

## HOW TO PERFORM SAFE RETROGRADE CHRONIC TOTAL OCCLUSION RECANALIZATION

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Chronic total occlusion (CTO) of the coronary artery is defined as more than three-month-old total (100%) antegrade flow obstruction in the native coronary artery.

The data show that 7% – 15% of CTOs are treated with percutaneous coronary intervention and that CTO recanalization still represents the cutting edge in percutaneous coronary intervention. Three different techniques for the CTO recanalization have been described in the literature: antegrade wire escalation, antegrade dissection/re-entry, and retrograde. In case of multiple possibilities for selection of collateral channels, the septal group still represents the most common choice in a large number of retrograde CTO interventions because of the lowest major complication rate. Septal perforations are generally not followed by serious complications and usually resolve spontaneously. On the other hand, epicardial collateral channels can be used with a high rate of success and low incidence of procedural complications when revascularization procedures of CTO lesions are performed by experienced interventional cardiologists and high-volume laboratories.

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**Key words:** chronic total occlusion, percutaneous coronary intervention, collateral channels

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### Introduction

Chronic total occlusion (CTO) of the coronary artery is defined as more than three-month-old total (100%) antegrade flow obstruction in the native coronary artery. The frequency of a CTO has been reported to be up to 30% among patients with a clinical indication for coronary angiography. The data show that 7% – 15% of CTOs are treated with percutaneous coronary intervention (PCI) and that CTO recanalization still represents the cutting edge in percutaneous coronary intervention (1).

Until today, three different techniques for the CTO recanalization have been described in the literature: antegrade wire escalation, antegrade dissection/re-entry, and retrograde (2, 3). Using

the antegrade approach, success rates have been limited between 60% and 70%. However, with the equipment and techniques improvement, some serious progress has been made in this sensitive field. Thanks to the vast knowledge and considerable expertise, retrograde techniques have become a crucial complement to the treatment of CTO. Retrograde approach to CTO percutaneous coronary intervention was first mastered and introduced by Japanese surgeons thanks to whom new perspectives regarding the use of small collateral channels (CCs) were opened. There are a few types of CCs: septal, epicardial, atrial and vein grafts (after cardiac bypass surgeries). Septal CCs are the safest and should be the primary choice whenever possible because the epicardial rupture is more serious than the septal rupture. Since the use of epicardial CCs may be associated with procedural ischemia, these CCs should be used only if no septal CCs are suitable (4).

### Case presentation

First attempt in General Hospital Zaječar

Procedure: JL guiding catheter (Judkins left) 4.0 6 French (Launcher, Medtronic, Minneapolis, MN, USA) was engaged in the left main trunk of the left coronary artery. Over Runthrough Floppy wire (Terumo, Japan), Microcatheter Finecross

(Terumo, Japan) was placed in front of the proximal cap of CTO. With the wire escalation technique, Progress 40 (Abbott, Santa Clara, USA) and Confianza Pro 9 (Asahi Intecc, Japan), the procedure failed. We could not open the chronic total occluded left anterior descending coronary artery (LAD) (Figure 1) with an antegrade approach because wires always went to the first diagonal branch. Consequently, we put the balloon in the ostium of this diagonal branch to prevent and block the entering of wires. We planned a retrograde approach in Clinical Center Niš over epicardial homo-collateral (septal collaterals from RCA did not exist).



**Figure 1.** LAD occlusion

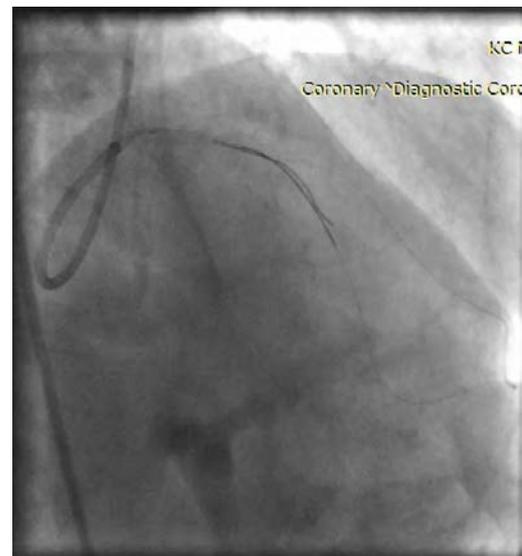
#### Second attempt in Clinical Center Niš

