



The retrograde technique for recanalization of chronically occluded coronary arteries: case series report

Tehnika retrogradnog pristupa kod rekanalizacije hronično okludiranih koronarnih arterija: prikaz serije slučajeva

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Abstract

Introduction. Chronic total occlusion (CTO) of the coronary artery still represents one of the most challenging lesion subsets in the field of interventional cardiology. Considering the complexity and increased risk posed by the retrograde approach, it is most often performed after a failed antegrade approach. **Case report.** We present a series of cases describing the retrograde approach as a special technique for treating CTO of the coronary artery. All cases had some special characteristics that are part of a dedicated portfolio in every catheterization lab today. In our series of cases, all three percutaneous coronary interventions (PCI) with a different strategies of the retrograde approach and supported with rotational atherectomy or intravascular ultrasound finished with successful recanalization of CTO. **Conclusion.** In cases where there is the presence of “interventional” collaterals, as well as when the antegrade approach is very difficult, the retrograde approach can increase the success rate of procedures. The retrograde approach requires a long learning curve as well as very skilled and experienced operators who are able to perform the procedure independently.

Key words:

coronary occlusion; endovascular procedures; methods; percutaneous coronary intervention.

Apstrakt

Uvod. Hronične totalne okluzije (HTO) koronarnih arterija i dalje predstavljaju neke od najizazovnijih lezija na polju interventne kardiologije. S obzirom na složenost i povećani rizik koji nosi sa sobom retrogradni pristup, HTO se najčešće izvodi nakon neuspelog anterogradnog pristupa. **Prikaz bolesnika.** Prikazana je serija slučajeva sa opisom retrogradnog pristupa kao specijalne tehnike lečenja koronarnih arterija putem HTO. Svi slučajevi su imali neke posebne karakteristike koje su danas deo svakodnevnog portofolija u svakoj sali za kateterizaciju srca. Sve tri prikazane perkutane koronarne intervencije izvršene različitim strategijama retrogradnog pristupa uz podršku rotablatora ili intravaskularnog ultrazvuka okončane su uspešnom rekanalizacijom HTO. **Zaključak.** U slučaju kada postoje „interventne“ kolaterale, kao i kada je anterogradni pristup veoma težak, retrogradni pristup može povećati uspešnost procedure. Retrogradni pristup zahteva dugotrajno učenje, kao i veoma iskusne operatore koji su sposobni da samostalno izvode ovakve procedure.

Ključne reči:

koronarna okluzija; endovaskularne procedure; metodi; perkutana koronarna intervencija.

Introduction

For many years, percutaneous treatment of chronic total occlusions (CTO) of the coronary arteries has been a clinical and technical challenge for interventional cardiologists. Successful recanalization rates are increasing primarily due to the constant development of techniques and technological

advancements for percutaneous coronary interventions (PCI), along with the growing experience of operators^{1,2}. Many retrospective and prospective registries show better survival, improved left ventricular function, reduced risk of malignant arrhythmias, as well as coronary artery bypass graft surgery (CABG) in procedural success groups^{3,4}. Recent randomized clinical studies suggest a better quality of life in patients

with successful recanalization of an occluded blood vessel compared to patients on optimal medical therapy (OMT) ⁵⁻⁸. Among the various techniques for PCI CTO, the retrograde approach with different strategy types is considered the most complex. The retrograde approach should be considered in occlusions with “interventional” collaterals (i.e., collaterals deemed to be negotiable by the operator depending on his/her experience), diseased landing zone, bifurcation at distal cap, and/or proximal cap ambiguity ^{9,10}.

We presented a complex retrograde technique as the first strategy choice according to the indication in every single case, combined with a contemporary armamentarium of available devices (guiding catheter extension, rotator of intravascular imaging) to achieve a successful and optimal result. All cases were performed at the Cardiology Department of the University Clinical Center of Serbia (UCCS).

