but is more lipophilic—allowing rapid absorption into the arterial wall at the site of vessel injury.

Why might these potential benefits be particularly relevant to complex PCI patients?

The very good performance of biodegradable polymers allows for treatment of patients with multivessel disease, long lesions, diabetes, left main disease, chronic total occlusions, bifurcations and other patients with high clinical and angiographic risk factors. These complex patients are often older with several comorbidities that make them not the ideal candidates for either coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI). If PCI is performed with several implanted stents, it is not always easy to individualise the optimal duration of the DAPT so that you have a good balance between the risks of stent thrombosis and bleeding; both potentially high in these types of patients.

Given the available one and 1.5-year data for Synergy, which you mentioned has synchrony between drug and biodegradation of the polymer, what might we expect to see with the longer term follow-up data?

A study[3] has reviewed the use of the Synergy stent in a real-life population from SCAAR, which includes an all-comer population with in-stent restenosis, left main disease, chronic total occlusion, or saphenous vein graft. In this population, the proportion of patients with STEMI or non-STEMI (NSTEMI) was higher than 60%. The definite stent thrombosis, restenosis and myocardial infarction rates up to one year in this study population are excellent for both the Synergy and the other new-generation drug-eluting stents reviewed. The patients in the Synergy stent group had a higher mean age, a higher proportion with diabetes and prior cardiovascular risk factors as well as more three vessel and left main disease, longer stents with smaller diameter and more bifurcation lesions. Yet, the overall procedural success and the one-year outcome results were similar when compared to other new-generation drug-eluting stents.

How much follow-up data are needed?

The five-year results from the LEADERS study[4] have shown the late benefits of bioabsorbable polymer stents, with a significant reduction in very late stent thrombosis and myocardial infarction in patients treated with the bioabsorbable polymer biolimus stent when compared with patients treated with the durable polymer sirolimus eluting stent. The newer stent design, the everolimus drug and the different polymer that resorbs faster (within four months) with the Synergy stent may allow the late benefits of biodegradable polymer drug-eluting stents to be greater and potentially emerge at an earlier stage after the first year.

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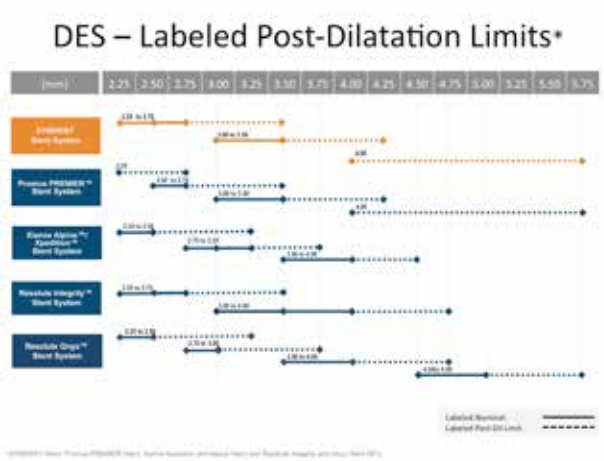
Left Main PCI Post EXCEL and NOBLE

The EXCEL and NOBLE studies[1,2] have caused some confusion about the optimal treatment of left main—with EXCEL suggesting percutaneous coronary intervention (PCI) is non-inferior to coronary artery bypass grafting (CABG) for managing left main disease and NOBLE indicating that it is inferior. This article will review whether these data are as conflicting they appear to be and the implications of these results for achieving optimal outcomes in the left main.

The EXCEL (Evaluation of Xience vs. CABG for effectiveness of left main revascularisation) investigators Stone *et al* found, according to their conclusion, that "PCI with everolimus-eluting stents was non-inferior to CABG", but the NOBLE (Nordic-Baltic-British left main revascularisation study) investigators Mäkikallio *et al* seemed to have found the opposite. They report "the findings of this study suggest that CABG might be better than PCI for treatment of left main stem coronary artery disease".

