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**Case Report / Приказ случаја**

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# Recanalization of Coronary Artery Chronic Total Occlusion by Retrograde Approach

Реканализација хроничне тоталне оклузије коронарне артерије ретроградним приступом

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**SUMMARY**

**Introduction** Chronic total occlusion (CTO) is defined as 100% obstruction of blood vessel lumen with TIMI grade 0 flow in the occluded segment which is at least three months old. Advancement of technological devices and techniques used during the percutaneous coronary interventions (PCI) in the past years brought more success in blood vessel recanalization. According to the latest guidelines for myocardial revascularization, the CTO treatment should be considered when there are symptoms or objective proof of viability or ischemia in the occluded area.

The aim of this work is present two case with recanalization of coronary artery CTO by retrograde approach.

**Case outline** The first patient had a single vessel coronary disease which led to a decision to first attempt PCI. During the attempt of antegrade recanalization, the guidewire penetrated subintimally risking blood vessel dissection below the occluded area as well as serious complications. Retrograde approach enabled easier and safer passing of guidewire through the occlusion and then successful establishment of the antegrade flow. In the second case the antegrade approach was also first attempted. Since it could not pass through the occluded area despite changing several guidewires, the strategy was changed during the intervention. It was continued with the retrograde approach which led to the successful revascularization.

**Conclusion** These two cases demonstrate that retrograde approach and new technological improvements in dedicated guidewirescan be implemented in everyday angiography practice for successful recanalization of CTO lesions.

**Keywords:** coronary artery occlusion, chronic total occlusion (CTO); percutaneous coronary interventions (PCI), retrograde approach

**САЖЕТАК**

**Увод** Хронична тотална оклузија (ХТО) се дефинише као 100% опструкција лумена крвног суда са *TIMI*-0 протоком у том сегменту у периоду од најмање три месеца. Напредак технолошких средстава и техника које се користе током перкутане коронарне интервенције (ПКИ) довео је до веће успешности у реканализацији крвног суда. Према званичном водичу за реваскуларизацију миокарда решавања ХТО треба размотрити у случају присуства симптома или објективних доказа вијабилности и исхемијеу подручју оклудиране артерије.

Циљ овог рада је приказ два болесника са реканализацијом коронарних артерија код ХТО ретроградним приступом.

**Приказ болесника** Код првог се радило о једно-судовној коронарној болести и то је био разлог да се одлучи прво за покушај ПКИ. Приликом покушаја антероградне реканализације жичани водич је продирао субинтимално уз ризик настанка дисекције крвног суда испод подручја оклузије, самим тим постојао је висок ризик за настанак озбиљних компликација. Примена ретроградног приступа је омогућила лакши и безбеднији пролазак жичаног водича кроз оклузију и успешно успостављање антероградног протока. И у другом случају иницијално је покушано са антероградним приступом, али се није могло проћи кроз подручје оклузије. Настављено је ретроградним приступом, што је резултирало успешном реваскуларизацијом.

**Закључак.** Ретроградни приступ заједно са новим технолошким достигнућима и специјализованим жичаним водичима може увести у свакодневну праксу ради успешне реваскуларизације ХТО.

**Кључне речи:** оклузија коронарних артерија, хронична тотална оклузија (ХТО); перкутане коронарне интервенције (ПКИ), ретрогардни приступ

## INTRODUCTION

Chronic total occlusion (CTO) is defined as 100% obstruction of blood vessel lumen with TIMI grade 0 flow in the occluded segment which is at least three months old, it is assumed that CTO with good collaterals is the same as 90% narrowing of coronary blood vessel [1]. By functional examination of collateral circulation Werner et al. proved that angiographycally well-developed collaterals cannot provide enough blood supply to the occluded segment. Even in patients with well-preserved ventricular function collaterals provide good “flow reserve” in less than 10% of the cases [2]. Hence, the symptoms of stable angina pectoris can be manifested since, under stress, there is



 

inadequate perfusion in some segment of the myocardium through collateral circulation. However, it needs to be stated that the risk of developing some form of acute coronary syndrome as a consequence of CTO is rare [3].

Recanalization of CTO represents one of the biggest challenges in interventional cardiology. The advancement of technological devices and techniques used during percutaneous coronary intervention (PCI) in the past years brought more success in blood vessel recanalization [4]. According to the latest guidelines for the myocardial revascularization, the CTO treatment should be considered when there are symptoms or objective proof of viability or ischemia in the area of occluded artery [5]. Not only that the successful revascularization of CTO contributes to the improvement of functionality and relief of anginal discomforts, but it also leads to the better left ventricular systolic ejection function and has positive correlation in relation to the long-term survival [6–9].

