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Retrograde approach for chronic total occlusion: present status and prospects

Masahiko Ochiai*, MD, FACC, FESC

Division of Cardiology and Cardiovascular Surgery, Showa University Northern Yokohama Hospital, Yokohama, Kanagawa, Japan

This editorial refers to "Retrograde approach to coronary chronic total occlusions: Preliminary single European centre experience" by Carlo di Mario et al published in this issue of Eurointervention.

Chronic total occlusion (CTO) is defined as TIMI flow grade 0 within an occluded segment for an estimated duration of ≥ 3 months[1,2]. Such occlusions are quite different from recent myocardial infarction (MI) occlusions, for which percutaneous coronary intervention (PCI) has not shown superiority over optimal medical therapy in some prospective randomised trials[3,4]. Indeed, no randomised trials have ever been performed to evaluate the impact of PCI on "true" CTO. However, numerous non-randomised registry data clearly indicate an improved patient outcome after successful PCI for CTO[5,6]. Although CTOs are frequently found in patients who undergo coronary arteriography for known or suspected coronary artery disease, only a few of these lesions (5.7-9.4%) are treated by PCI[7]. The reason for this low number may be due to the low success rate of PCI, as well as the high procedural cost and high radiation exposure for both patients and operators[7]. Of course, the most common reason that PCI fails in patients with CTO is the inability to pass a guidewire across the occlusion into the distal vessel.

Since the early 1990s, some Japanese physicians have made tremendous efforts to improve the success rate for CTO so that it becomes acceptable for the interventionalist community, including the development of special devices such as dedicated stiff wires that can still transit torque at sites of occlusions (Miracle and Confianza Pro wires; Asahi Intecc. Nagoya. Japan). Contralateral injection has been used routinely, if the distal vessel beyond a CTO is mainly filled by retrograde collaterals. Based on the findings of contralateral injections in multiple projections, the interventionalist draws an imaginary line across the occluded segment and then can advance a dedicated CTO wire with support from a microcatheter or over-the-wire balloon. In actual practice, of course, there are serious problems which may arise, i.e., the procedure is easy to describe but hard to actually perform. Even with contralateral injections, we can clearly recognise the terminus of the CTO for only a few seconds during the procedure while contrast medium opacifies the distal vessel. We must remember its position on the monitor, and then advance the wire accordingly, after which we check its position again by contralateral injection. As a result, the wire is frequently advanced into a false lumen in the distal vessel, after which it becomes invisible due to compression by an intramural haematoma created through manipulation of the wire.

In order to overcome this problem, the parallel wire technique was established in the late 1990s, which is still the most important of the various wiring strategies[8]. If the first wire has entered a false lumen, the operator should not manipulate it any further and should leave it as it is. Because the first wire in the false lumen can always be clearly seen on fluoroscopy, and its relationship to the distal true lumen is more easily recognisable as well, it becomes simple to advance the second wire into the distal true lumen. However, the distal true lumen will finally become invisible if we repeat this technique several times. One of the countermeasures for this situation is intravascular ultrasound (IVUS) guided wiring. If we place an IVUS probe in the false lumen, the position of the true lumen will become clear, even if it is completely invisible on angiography, and we can sometimes achieve re-entry into the true lumen with another stiff wire[9,10]. However, pre-dilatation with a small balloon is essential to advance the IVUS probe into the false lumen, which results in long and massive dissection up to the distal bifurcation with a large side branch. If the wire is actually located outside the vessel, pre-dilatation with a balloon will result in massive coronary perforation.

* *Corresponding author: Division of Cardiology and Cardiovascular Surgery, Showa Unversity Northern Yokohama Hospital, 35-1 Chigasaki-chuo, Tsuzuki, Yokohama, Kanagawa 224-0032, Japan*