In fact, these two conclusions cannot be directly compared because the studies had different endpoints and different follow-up points: EXCEL had a composite primary endpoint of stroke or myocardial infarction at three years and NOBLE had major adverse or cerebrovascular events (MACCE; a composite of all-cause mortality, non-procedural myocardial infarction, any repeat revascularisation and stroke) at five years as its primary endpoint. The key differences in the endpoints (aside from the follow-up time points), according to NOBLE investigator Evald Christiansen (Department of Cardiology, Aarhus University Hospital, Skejby, Denmark), were that NOBLE—unlike EXCEL—did not review procedural myocardial infarction and EXCEL did not include repeat revascularisation. Christiansen explains: "When we designed the NOBLE study, there was not a generally accepted definition of large procedural myocardial infarction; thus, we did not include it. The EXCEL investigators did not consider repeat revascularisation to be important, which I think you can debate. **I think a meaningful endpoint is one that the patient would like to avoid; they want to avoid death, stroke, myocardial infarction, and coming back to the hospital. Then again, a repeat PCI may not be seen as important as a stroke."**



Furthermore, he believes that the studies actually have similar findings and comments: "If we take a look at some of the individual components of the endpoints of the study, they are exactly the same."

For example, both studies show that there were no significant differences in survival between PCI and CABG. They also both found that there were no significant differences in the rate of stroke between PCI and CABG at three years, but NOBLE did find an indication of a higher rate of stroke in the PCI arm at five years (according to Kaplan-Meier intention-to-treat estimates: 5% vs. 2% for CABG; p=0.073). Noting that this result did not reach statistical significance, Christiansen attributes the apparent higher rate of stroke in the PCI arm to the "striking finding" of there being a very low periprocedural stroke rate in the CABG arm. He adds that this low rate may relate to the high quality of the surgery in the CABG arm but could also be a chance finding.

According to Christiansen, the event curves in EXCEL are "very much like those of NOBLE". In EXCEL, PCI was associated with a significantly lower rate of the primary endpoint at 30 days (p=0.008 for the comparison) but a landmark posthoc analysis found that more events occurred in the PCI arm than in the CABG arm between 30 days and three years. He notes: **"It is just a question of how you combine endpoints and how long you follow the patients for."**

The choice between PCI and CABG in left main disease

Given that both EXCEL and NOBLE showed CABG and PCI to have similar survival rates, the choice between treatment options may depend on the lesion and patient characteristics. Christiansen says that for PCI to be a potential option, in the case of multivessel disease, complete revascularisation must be achievable with PCI. Therefore if the lesions outside of the left main are too complex (ie. the patient has a high SYNTAX score) for PCI, then surgery may be the better option. However "if there is just one lesion outside the left main and it is not too complex, you have both options and you can discuss them with the patient," he comments, adding that the heart team—including a cardiac surgeon and an interventional cardiologist—should be involved in the decision-making process.

If PCI is an option, the patient should be told the potential advantages and disadvantages of PCI vs. CABG (as seen in EXCEL and NOBLE). "The need for repeat revascularisation seems to be a little higher with PCI compared with CABG. On the other hand, you have to stay in hospital for nine days after the index treatment with CABG but you can go home after two with PCI. You have to individualise the treatment to what the patient prefers," Christiansen observes. Furthermore, another consideration is dual antiplatelet therapy, which is not required after CABG.

Optimising outcomes in left main PCI

If the heart team, and the patient, choose PCI, a key consideration is which stent to use. Christiansen explains that the chosen stent has to have the "expansion capacity" to treat the left main, noting that a problem with the first-generation drug-eluting stents was that some of them lacked the capacity to treat large vessels in the left main. He adds: "With left main PCI, you may need a stent that is capable of expanding beyond 4.5mm."

Another important consideration when choosing a stent for left main is strut thickness, which Christiansen explains is "important for what we call the footprint". He says: **"When putting metal inside the vessel wall, you need to understand the area that you are covering—the lower the footprint, the better.** A stent with a high footprint (ie. with thick struts) may cause the flow to be disturbed and we know that flow velocity protects against disease and narrowing. If, because of the

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stent, you reduce the flow in a side branch, you will increase the risk of having a stenosis in the side branch. Therefore, the footprint is very important."