The success of the CTO revascularization is smaller than in other lesions and it largely depends on operators' experience, good analysis of the lesion itself and available technical devices. Until 2005 the success of CTO revascularization had remained unchanged for long and was around 60-70%. Since the CTO revascularization was significantly less successful, the representation of these procedures was therefore small and did not exceed 10%, so the patients were more frequently referred to CABG [10, 11].

Introducing modern techniques (CART, reverse CART, knuckle wire technique), modern retrograde approach to CTO revascularization gained in importance and started being used more frequently especially when antegrade approach failed. In more complex lesions the operators from the beginning choose retrograde approach due to its better efficacy [12, 13].

Here, we presented our initial experience in two cases of successful revascularization of chronic total occlusion by retrograde approach.

## CASE REPORT

### Case 1.

A 61 year old male patient S.B was admitted to the Institute of CVDV in February 2015 for elective coronarography due to stable angina pectoris CCS 2 and previous anterior wall myocardial infarction from November 2013 when he underwent conservative treatment in the regional center. Stress test demonstrated signs of anterior wall ischemia. Echocardiography examination registered hypokinesis on medioapical and anteroseptal area and slightly decreased ejection fraction of 50%.

The patient underwent diagnostic coronarography which found single-vessel coronary disease along with the chronic occlusion of proximal left anterior descending (LAD) segment. Since it was over 20 mm long lesion with calcifications, the J-CTO score was 2 ie. difficult lesion for revascularization. The case was presented at the Board of Cardiologists and Cardiac Surgeons who suggested the attempt of CTO LAD opening.



 

The recanalization of CTO LAD with antegrade approach was tried first. Judkins left 4 guiding catheter (Launcher, Medtronic, USA) was placed in the left main coronary artery (LMCA) and right amplatz 1 guiding catheter (Launcher, Medtronic, USA) was placed in the right coronary (RCA).

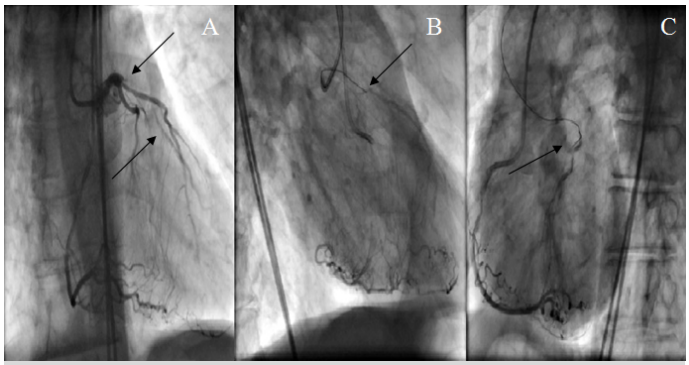


**Figure 1. A) Upper arrow shows the occluded area, while lower arrow shows distal part of blood vessel being shown through collateral circulation. Arrows in images B and C show subintimal guidewire penetration though the occluded area.**

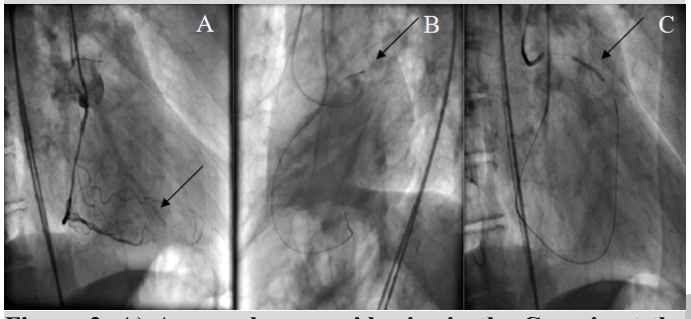


**Figure 2. A) Arrow shows guidewire in the Corsair at the septal collateral channels between ACD and RIA. B) Arrow showing Corsair below the occlusion in RIA. C) After passing od guidewire through the occlusion, it was used to perform PTCA of occlusion in RIA**