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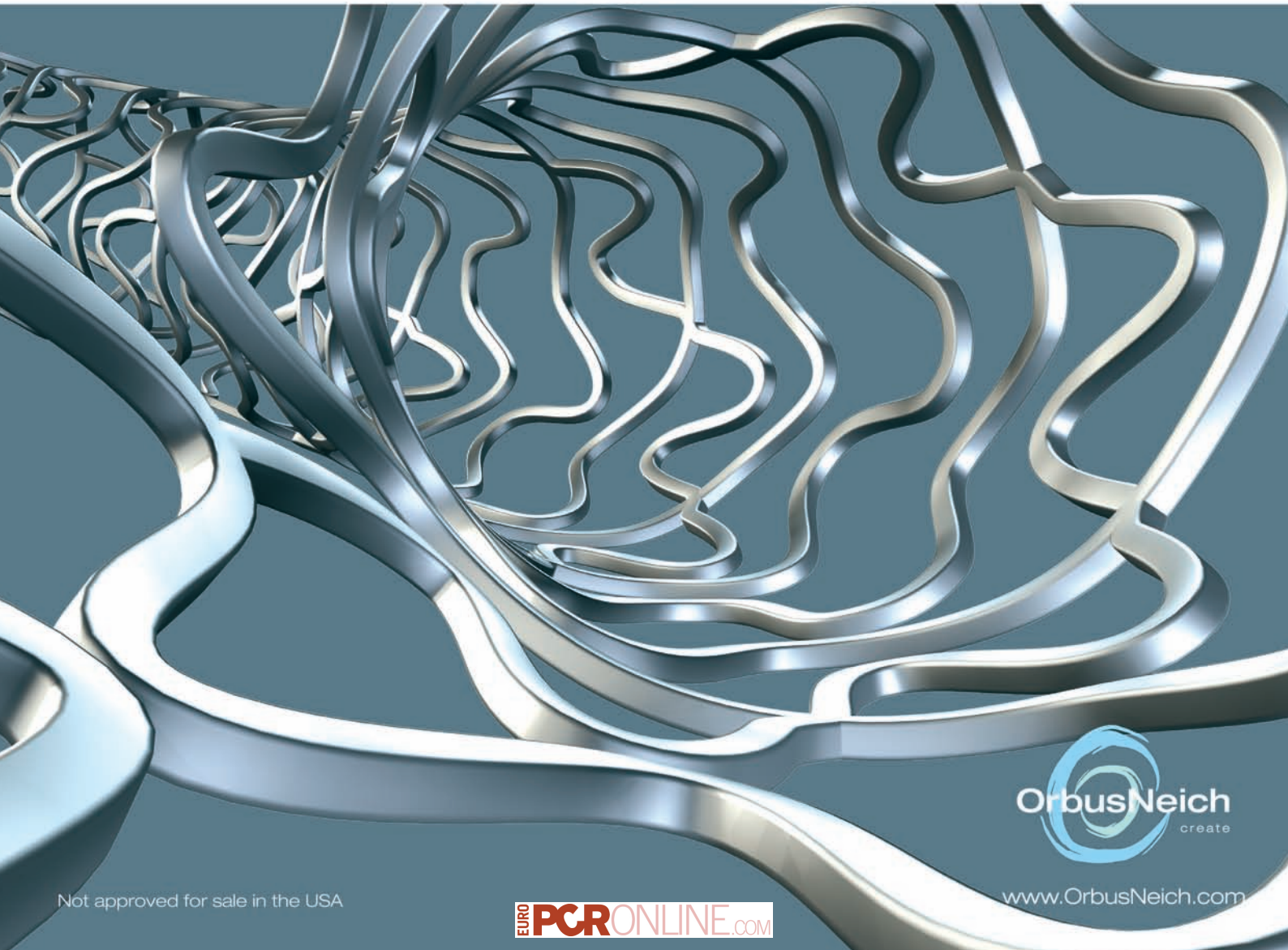

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Thus, this technique is regarded as the method of last resort to find the true lumen and should only be used by a very experienced operator. Another indication for IVUS is to look for the entry into an abrupt type of CTO without a stump[10]. Of course, a side branch of sufficient size to accept an IVUS probe is essential. The antegrade approach faced several limitations in the early 2000s, and we continued looking for a breakthrough.

If we review the history of PCI for CTO again, the first report on the retrograde approach was published in 1990[11]. Seven CTOs were successfully opened after crossing a retrograde wire through vein grafts. This strategy utilised a characteristic of CTOs, since the distal fibrous cap is usually less resistant than the proximal cap[12]. Although the retrograde approach was tried afterwards for patients who had undergone previous bypass grafting or had large collateral vessels from the other coronary artery, this technique was not applied frequently or systematically for complex CTOs, because the delivery of a balloon via small collaterals was not easily accomplished. In some cases, a soft and slippery wire is advanced into the distal coronary artery via a collateral to provide a clear landmark that identifies the distal true lumen. Because the position of distal true lumen is always recognisable on fluoroscopy without injection of contrast medium, an antegrade wire can sometimes be advanced easily through the occlusion towards the distal true lumen by using the retrograde wire as a landmark (kissing wire technique)[13]. However, in patients with a long or calcified CTO, it is not always easy to achieve a successful antegrade wiring by this technique alone.