Christiansen also "strongly recommends" the use of intravascular ultrasound (IVUS) with left main PCI because visualisation of the circumflex ostium "can be difficult" with X-ray as "you cannot get an adequate X-ray angle". He says that IVUS is also useful to assess the true diameter of a vessel in cases of diffused disease because studies show that estimating the true diameter is "very difficult" with the angiogram.

Operator experience is also an important element of optimising outcomes with left main PCI. Christiansen comments: "I would recommend that left main PCI is performed by an operator who does more than 30 left main PCIs per year because we now have evidence that more experienced left main PCI operators have better outcomes than non-experienced PCI operators."

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Rotational Atherectomy in Contemporary PCI

Rotational atherectomy fell out of favour after studies indicated that it was associated with higher rates of restenosis than angioplasty.[1] However, during the past decade, interest in the approach as a potential tool for plaque modification has grown.[2] In this article, *Cardiovascular News* explores the use of rotational atherectomy in modern percutaneous coronary intervention (PCI).

According to Emanuele Barbato (Cardiovascular Center Aalst, Belgium; University of Naples Federico II, Naples, Italy), rotational atherectomy represents "the technical solution" to enabling complete revascularisation in heavily calcified coronary stenoses. He explained, in his talk at the Contemporary Issues in Complete Revascularisation meeting* (2 December 2016, Copenhagen, Denmark), that a solution is required for such lesions because **coronary calcification is "one of the main reasons for incomplete and/or suboptimal percutaneous revascularisation".** Barbato added that coronary calcification is associated with a predisposition for "stent under expansion and increased risk of stent failure" and is an independent predictor of adverse events.

However, while the European Society of Cardiology (ESC) recommends the use of rotational atherectomy—for the "preparation of heavily calcified or severely fibrotic lesions that cannot be crossed by a balloon or adequately dilated before planned stenting"[3]—Barbato commented that there is a lack of standardisation about how it should be performed. Therefore, he and other experienced rotational atherectomy operators came together to produce a consensus document, published in *EuroIntervention*, for the procedure.[2]

In this document, Barbato *et al* outline that the "main objective" of rotational atherectomy is indeed plaque modification, which they define as smoothing "the vessel lumen, disconnecting intravascular calcium rings, and facilitating further balloon dilation and stent implantation". Observing that this objective moves rotational atherectomy away from its original purpose, in "the pre-stent era", of debulking atherosclerotic plaque as an adjunct to balloon angioplasty, the authors state that "there might still be angiographic settings where a more extensive rotablation [ie. debulking] is desirable; ie. ostial lesions, prevention of plaque shift or prolapse, which might be safely achieved with a step-up in burr size".

They also discuss the use of rotational atherectomy in specific settings of contemporary PCI. For example, recognising that the transradial approach is now seen as the default approach (at least in Europe), they state rotational atherectomy can be performed with either "transfemoral or transradial procedures". "The smaller size of the guiding catheters routinely used during transradial procedures does not represent a limitation, considering plaque modification is easily achieved with a 1.25mm or 1.5mm burr in most cases," Barbato *et al* comment. They add that "even in cases which require more extensive rotablation with a bigger burr size," transradial shealthless guiding catheters with an internal diameter of 7.5Fr can be "safely used".

Furthermore, the authors review the use of the technique in more complex anatomies—in fact, they state rotational atherectomy has "undergone a resurgence of interest" because of the ageing population and the "expansion of PCI to more challenging anatomic settings". Barbato *et al* discuss ostial lesions and chronic total occlusions, noting rotational atherectomy might be a useful tool for the latter in cases in which "the guidewire has crossed the occlusion but the balloon failed to cross or to dilate the stenosis." They write: "A single run with the 1.25mm burr followed by balloon dilation is sufficient to achieve plaque modification in most cases."

However, of all of the recommendations in the document, Barbato told delegates at the Complete Revascularisation meeting that probably the most important was the speed at which rotablation is performed. He stated: "We all agreed that going above 180,000rpm or below 135,000rpm was not a good idea. Above that range, you might incur distal embolisation whereas below that range you might have burr lodging."