Case report

Case 1

A 69-year-old male had a posterior myocardial infarction in April 2019 as the first manifestation of coronary heart disease. He generally complained of typical anginal symptoms with minimal physical exertion. Stress echocardiography (SEHO) test was not done. Echocardiographic examination showed a left ventricle of normal dimensions with hypokinetic inferolateral wall and preserved systolic function; ejection fraction (EF) was 50%. Apart from hypertension and a positive family history of cardiovascular disease (CVD), the patient had no other risk factors.

During index hospitalization, primary PCI was attempted, in which a single-vessel coronary disease, a calcified subocclusive lesion about 20 mm long in the proximal segment of the dominant circumflex (Cx) artery, intermediate stenosis in the medial segment of the left anterior descending (LAD), and minor right coronary artery (RCA) were ob-

served. Furthermore, catheter guide EBU 3.5/6F was placed in the left main (LM) shaft through the right radial approach. After a challenging placement of the Sion[®] blue (Asahi Intecc Co., Japan) coronary wire in the distal segment of Cx artery, a 2.5 x 20 mm semi-compliant balloon was placed at the lesion site after being supported by a GuideZilla 6F extension catheter (Boston Scientific, Marlborough, MA). Due to the inadequate expansion of the semi-compliant balloon, an attempt was made to place the non-compliant (NC) balloon without any success (Figure 1).

In May of the same year, PCI of the same lesion was attempted by the femoral approach 6F. The same catheter guide and coronary wire were placed, after which a 3 x 20 NC balloon predilatation was performed. A larger dissection was formed, and the stent could not be placed due to the deviating angle and the existing extensive calcifications (Figure 2). It was proposed to present the patients to the Heart Team, which met in June at the UCCS. The council made the decision to do the first fractional flow reserve (FFR) for the lesion on the LAD, and if the lesion is functionally significant, the patient will be offered surgical revascularization of the myocardium. Otherwise, trying PCI Cx again using a rotator was suggested.

In the same month, the EBU 3.5/7F guide catheter was placed by right radial access, and the flow reserve was measured at 0.84. With the support of the Corsair microcatheter (Asahi Intecc Co., Japan), Gaia 2 (Asahi Intecc Co., Japan) still has not undergone occlusion in the proximal Cx artery segment with developed ipsilateral collaterals (CC 1-2). Further intervention was abandoned (Figure 3).

A month later, in December 2019, a femoral approach with an EBU 3.5/7F guide catheter was set up for a fourth PCI attempt at the same center. After the placement of the temporary PM, the coronary arteries of BMW (Abbott Vascular) as well as Fielder XT (Asahi Intec Co., Japan) did not undergo occlusion, and further intervention was abandoned (Figure 4).

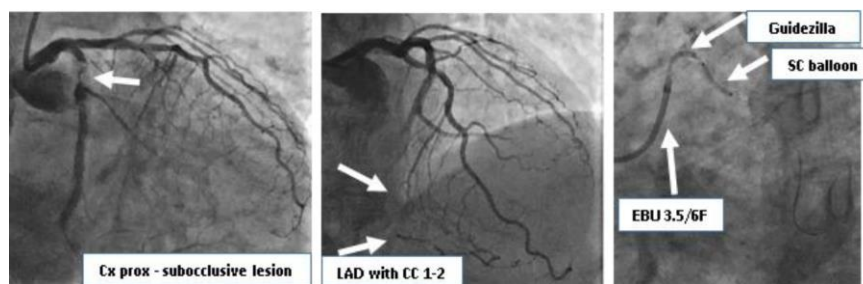


Fig. 1 – Failed recanalization attempt during the index hospitalization.

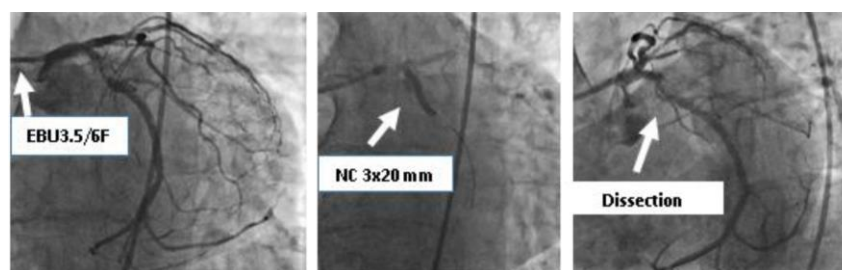


Fig. 2 – Second failed attempt.