**Procedure:** In this attempt, the retrograde approach was planned as a first-line strategy. EBU (Extra backup) 3.75 7F (French) was placed in the left coronary artery. Over the standard Floppy wire, we went to the first diagonal branch with Finecross (Terumo, Japan) microcatheter to examine the possibilities for a retrograde approach. We started with Sion wire (Asahi Intecc, Japan) and went very easily through this epicardial collateral to the distal cap of CTO (Figure 2). This wire penetrated the distal cap of LAD CTO. Then, we went further down over Sion with a Finecross microcatheter to give support for further wires. Sion went very close to the proximal cap (sliding to septal in the proximal part of CTO), but could not penetrate it. We switched Sion through Finecross for Ultimate Bros 3 (Asahi Intecc, Japan) and Pilot 200 (Abbott Vascular, USA), but those wires could not cross the proximal CTO segment. Finally, Progress T 140 crossed the CTO but finished in the subintimal space and could not reenter into the proximal true lumen. To minimize the dissected proximal segment, we exchanged the last stiff wire—Confianza Pro 12 (Asahi Intecc,



**Figure 2.** Retrograde wire crossing

Japan) for Runthrough Hypercoat (Terumo, Japan). After that, we switched to antegrade preparation for the reverse cart. With Finecross support, coronary wire Progress 200 T (Abbott Vascular, Santa Clara, CA) went through the proximal CTO cap and allowed antegrade balloon inflations in reverse cart technique (Figure 3). First, we removed antegrade Finecross using the trapping balloon technique and the advanced smallest monorail coronary balloon Sprinter Legend 1.25 x 15 mm, then bigger Sprinter Legend 2.5 x 15 mm. After a few inflations of 2.5 mm balloon, retrograde wire Sion Blue (Asahi Intecc, Japan) went to the proximal true lumen. Suddenly, the occurrence of ventricular fibrillation was noted. During short resuscitation and defibrillation with 360 J, the guiding catheter and both coronary



**Figure 3.** Reverse CART

wires (antegrade and retrograde) lost previous positions. When the patient's hemodynamic condition was stabilized, we used again guiding catheter and two wires and tried to cross the CTO segment antegradely into the true lumen in LAD and first diagonal branch—Balance Middle Weight (BMW) (Abbott Vascular, Santa Clara, USA) and Whisper ES (Abbott Vascular, Santa Clara, USA). After successful wiring of distal LAD, several predilatations were performed in the occluded segment with Maverick Monorail 3.0 x 20 mm (Figure 4) (Boston Scientific Corporation, USA). We put

two BioMime sirolimus-eluting stents (SES) (Meril Life Sciences Pvt. Ltd., Gujarat, India) 3.0 x 29 mm (Figure 5) in the distal and 3.5 x 19 mm (Figure 6) in the proximal part of CTO to cover dissection caused by the retrograde system. After the implantation of the three SES, we achieved TIMI 3 flow in LAD. Finally, we found a very small dissection at the end of the distal stent, but we were satisfied with the angiographic result and finished the procedure (Figure 7, Figure 8).