Barbato *et al* conclude the consensus document by saying **"for experienced users, contemporary rotational atherectomy offers a safe and effective means of percutaneous treatment of highly calcified obstructive lesions,"** adding: "this consensus document provides a range of agreed opinion by experienced rotablation operators that can be disseminated as best practice."

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** = Sponsored by Boston Scientific*

Manual Thrombectomy *vs.* Mechanical Thrombectomy

According to Matthias Götberg (Department of Cardiology, Lund University, Skåne University Hospital, Lund, Sweden), evidence indicates that mechanical thrombectomy may provide advantages over manual thrombectomy.

At the Complete Revascularisation meeting, he explained that "manual thrombectomy has reduced efficacy compared to modern mechanical thrombectomy devices", noting this may be a potential reason for the lack of effectiveness seen with manual thrombectomy in the TOTAL (Thrombectomy with PCI *vs.* PCI alone in patients with STEMI) study.[1]

Götberg added that Parodi *et al*,[2]

in the SMART PCI study, found that "mechanical thrombectomy was associated with improved flow, decreased thrombus and improved outcomes" compared with manual aspiration.

However, he stated that the data for mechnical thrombectomy were from small studies and "large trials powered to assess event rates are lacking". "Until we have more data, we should probably consider performing thrombectomy in patients with a high thrombus burden and look at using mechanical thrombectomy in these patients," he summarised.

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A New "Workhorse" Wire for FFR

Presenting his impressions of a new optical pressure guidewire (Comet, Boston Scientific) at the Complete Revascularisation meeting, Iwar Sjögren (Falun Hospital, Falun, Sweden) said that he believed that the technological advancements, compared with existing wires, of the Comet wire meant it was a "diagnostic wire that behaved like a true workhorse wire".

The Comet wire, developed with Asahi, is designed to be highly deliverable and provide clear results to enable operators to make the optimal decision for their patient. The deliverability of the wire relates to its tip shapeability and retention—with one to one torque and rail support "for the entire procedure". Furthermore, for reliable disconnection and reconnection, the wire has free rotation while steering. Sjögren noted that the "free spinning handle" is associated with "extremely little friction" and operators could connect or reconnect the wire without drift, which was "important in multivessel disease". However, he added that problems with the connection could occur if operators were "too fast". Therefore, to avoid this issue, he advised that they should "try before their first case" and that "once you have learnt how to use, it is easy".

Sjögren reported that the Comet wire is used with the Polaris system (Boston Scientific). "Polaris is a multimodal intravascular ultrasound and fractional flow reserve (FFR) system. It is software that is intuitive and makes the procedure much easier. It is simple to put the time window for the part of the measurement of interest—for example, the injection of adenosine or during pullback."

The Realities of Performing Complex PCI

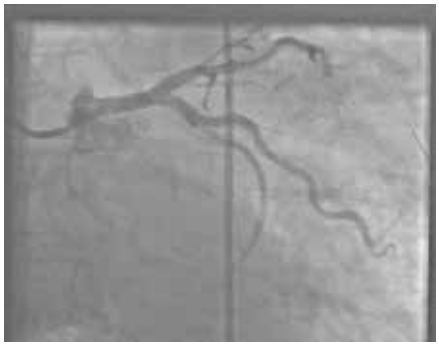
At the Contemporary Issues in Complete Revascularisation meeting* (2 December 2016, Copenhagen, Denmark), three edited live cases were presented to give an insight into how complex percutaneous coronary intervention (PCI) is performed in clinical practice. The main operators in these cases, in this article, outline what made procedure complex and how they addressed the challenges of the case, and report the procedural outcomes achieved.

LEFT MAIN PCI IN A PATIENT WITH HIGH BLEEDING RISK
By Iwar Sjögren (Falun Hospital, Falun, Sweden)

The patient, who had declined surgery, had a history of abusing alcohol and was very overweight—both of which make him a complex patient. The alcohol abuse, if he started to drink again, meant that he was likely to comply poorly with his dual antiplatelet therapy (DAPT) drug regimen. For this reason, I planned to prescribe him a short duration of DAPT.