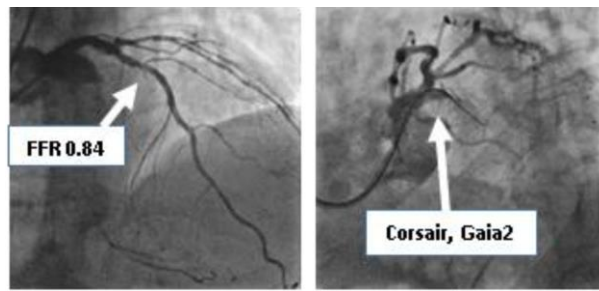


Fig. 3 – Functional assessment of the significance of left anterior descending (LAD) artery stenosis and the third unsuccessful antegrade recanalization attempt.

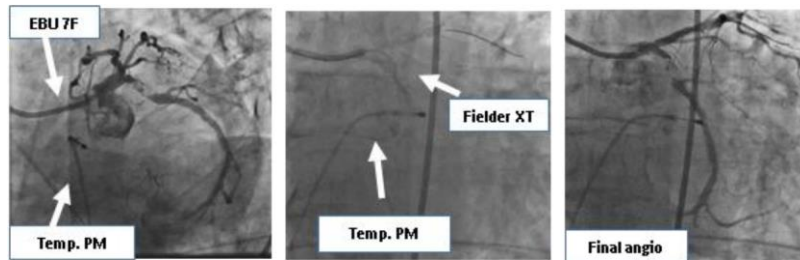


Fig. 4 – Fourth recanalization attempt in the same percutaneous coronary intervention (PCI) center.

It was concluded that the fifth attempt would be in a dedicated center.

In July 2020, the intervention began with a left femoral approach, 7F. The right femoral artery was not palpable, as was the right radial artery. Due to the pronounced calcifications of the left radial and ulnar arteries, placement of the introducer was impossible (Figure 5).

After the placement of EBU 3.5/7F, with the support of the Corsair coronary microcatheter Fielder XT, Gaia 3, and Confianza pro (Asahi Intecc Co., Japan) did not undergo occlusion. After the evaluation of interventional ipsilateral collaterals, a retrograde approach was attempted (Figure 6). The Asahi Sion® black (Asahi Intecc Co., Japan) wire supported by a Corsair microcatheter passed through the septal collat-

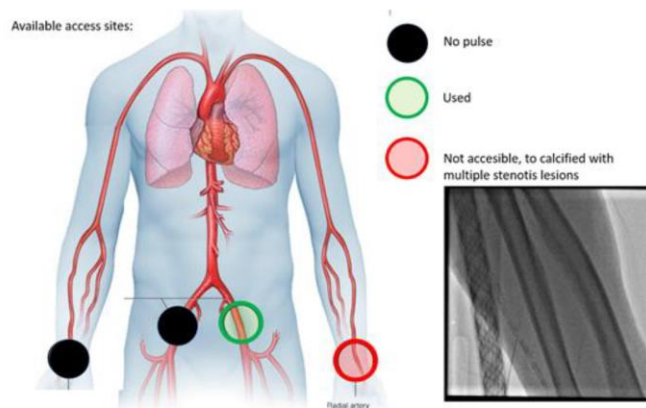


Fig. 5 – Available vascular approaches.

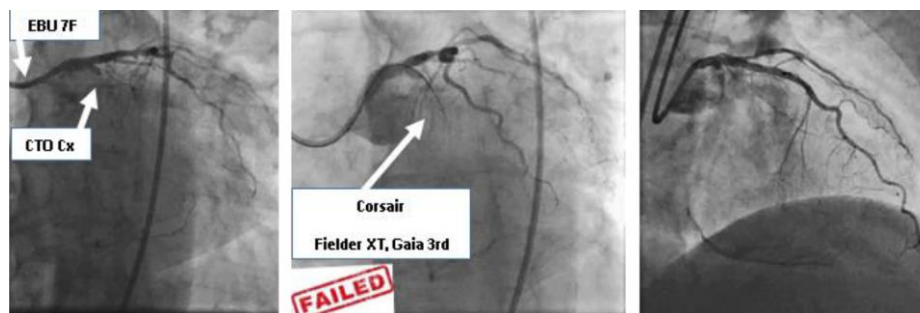


Fig. 6 – Unsuccessful attempt at antegrade recanalization in a dedicated center.