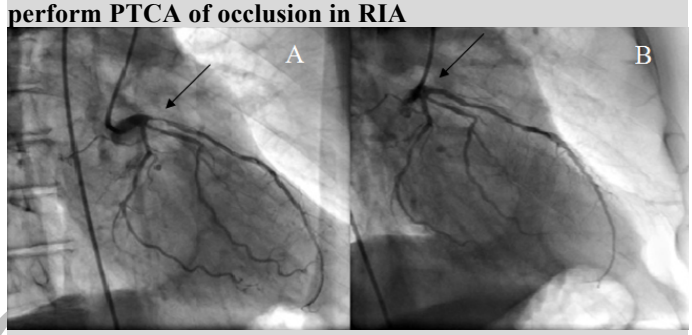


**Figure 3. A) Result after PTCA of RIA and establishment of antegrade flow B) Arrow indicating where DES was implanted with optimal result.**

Catheter in RCA was used to show the area below the occlusion through collateral circulation and for better orientation during the wire passing through the occlusion. Since the guidewires Fielder XT and Confianza (Asahi Intec, Japan) could not be advanced there was great possibility of subintimal guidewire penetration and blood vessel dissection below the occluded area, we decided to try recanalization using the retrograde approach (Figure 1).

The guidewire Runthrough NS (Terumo, Japan) was placed through the donor RCA artery and was used for positioning of the Corsair microcatheter (Asahi Intec, Japan) below septal collaterals. Then the Sion guidewire (Asahi Intec, Japan) was used for crossing through the septal collaterals and positioning the Corsair in the LAD below the occluded area. The Sion guidewire was exchanged with the coronary retrograde guidewire Asahi RG3 (Asahi Intec, Japan) that crossed through the occlusion. Afterwards, the externalization of Asahi RG3 guidewire was performed through the catheter in the LMCA. Balloon dilatation of the occlusion was done using the externalized guidewire Asahi RG3 establishing antegrade flow. New guidewire Runthrough NS was placed in the LAD through the catheter and a drug-eluting stent Biomatrix Flex 18 x 2.75 mm (Biosensors, Newport beach, CA, USA) was implanted giving optimal result (Figures 2 and 3).



 

**Case 2.**

A 56-year-old male patient S.L was admitted to the ICVDV in January 2015 for planned PCI of CTO on LAD and circumflex coronary artery (Cx). The patient was hospitalized at our hospital in December 2014 due to the inferior wall STEMI when primary PCI was performed with implantation of one stent in RCA and one in posterolateral branch. Since the Syntax score was 23.5, the Board of Cardiologists and Cardiac Surgeons decided that the PCI of CTO on LAD and significant Cx lesion should be attempted and in case the CTO LAD recanalization was unsuccessful, the surgical myocardial revascularization should be done. The J-CTO score of the LAD lesion was two since it was over 20 mm long and had calcifications or, in other words, it was a difficult lesion for revascularization.

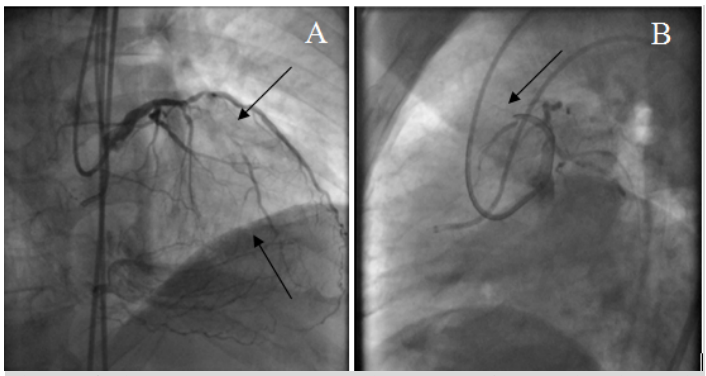


**Figure 4. A) Upper arrow showing area of occlusion in RIA, lower arrow pointing to the transseptal collaterals B) Arrow showing the occluded area as well as coronary guide that could not advance futher in the occluded area.**

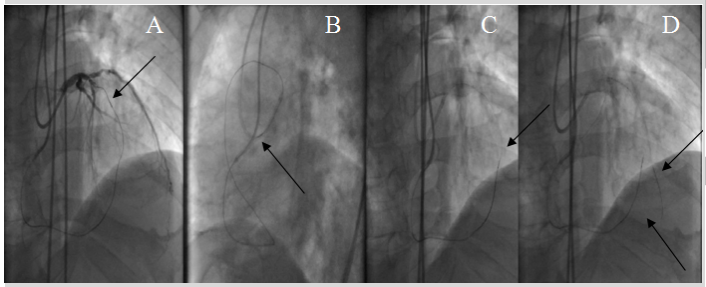


**Figure 5. A) The guidewire in the occluded area is shown as well as the Corsair which is below the occlude area B) Corsair placed in the catheter which is in the ACS. C) Corsair was returned in the septal collateral while the guidewire, placed antegradely in the Corsair, is being released. D) Guidewire was placed in RIA and was being used to continue the intervention while the Corsair was being removed.**