His weight meant that the X-ray would be an issue—to ensure we would get a good image, we would have to use a high dose and that would leave him at risk of skin problems. Therefore, I used intravascular ultrasound (IVUS) as much as possible to minimise the use of X-ray. Furthermore, because of his weight, I would have preferred to use the transradial approach. But I had to use the transfemoral approach because his left and right radial arteries were occluded (due to previous procedures). To avoid bleeding complications, which we had to be very careful about, I used a 6Fr guiding catheter. For me, a 6Fr allows you to do everything without damaging the left main; although, it does not always give you the technical support required.

I used fractional flow reserve (FFR) to assess the stenosis in the left main, which was not very tight, and it showed that the stenosis was not functionally significant. However, IVUS did indicate that the stenosis was of borderline significance. I decided to treat because we found that he had a highly significant circumflex marginal stenosis and to treat that, I would also have had to treat the left main. In multivessel disease, it is important to differentiate which stenosis is causing the problem. FFR is also particularly important in cases of diffused disease, so I very often perform IVUS and FFR. With FFR, I used the Boston Scientific Comet wire. The quality of the Comet wire makes life so much easier because it behaves as a standard wire.



Post PCI result

During the procedure, I struggled to predilate the circumflex marginal; it was impossible even with the extremely good technical support I was using. The only way to resolve the issue was to use rotablation, which took some time to get down the vessel but went down fairly easily. Also, the patient did develop a haematoma in the distal circumflex. However, it was easy to pass and I do not think it will cause a big issue.

I then put Synergy stents into everything. Synergy works differently from other stents because of its design. It works itself slowly down the vessel with each heartbeat, which makes it easy to deliver. Also, I needed a stent that you could expand to 5mm to treat the large left main. I decided to use the culotte technique to treat the stenoses because the patient had previously undergone PCI with a first-generation stent and I did not know exactly where they were. I think the Synergy stent is extremely useful stent for performing culotte stenting.

The postprocedure IVUS result was as expected (ie. good). At the moment, the patient seems to be doing very well. But I only performed the case, at the time of writing, three weeks ago, and you really need a year's follow-up to know if a procedure has been successful.

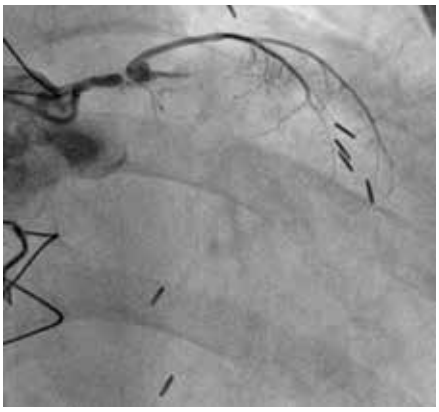
COMBINED ROTABLATION/IVUS/EMBOLIC PROTECTION IN A COMPLEX SECONDARY REVASCULARISATION

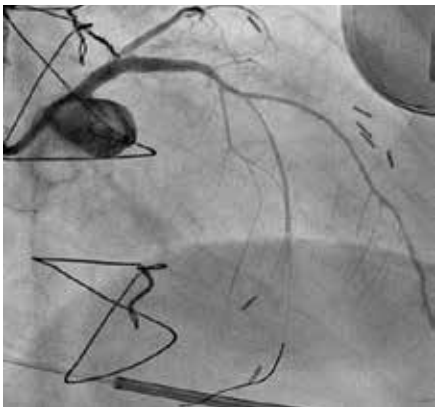
By Javier Escaned (Hospital Clinico San Carlos/Faculty of Medicine Complutense University, Madrid, Spain)

The patient was a good example of the challenges imposed by secondary revascularisation after coronary artery bypass grafting (CABG). He had a long history of cardiovascular disease: his first myocardial infarction was 40 years ago, he had low left ventricular ejection fraction (LVEF) and had an implantable cardioverter defibrillator because of recurrent ventricular tachyarryhtmias (and had also undergone cardiac ablation). In terms of this case, he had failure of some of his CABG conduits, extensive, calcific native atherosclerotic disease (leading to an important ischaemic burden), and concomitant conditions such as chronic renal failure. From an angiographic standpoint it was not possible to rule out that the left main stenosis was, in fact, a chronic total occlusion. Besides, beyond the left main, the left coronary artery vessels had severe diffuse disease with luminal diameter below available stent diameters.