erals into the Cx and without resistance through the distal occlusion cap all the way to the LM. Corsair remained “stuck” in the collateral being intervened. Since the Sion black wire could not be placed in the catheter guide after several attempts, a “rendezvous” in the proximal segment of the Cx artery was attempted with a Finecross® microcatheter being placed antegradely unsuccessfully. Finecross® (Terumo Interventional Systems, Tokyo, Japan) then replaced the Corsair as a retrograde catheter and placed it over the lesion into a catheter guide (Figure 7). Then a “rendezvous technique”¹¹ retrograde coronary BMW wire was placed with the support of a retrograde Finecross® microcatheter into an antegrade Corsair microcatheter (Figures 8 and 9).

After placing the Rota wire in the distal segment of the Cx artery, a rotational atherectomy with burr 1.75 mm was performed, followed by NC balloon predilatation 3 x 15 mm and placement of drug-eluting stents (3 x 30 mm and 3 x 25 mm) in the distal and proximal segment of the Cx artery with proximal optimization with NC balloon 3.5 x 15 mm, without significant residual stenosis (Figure 9).

Case 2

A 65-year-old female complained of typical anginal symptoms with moderate physical exertion. A positive SEHO test showed inferolateral hypokinesia. Echocardiographic examination showed a left ventricle of normal dimensions with preserved systolic function; EF was 65%. Furthermore, this was a long-term cardiac patient with a previous myocardial infarction in 2016. So far, three unsuccessful attempts have been made to recanalize RCA.

The fourth attempt to recanalize CTO RCA started with a bifemoral approach. Angiographically, single-vessel coronary heart disease has been previously verified, with occlusion more than 5 cm long from the RCA ostium. The posterolateral branch did not show retrograde collaterals, and the impression was gained that it was occluded from its ostial segment (Figure 10). The Corsair microcatheter was placed practically to the distal occlusion cap via LCA intervention collaterals, after which Sion® black was replaced with Gaia 3 coronary wire. Subsequently, a reverse controlled

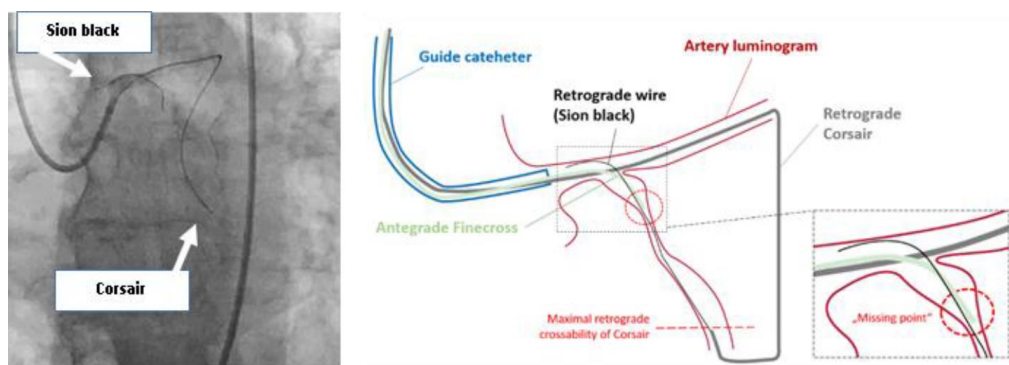


Fig. 7 – Attempt a “rendezvous” technique with a stuck Corsair.