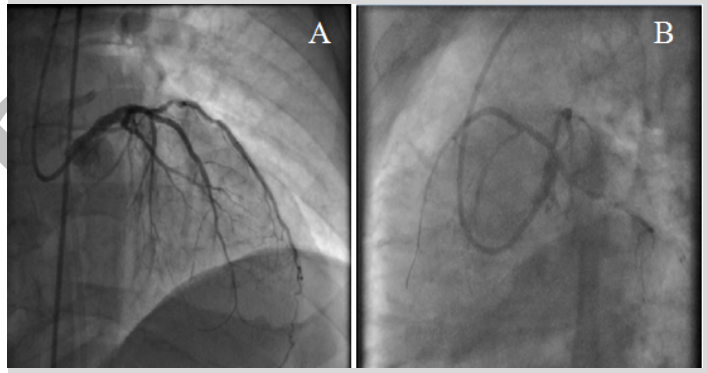


**Figure 6. Images A) and B) show optimal result after the implantation of two stents.**

The recanalization of CTO LAD using antegrade approach was first attempted. Two guiding catheters were placed one EBU 3.5 (Launcher, Medtronic, USA) in the LMCA and left Amplatz1 (Launcher, Medtronic, USA) was placed in RCA. Initially, it was planned that the catheter in RCA served for retrograde visualization of the artery below the LAD occlusion. Since none of the guidewires Fielder XT and Gaia second (Asahi Intec, Japan) could pass the occlusion, we decided to switch to retrograde approach. (Figure 4).

The guidewire Runthrough NS (Terumo, Japan) was placed through the donor RCA artery and was used for positioning of the Corsair microcatheter (Asahi Intec, Japan) below septal collaterals. The Sion guidewire (Asahi Intec, Japan) passed through septal collaterals, distal occlusion cap, and then through the occlusion itself. The guidewire was then placed in the left guiding catheter in LMCA. The advancement with the Corsair was continued placing it also



 

through the occlusion in the left guiding catheter in the LMCA. The guidewire Runthrough NS was placed in the Corsair microcatheter which was in the LMCA guiding catheter. The Corsair was then gradually removed and the guidewire Runthrough NS was released below the occluded LAD area (Figure 5). The intervention continued using the antegrade approach. After predilatation the antegrade flow was established and two drug-eluting stents, Promus Premier 32 x 2.5 mm (Boston scientific, USA) and Resolute 26x2.5 mm (Medtronic, USA) were implanted showing optimal result (Figure 6).

**DISCUSSION**

Chronic total occlusion represents one of the biggest and most demanding challenges in the interventional cardiology. Registering CTO along with the lesions in other coronary blood vessels strongly influences the decision making for surgical myocardial revascularization (CABG).

The exact prevalence of chronic total occlusions in general population is still unknown. However, some studies have shown that CTO can be found in 24% of patients who underwent coronarography and that it is found in 52% of cases where patients have at least one lesion >70% [16]. To estimate the difficulty of guidewire crossing through CTO and to plan revascularization strategy the J-CTO score is used. It is based on assigning one point for each of the five factors that influence the complexity of CTO revascularization (prior failed attempt to revascularize the CTO, blunt stump, calcification, lesion bending, and occlusion length). Based on the scoring system, the lesions are classified as: easy (J-CTO 0), intermediate (J-CTO 1), difficult (J-CTO 2) and very difficult (J-CTO 3) [14].

Introduction of modern techniques in CTO recanalization by Japanese experts, primarily retrograde approach, contributed to the more frequent use of CTO revascularization by percutaneous coronary intervention [17].

The use of intravascular diagnostic procedures, particularly IVUS, significantly increased the sureness of performing PCI CTO. Unlike OCT that can only be used after the establishment of antegrade flow, IVUS needs no contrast during scanning and enables guidewire position checking during occlusion crossing.

Patohistology demonstrated that CTO segments are thinner and softer in the distal in comparison to proximal cap. Therefore, the distal cap is more suitable for guidewire penetration in relation to the proximal cap and that is the mechanism underlying the advantage [18].