In the early 2000s, Katoh found that septal collaterals can frequently be dilated with a very small balloon (1.25-1.3 mm at 2-3 atmospheres) after a soft and slippery wire has been passed through[14]. Following septal dilatation, delivery of an over-the-wire balloon (OTW) is the same size as the distal coronary artery can be achieved as well. Once a larger OTW balloon is delivered into the distal coronary artery, the soft wire can be exchanged for a stiffer one, such as a Miracle 3 g or Confianza Pro, which may be used to cross the occlusion in a retrograde fashion supported by the inflated balloon (retrograde wire crossing technique). Of course, this technique utilises IVUS data on the CTO, as mentioned above[12]. If a soft wire is placed in the vessel proximal to the CTO, the exit or goal of the retrograde wire will always be clear on fluoroscopy. When the stiff retrograde wire enters a false lumen, the controlled antegrade and retrograde subintimal tracking technique – the Controlled Antegrade and Retrograde Subintimal Tracking (CART) technique – can be used[15]. The subintimal lumen is enlarged by inflation of the retrograde balloon, which is advanced into the occlusion, and then an antegrade wire can be advanced to penetrate the dissection. We can manipulate the antegrade wire by using the retrograde balloon as a landmark. Because the dissection is dilated by the retrograde balloon, the antegrade wire can finally be advanced into the distal true lumen. The performance of retrograde wire crossing or CART techniques after septal dilatation represents the biggest recent breakthrough in the area of PCI for CTO. We are now able to treat very complex occlusions if there is an appropriate connection through septal collaterals. This has been clearly shown in Japan as well as in Europe[14-16].

To achieve more widespread application of the retrograde approach by the interventionalist community, collaboration between physicians and the medical device manufacturers has played a very important role, as was the case in the development of drug eluting stents. In the early days of the retrograde approach, we used conventional polymer-coated wires to track the septal collaterals. Nowadays, we have dedicated wires for the retrograde approach with a more flexible tip and more supportive shaft (X-treme and Fielder FC, Asahi Intecc, Japan). In the old days, we had to cut the conventional 100-cm guide catheter before the procedure, or the retrograde balloon could not reach the occlusion. In tall patients, it was impossible to engage a shortened guide catheter into the coronary artery via the femoral approach and we needed to use the brachial approach, which made the procedure more complex. Now, we have a long shaft over-the-wire balloon (148 cm OTW Ryujin Plus, Terumo, Tokyo, Japan), that is compatible with any conventional guide catheter. Further collaboration will lead to the creation of even better equipment for this approach.

As is always true with new strategies, the retrograde approach has at least three issues to be solved in the near future. First, the biggest drawback of the retrograde approach is the need for a second guide catheter (usually ≥ 7 Fr) in the donor (or healthy) coronary artery. If the proximal coronary artery dissects from the tip of the guide catheter or thrombus develops, the patient will suddenly be in a very serious situation. There is also a specific complication of septal dilatation, which is the rupture of septal collaterals. Therefore, meticulous care should be taken when device manipulation is done. The activated clotting time should be measured every 30 minutes, and be kept longer than 300 seconds. Considering the possible risk of these fatal complications, it is still unclear whether the retrograde approach can be applied as the initial procedure, or should be reserved for salvage after failure of the antegrade approach. Second, both the retrograde wire crossing and CART techniques are equally important to treat complex CTOs by the retrograde approach. How should these two strategies be used for different CTOs? For retrograde wire crossings, some operators prefer the Miracle 3gr, while others use the Confianza Pro. We are still unclear about the optimum selection of devices and strategies. Third, if the patient has multivessel disease, the CTO is treated first according to our standard procedure. If PCI for CTO is unsuccessful, we can still achieve complete revascularisation by referring the patient for bypass surgery. However, in order to perform the retrograde approach safely, tight or even moderate stenoses in the donor coronary artery should be treated first to prevent severe ischaemia during the retrograde approach. Also, if the retrograde approach for CTO is unsuccessful, complete revascularisation will not be achieved. Is such a strategy justifiable? If so, how high a success rate should the retrograde approach achieve?