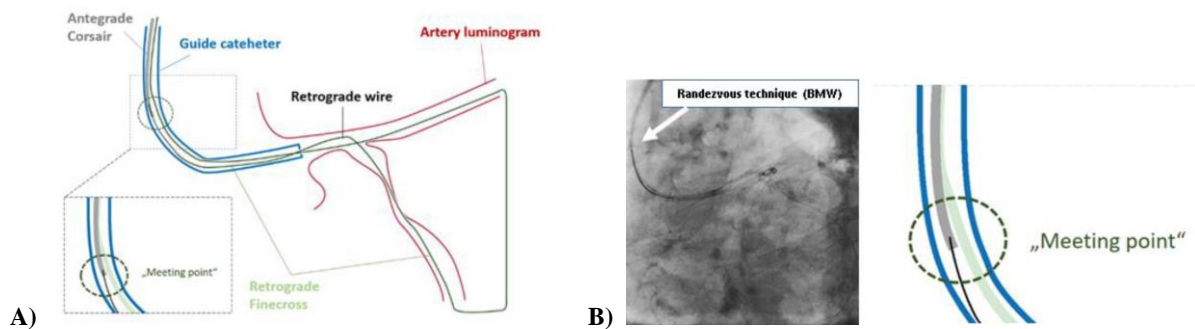


Fig. 8 – A) and B): “Rendezvous” technique – retrograde BMW wire was placed with a retrograde Finecross microcatheter into an antegrade Corsair microcatheter.

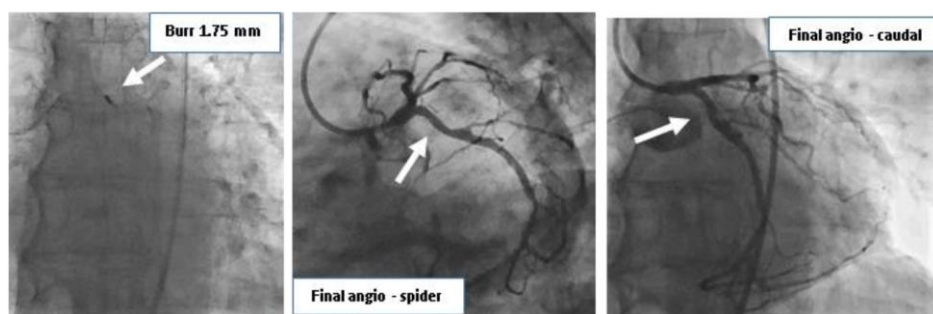


Fig. 9 – Final result after rotational atherectomy.

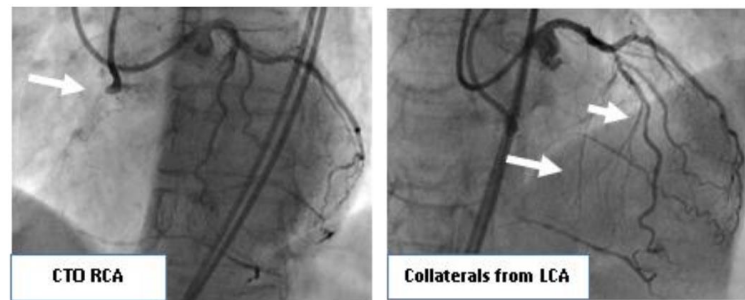


Fig. 10 – Single vessel coronary heart disease with long chronic total occlusion (CTO) of the right coronary artery (RCA) from ostium.

antegrade and retrograde tracking (CART) technique was performed with the help of the Guidezilla™ extension catheter (Figure 11). Gaia 3 retrograde wire was placed in an antegrade extension catheter. Afterward, externalization was performed with RG3 (Asahi Intecc Co., Japan), and 3 drug-eluting stents were placed after appropriate predilatation. Due to the lack of adequate flow in the distal segment of the artery, intravascular ultrasound (IVUS) optimization was performed, followed by additional angioplasty. Thrombolysis in myocardial infarction (TIMI 3) coronary flow was obtained (Figure 12).

Case 3

A 64-year-old female complained of typical anginal discomfort with greater physical exertion. A SEHO test was performed, which showed hypokinesia in inferolateral, and the test was evaluated as positive. Echocardiographic examination showed a ventricle of normal dimensions with preserved systolic function; EF was 60%. The patients was treated due to hypertension and hyperlipidemia as risk factors for CVD. Two years ago, PCI Cx was performed with the implantation of a single stent with drug release.