Due to the complexity of PCI CTO lesion, the risk of complications is slightly bigger than during PCI of other lesions. Therefore, it is more common for complications to occur such as blood vessel perforation, periprocedural myocardial infarction and stent slipping. Radiation injuries and contrast-induced nephropathy are also possible due to the length and complexity of the procedure. [19, 20]

U.K National Institute for Cardiovascular Outcomes Research analyzed data from 13,500 patients who underwent elective PCI of one or more CTO lesions in the period from 2005 till 2009.



 

The results showed that the successful PCI is strongly related to the reduction of all causes of mortality. [21]

In time the success of CTO revascularization significantly increased from previous 50-60% up to 90% primarily due to experienced operators as well as the use of modern techniques and the growing use of retrograde approach. [12]

It should be pointed out that there is still insufficient amount of randomized clinical trials that demonstrate advantages of different approaches to CTO revascularization as well as their long-term patient benefit.

We have presented two cases of unsuccessful antegrade approach to CTO revascularization where both interventions were immediately continued with successful retrograde approach.

The first patient had a single-vessel coronary disease, J-CTO score 2 (difficult). For that reason it was decided to first attempt PCI and then, if it failed, to undergo CABG. During the attempt of antegrade recanalization, the guidewire was penetrating subintimally with the risk of blood vessel dissection below the occluded area and the risk of serious complications. The use of retrograde approach enabled easier and safer passing of the guidewire through the occlusion as well as the successful establishment of antegrade flow. Then the antegrade guidewire was placed and used for stent implantation. It should be noted that, in these types of cases, the use of dual lumen catheter for antegrade guidewire placement is highly recommended because it significantly lowers the risk of blood vessel dissection. In this case, due to the lack of dual lumen catheter, it was not used. The second case showed a patient who initially had a three-vessel coronary disease which was first, since he had had STEMI, treated with the PCI. In this case also the J-CTO score was 2 (difficult). Afterwards, the coronary disease could be completely solved with the percutaneous coronary intervention or the hybrid procedure i.e. surgical revascularization of the LMCA system. It was also initially tried with the antegrade approach but, in spite of changing several guidewires, we were not able to pass through the occluded area. The strategy was changed during the intervention and was continued with the retrograde approach. Since the distal cap was softer, the guidewire followed by the microcatheter went through the occluded area enabling the intervention to continue and finish with the Randezvous technique, establishing the antegrade flow [22].

Pure retrograde technique was used in both cases. It should be stated that there are numerous other techniques that increase technical success of CTO revascularization for 20%. Successful treatment of lesions in both patients enabled to further continue with the medical treatment.

These two cases demonstrate that retrograde approach and new technological improvements in dedicated guidewire scan be implemented in everyday angiography practice for successful recanalization of CTO lesions. Therefore, we expect that this approach will be used more frequently in our center to improve the clinical outcome of these patients.



 