Because of these factors, a key consideration in this case was ensuring the patient's safety during the PCI procedure. His low LVEF, the presence of chronic renal failure and the anatomical complexity dictated a thorough planning of the procedure; also, intracoronary imaging was considered mandatory to guide this complex PCI and to ensure an optimal result.

After the procedural risk stratification was performed using the CABG SYNTAX score and an ad hoc heart team meeting, the consensus that PCI would be the optimal treatment was reached. We decided to stage the procedure to limit/decrease the risk of contrast-induced nephropathy. The first procedure was the PCI to the saphenous vein graft stenosis. Then, a second procedure would be performed to the left main stenosis with intra-aortic balloon pump (IABP) support. The aim of this second procedure would be treat the calcific left main stenosis.





Pre and post PCI result

To decrease the risk of procedural complications during the saphenous vein graft PCI, embolic protection with a FilterWire D (Boston Scientific) was performed. In the second procedure, the first challenge was the severe calcification of the left main stenosis and the possibility that it was a chronic total occlusion. PCI was performed under guidance with bilateral angiography (one radial and one femoral access) while the IABP was inserted in the other femoral artery. After a successful crossing, we performed rotational atherectomy. After this was accomplished, we faced the next challenge: extensive diffuse disease of the left anterior descending with luminal diameters of less than 2mm. The OptiCross IVUS catheter (Boston Scientific) was navigated after atherectomy to assess stent dimensions and location of the best landing zone. It became clear that we should use two Synergy stents to separately treat the proximal left anterior descending and left main. During PCI, the potential damage of the left main stent by the guiding catheter was minimised by placing an additional guidewire in the Valsalva sinus, allowing better control of the guiding catheter tip and avoiding its accidental entry into the stented left main. IVUS guidance to ensure adequate expansion and apposition of the stents was performed.

IVUS imaging demonstrated optimal expansion and apposition of the stents and no distal dissection, and IABP was withdrawn in the afternoon after the procedure. His renal function was unaffected by the intervention. The patient was discharged three days later and his symptomatic status improved considerably.

CHRONIC TOTAL OCCLUSION CASE

By Simon Walsh (Belfast Health Trust, Belfast, Northern Ireland, UK)

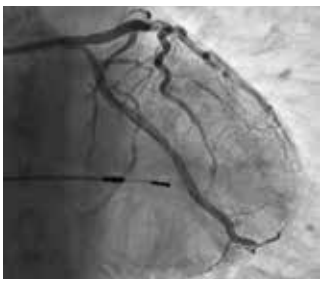
The patient had a chronic total occlusion (CTO) of the left circumflex artery. This had an ambiguous proximal cap, was a long lesion, and there had already been a failed attempt to re-open it. Additionally, collaterals were ipsilateral from the diagonal vessels and were small and very tortuous. Each of these anatomical factors suggest that the occlusion would be potentially difficult to re-open.

Therefore, the most important considerations were the technical approaches or strategies that would be employed to re-open the chronic total occlusion. The anatomical features were used to provide information that fits into the four key questions of the hybrid chronic total occlusion algorithm. The aim of this process is to subsequently predict the approach or approaches that are most likely to lead to a safe, efficient and successful PCI for the patient.

The initial strategy was to re-open the chronic total occlusion using a retrograde approach. However, the collaterals proved to be unsuitable for an interventional strategy. We then had to default to a secondary strategy of antegrade dissection and re-entry using the CrossBoss chronic total occlusion crossing catheter and the Stingray chronic total occlusion re-entry system (both Boston Scientific).

We were able to successfully cross the chronic total occlusion lesion and re-enter the distal vessel. Drug-eluting stents were then implanted and the patient had a complete revascularisation of all distal branches with an excellent result.

This patient had been suffering from a substantial burden of angina (despite tablet treatment), but this has now completely resolved. His exercise capacity is no longer restricted and he has stopped needing to take his anti-angina medication.



Post PCI result

* = Sponsored by Boston Scientific

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