Fig. 11 – Reverse controlled antegrade and retrograde tracking (CART) technique with the support of the Guidezilla extension catheter.

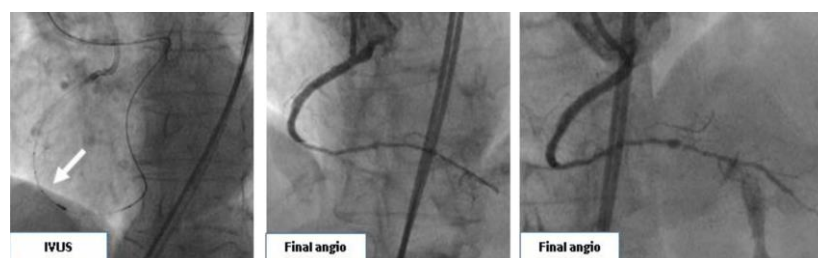


Fig. 12 – Final angiogram result after intravascular ultrasound (IVUS) optimization.

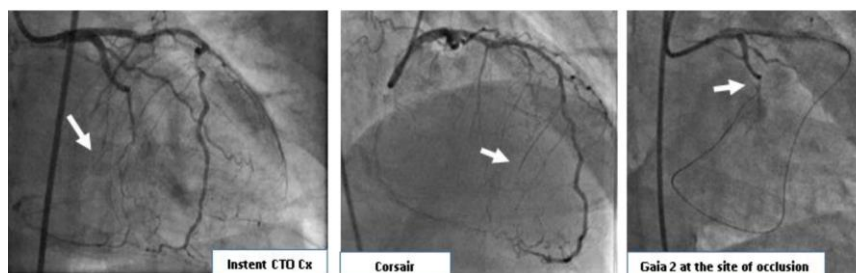


Fig. 13 – Single vessel coronary disease with no stump instent occlusion.

Diagnostic coronary angiography revealed single-vessel coronary disease, with no stump occlusion at the site of a previously implanted stent in the Cx artery, about 15 mm long. The intervention began with a femoral approach, 6F. Corsair was placed retrogradely, overcoming collaterals and Gaia 2 wire, which underwent occlusion with the support of microcatheters, and was placed in the proximal Cx artery (Figure 13). The Fielder XT antegrade wire was then placed, which, with a slight return of the Corsair microcatheter, was placed in the distal segment of the Cx artery parallel with the BMW retrograde wire (which replaced the Gaia 2 wire after the microcatheter underwent occlusion). After adequate predilatation, two drug-releasing stents were implanted, after which TIMI 3 flow was obtained in the distal segment of the Cx artery without significant residual stenosis (Figure 14).

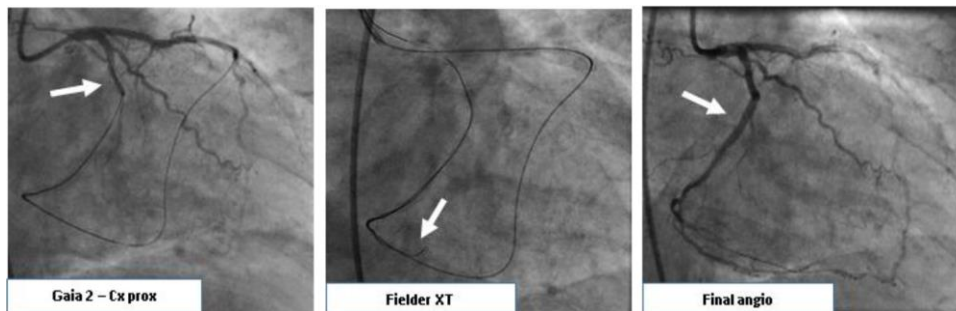


Fig. 14 – Final angio result after Gaia 2 crossing occlusion with support of the Corsair.

Discussion

We presented a series of three cases of recanalization of chronically occluded arteries using the retrograde approach, supported by rotational atherectomy (RA), IVUS as well as various techniques within the retrograde approach.