I hope that we can find answers to these questions and adopt a standardised strategy for the retrograde approach within a couple of years.

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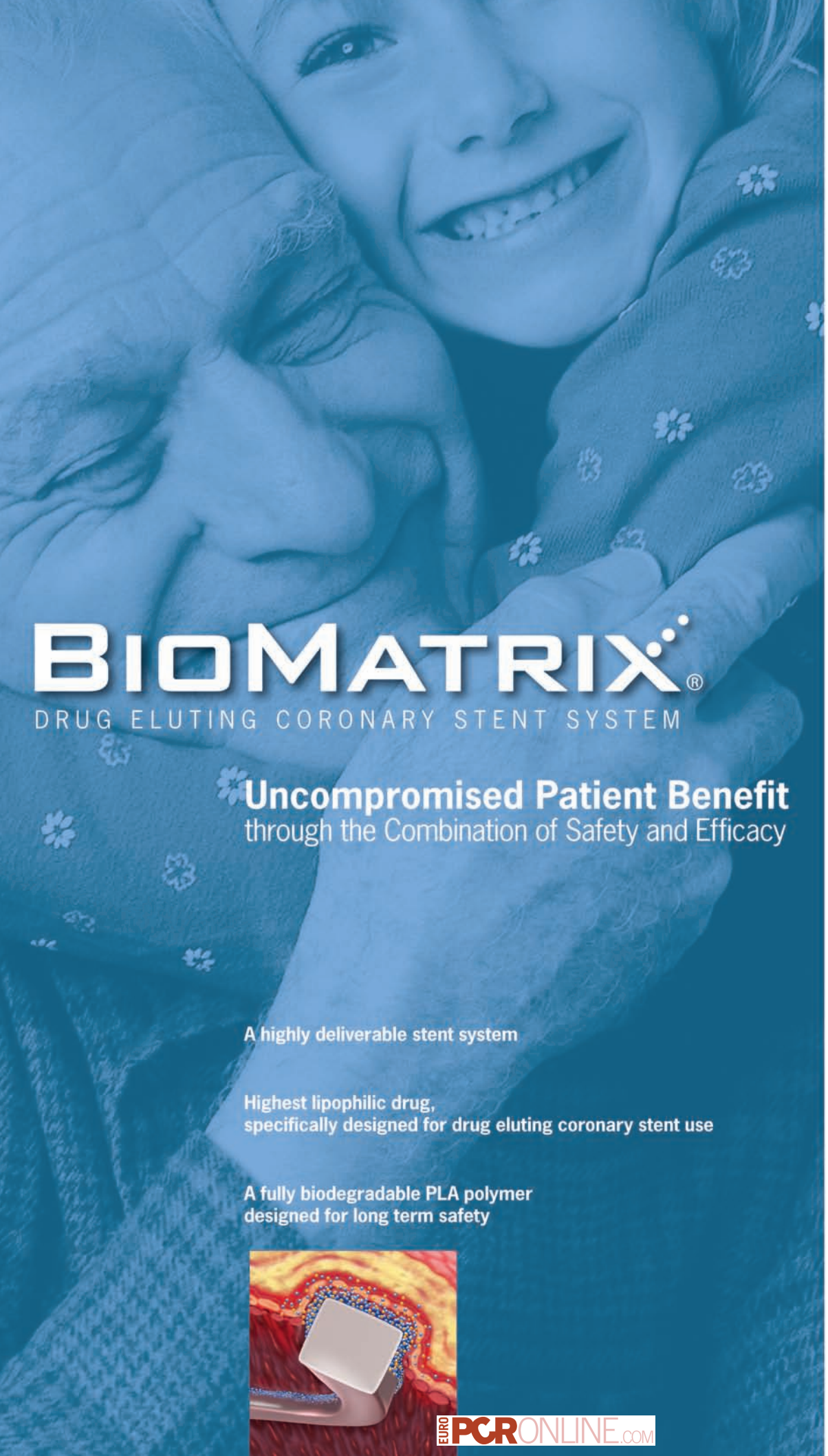

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