Figure 4. Balloon predilatation

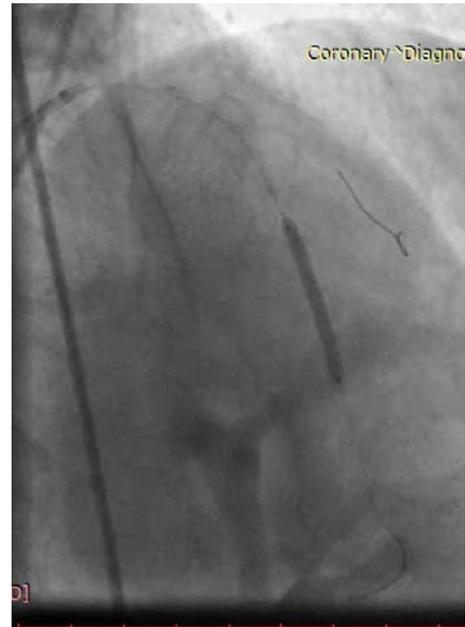


Figure 5. Stent implantation



Figure 6. Stent implantation



Figure 7. Final result



**Figure 8.** Final result

## Discussion

Despite the continuing improvement of percutaneous coronary intervention materials, technical expertise and equipment, the treatment of CTO lesions still represents a challenge for interventional cardiologists in current clinical practice (5, 6). Because of procedural complexity, CTO interventions are associated with a higher risk of complications and lower success rates (60%–70%) in comparison with PCI of nonoccluded or acutely occluded vessels (2, 7). Also, restenosis rates are high even in successful cases of CTO recanalization (8). The most commonly described complications which may occur during PCI of CTOs are coronary perforation which can be associated with cardiac tamponade, coronary dissection due to aggressive guide manipulation, periprocedural myocardial infarction, device embolization, systemic embolization, side branch occlusion, renal dysfunction (contrast induced nephropathy), and radiation dermatitis (6, 7). However, despite all disadvantages, successful recanalization of CTOs can reduce angina symptoms and need for coronary artery bypass graft surgery in appropriately selected patients with documented viable myocardium. Besides, in these patients successful PCI of CTOs is also associated with improvement of left ventricular function, increased exercise tolerance, decreased incidence of myocardial infarction, reduced risk of arrhythmic events as well as improvement of long-term survival (2, 3, 9).

In case of multiple possibilities for the selection of collateral channels, the septal group still represents the most common choice in a large number of retrograde CTO interventions because of the lowest major complication rate (10). Septal perforations are generally not followed by serious complications and usually resolve spontaneously. However, in some cases, septal perforations may

lead to the occurrence of ventricular dysrhythmias or septal haematoma which can cause hypotension due to obstruction of the left ventricular outflow tract (11, 12). As opposed to septal collaterals, retrograde approach to CTO percutaneous coronary intervention through an epicardial vessel carries an increased risk of vessel perforation during the wire manipulation which can rapidly cause pericardial tamponade. Likewise, cardiac tamponade can occur as a result of epicardial collateral rupture due to balloon dilatation. According to that, dilatation of these collaterals should be avoided. However, in patients who have undergone coronary artery bypass grafting (CABG), the chance for pericardial tamponade is lower because the pericardial space has been accessed before. Nevertheless, local chamber compression can still occur in these patients (12).

## Conclusion

Nowadays, CTO recanalization is considered to be the most modern method in the field of interventional cardiology. The presence of severe tortuosities, fibrous and calcified material, and large bifurcations may represent aggravating circumstances for the surgeon and therefore adequate assessment of lesions and appropriate selection of the collateral channels are crucial factors for the success of the procedure. Septal collaterals are safer and should be the first choice whenever possible. On the other hand, epicardial collateral channels can be used with a high rate of success and low incidence of procedural complications when revascularization procedures of CTO lesions are performed by experienced interventional cardiologists in high volume laboratories.

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Prikaz bolesnika

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## KAKO BEZBEDNO IZVESTI REKANALIZACIJU HRONIČNE TOTALNE OKLUZIJE RETROGRADNIM PRISTUPOM

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Hronična totalna okluzija (engl. *chronic total occlusion* – CTO) koronarne arterije definiše se kao totalna (100%) opstrukcija anterogradnog protoka u nativnoj koronarnoj arteriji stara više od tri meseca.

Podaci pokazuju da se od 7% do 15% CTO leči perkutanom koronarnom intervencijom i da rekanalizacija CTO i dalje predstavlja vrhunac u perkutanom koronarnim intervencijama. U literaturi su opisane tri različite tehnike za CTO rekanalizaciju: antegradna eskalacija žice, anterogradna disekciona tehnika i retrogradna disekciona tehnika. Septalne kolaterale i dalje predstavljaju najčešći izbor u velikom broju retrogradnih CTO intervencija zbog najniže stope ozbiljnih komplikacija. Perforacije septalne kolaterale uglavnom nisu praćene ozbiljnim komplikacijama i obično se spontano povlače. Sa druge strane, korišćenje epikardnih kolaterala može biti praćeno velikom stopom uspeha i malom incidencijom proceduralnih komplikacija kada procedure revaskularizacije CTO lezija izvode iskusni interventni kardiolozi.

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**Ključne reči:** hronična totalna okluzija, perkutane koronarne intervencije, kolateralni krvni sud

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