The first case is a clear demonstration of a technically very complex case that requires a highly flexible and experienced operator. The most aggressive wires, such as Gaia third or Confianza pro 12 (Asahi Intecc Co., Japan), could not cross very complex and calcified lesions. The operator quickly switched to the ipsilateral retrograde technique with soft polymeric wire (Sion black, Asahi Intecc Co., Japan), which crossed occlusion within a few seconds, allowing further calcified lesion modification using RA. The application of RA is considered safe after unsuccessful results for predilatation of calcified lesions in CTO and is considered equally successful in non-CTO procedures. This approach made it possible to finish the procedure with optimal results and minimal risk after four previous unsuccessful attempts.

The second case demonstrated the usage of the guiding catheter extension to facilitate the “reverse CART technique”, which is becoming a standard approach nowadays. Certainly, the most ideal option of the retrograde approach is the “true-to-true lumen” technique, which is possible when there are short uncalcified occlusions. In most cases, successful retrograde recanalizations end in reverse controlled antegrade and retrograde subintimal “tracking” (reverse CART technique). Without a doubt, this technique is the most used. A balloon positioned on the antegrade wire creates a subintimal space for the retrograde wire to advance and make a connection between the antegrade

and retrograde space. It usually starts with a smaller balloon (2 mm), and in case of failure, larger balloons are used. For retrograde wire, a very controllable wire is most often used, which also has the power to make this connection (for example, the Gaia wire family). Furthermore, this case showed that after successful recanalization and stent implantation, lack of flow should be assessed by the IVUS. IVUS demonstrated significant mid-stent compression and a very diseased distal vessel. These findings allowed further stent deployment optimization and distal balloon dilatation with excellent TIMI 3 flow. Randomized studies have shown that IVUS improves the outcome of PCI CTO in terms of major adverse cardiac events (MACE) and stent thrombosis¹², most likely due to better optimization of the implanted stent. In the arena of retrograde approach, IVUS can also be helpful in two cases: the passage of a retrograde wire and

reverse controlled antegrade and retrograde tracking (CART) technique. When passing a retrograde wire, IVUS can be useful in bifurcation “blunt stump” occlusions as well as ostial occlusions, especially the LAD and Cx arteries, to avoid dissection of the main trunk of the left coronary artery and closure of the second branch¹³.

In-stent CTOs represent about 12% of all PCI CTOs, and these procedures are more complex than in unstented blood vessels¹⁴. In the third case, the proximal cap of the occlusion was ambiguous, with a small branch originating at that exact level. The occlusion was positioned at least 10 mm proximally to the proximal edge of the previously implanted stent. In such cases, an antegrade approach is possible with IVUS guided antegrade puncture (with IVUS probe in the side branch if possible) or by the analyses of the index procedure and possibly available computed tomography (CT) angiography. In this case, the operator correctly started with a retrograde approach using septal interventional collateral, which allowed a very easy crossing of the occlusion body with standard Gaia second wire (Asahi Intecc Co., Japan) since the distal cap is usually softer than the proximal one and that proximal vessel was a relatively big target.

From 2009 until the present time, we have estimated that roughly 300 procedures were performed with the retrograde approach in Serbia^{15*}.

* **Note:** We would like to underline that the first retrograde procedure was performed in 2009 by prof. George Sianos from Greece as a guest operator in Belgrade, and during the same year, prof. Siniša Stojković did the first retrograde recanalization of the right coronary artery at the UCCS.

The retrograde approach should not be used as the first choice technique and is usually reserved for situations after an unsuccessful attempt to recanalize using the antegrade approach. As shown in our series of cases, the retrograde technique can be used as the first choice in certain cases, especially there where “interventional” collaterals are observed and when anterograde recanalization seems challenging due to the complex coronary anatomy of the occluded coronary vessel¹⁶.

Conclusion

In cases where there is the presence of “interventional” collaterals, as well as when the antegrade approach is very difficult, the retrograde approach can increase the success rate of procedures. The retrograde approach requires a long learning curve as well as very skilled and experienced operators who are able to perform the procedure independently.

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