## REFERENCES


1. Di Mario C, Werner GS, Sianos G, Galassi AR, Buttner J, Dudek D et al. European perspective in the recanalisationof Chronic Total Occlusions (CTO): consensus document from the EuroCTOClub. EuroIntervention 2007; 3(1): 30–43.
2. Werner G, Surber R, Ferrari M, Fritzenwanger M, Figulla HR. The functional reserve of collaterals supplying long-term chronic total coronary occlusions in patients without prior myocardial infarction. Eur Heart J 2006; 27: 2406–12.
3. Ahmed A. Khattab, Bernard Meier. Chronic Total Oclusion. In: Eric J Topol and Paul S. Teirstein, editor. Textbook of Interventional Cardiology. Philadelphia: Elsevier saunders; 2012. p. 312–22.
4. Joyal D, Afilalo J, Rinfret S. Effectiveness of recanalization of chronic total occlusions: a systematic review and meta-analysis. Am Heart J. 2010; 160(1): 179-87.
5. Windecker S, Kolh P, Alfonso F, Collet JP, Cremer J, Falk Vet al. Guidelines on myocardial revascularization: The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J 2014; 35(37): 2541–619.
6. Grantham JA, Jones PG, Cannon L, Spertus JA. Quantifying the early health status benefits of successful chronic total occlusion recanalization: Results from the Flow-Cardia's Approach to Chronic Total Occlusion Recanalization (FACTOR) Trial. Circ Cardiovasc Qual Outcomes 2010; 3(3): 284–90.
7. Claessen BE, Dangas GD, Godino C, Lee SW, Obunai K, Carlino M, et al. Longtermclinical outcomes of percutaneous coronary intervention for chronic total occlusions in patients with vs. without diabetes mellitus. Am J Cardiol 2011; 108(7): 924–31.
8. Mehran R, Claessen BE, Godino C, Dangas GD, Obunai K, Kanwal S, et al. Long-term outcome of percutaneous coronary intervention forchronic total occlusions. JACC Cardiovasc Interv 2011; 4(9): 952–61.
9. Melchior JP, Doriot PA, Chatelain P, Meir B, Urban P, Finci L, et al. Improvement of left ventricular contraction and relaxationsynchronism after recanalization of chronic total coronary occlusion byangioplasty. J Am Coll Cardiol. 1987; 9: 763–8.
10. Suero JA, Marso SP, Jones PG, Laster SB, Huber KC, Giorgi LV, et al. Procedural outcomes and long-term survival among patients undergoing percutaneous coronary intervention of a chronic total occlusion in native coronary arteries: a 20-year experience. J Am Coll Cardiol. 2001; 38: 409–14.
11. Abbott JD, Kip KE, Vlachos HA, Sawhney N, Srinivas VS, Jacobs AK, et al. Recent trends in the percutaneous treatment of chronic total coronary occlusions. Am J Cardiol. 2006; 97: 1691–6.
12. Surmely JF, Tsuchikane E, Katoh O, Nishida Y, Nakayama M, Nakamura S, Oida A, Hattori E, Suzuki T. New concept for CTO recanalization using controlled antegrade and retrograde subintimal tracking: the CART technique. J Invasive Cardiol. 2006; 18: 334–8.
13. Stojkovic S, Sianos G, Katoh O, Galassi A, Beleslin B, Vukcevic V et al. Efficiency, safety and Long-Term Follow-up of Retrograde Approach for CTO Recanalization: Initial (Belgrade) Expirience with International Proctorship. J Interven Cardiol. 2012; 25(6): 540–8.
14. Morino Y, Abe M, Morimoto T, et al. Predicting successful guidewire crossing through chronic total occlusion of native coronary lesions within 30 minutes: the J-CTO (Multicenter CTO Registry in Japan) score as a difficulty grading and time assessment tool. JACC Cardiovasc Interv 2011; 4: 213–21.
15. Neville Kukreja, Pawel Tyczynski and Cardlo di Mario. Chronic total occlussions. In: Simon Redwood, Nick Curzen and Martyn Thomas, editor. Oxford Textbook of Interventional Cardiology. New York: Oxford University Press Inc; 2010. p. 333–48.
16. Christofferson RD, Lehmann KG, Martin GV, Every N, Caldwell JH, Kapadia SR. Effect of chronic total coronary occlusion on treatment strategy. Am J Cardiol 2005; 95(9): 1088–91.
17. Surmely JF, Katoh O, Tsuchikane E, Nasu K, Suzuki T. Coronary septal collaterals as an access for the retrograde approach in the percutaneous treatment of chronic total occlusions. Catheter Cardiovasc Interven 2007; 69: 826-32.
18. Sharad Chandra, Sudarshan Kumar Vijay, Sudhanshu Kumar Dwivedi. Successful Recanalization of a Left Anterior Descending Chronic Total Occlusion Via an Ipsilateral Intraseptal Collateral Using Reverse CART Technique. J Invasive Cardiol 2013; 25(4): E72–E74.
19. Graning R and DeMartini T. Complications of Chronic Total Occlusion Percutaneous Coronary Intervention. In: Rinfert S, editor. Percutaneous Intervention for Coronary Chronic Total Occlusion. Switzerland: Springer 2016. p. 193-206.
20. Šalinger-Martinović S, Stojković S, Pavlović M, Perišić Z, Obradović S, Apostolović S et al. Successful Retrieval of an Unexpanded Coronary Stent from the Left Main Coronary Artery during Primary Percutaneous Coronary Intervention. Srp Arh Celok Lek. 2011; 139(9-10): 669–72.




 

21. George S, Cockburn J, Clayton TC, Ludman P, Cotton J, Spratt J et al. Long-term follow-up of elective chronic total coronary occlusion angioplasty: analysis from the U.K. Central Cardiac Audit Database. J Am Coll Cardiol. 2014; 64(3): 235-43.
22. Muramatsu T, Tsukahara R, Ito Y. "Rendezvous in Coronary" Technique with the Retrograde Approach for Chronic Total Occlusion. J Invasive Cardiol 2010; 22: E179–E182.



 