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Right Coronary Artery Chronic Total Occlusion After Bypass Grafting Successfully Treated Using Reverse Controlled Antegrade and Retrograde Subintimal Tracking (CART) Technique via the Gastroepiploic Artery: A Case Report

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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Patient: Male, 63-year-old
Final Diagnosis: Chronic total coronary artery occlusion
Symptoms: Angina pectoris
Medication: —
Clinical Procedure: Percutaneous coronary intervention
Specialty: Cardiology

Objective: Unusual setting of medical care

Background: Percutaneous coronary intervention (PCI) of chronic total occlusions (CTO) is a well-established treatment option, improving health status and angina in selected patients with angina and/or a large area of documented ischemia and suitable anatomy. It has been used in patients with a history of coronary artery bypass grafting (CABG) but remains controversial in unusual bypass constructions. This report is of a 63-year-old man with angina due to right coronary CTO, 6 years following CABG, successfully treated using the reverse controlled antegrade and retrograde subintimal tracking technique (reverse CART technique) via the gastroepiploic (GE) artery.

Case Report: A 63-year-old man with a history of extensive coronary artery disease, including a CTO of the right coronary artery (RCA), previously treated with a right GE artery bypass graft, presented with unacceptable angina despite optimal medical treatment. A vascular CT scan suggested severe stenosis at the level of the anastomosis between the GE artery graft and the posterior descending (PD) artery. A PCI of the native RCA CTO was successfully performed using the GE artery bypass graft as a retrograde conduit, with good angiographical and clinical outcomes.

Conclusions: PCI of a CTO via the GE artery has been described only occasionally before, and remains a rare treatment. This report shows that retrograde coronary artery recanalization of CTO using the reverse CART technique, via the GE artery bypass graft, was safe and effective in this case, and that it can and should be considered in selected patients.

Keywords: Coronary Artery Bypass • Coronary Vessels • Gastroepiploic Artery • Percutaneous Coronary Intervention • Coronary Occlusion

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Background

Percutaneous coronary intervention (PCI) is considered a reasonable treatment in patients with unacceptable angina despite optimal medical treatment (OMT) and a history of previous coronary artery bypass grafting (CABG), in the presence of 1 or more significant coronary artery stenoses associated with ischemia [1].

PCI of chronic total occlusions (CTO) is a well-established treatment option in selected symptomatic patients, improving health status and angina burden if successful [2]. Current American guidelines state that CTO PCI is reasonable in patients with appropriate clinical indications and suitable anatomy [3]. European [4] guidelines endorse CTO PCI as well in patients with angina and/or a large area of documented ischemia in the territory of the occluded vessel.

Several techniques can be used when performing CTO PCI, and both antegrade and retrograde approaches have been described, with significantly higher success rates with the retrograde approach [5]. The reverse controlled antegrade and retrograde tracking (reverse CART) technique is the most frequently used retrograde technique. Dual arterial access is obtained and wires are placed both proximally and distally of the CTO, the latter through collateral vessels. Both proximally and distally of the CTO, a subintimal dissection is performed and the wires are advanced through this subintimal space until there is overlap of the wires. A balloon is advanced over the antegrade wire and is inflated, creating a common subintimal space. Through this space, the retrograde wire is advanced, until it reaches the proximal true lumen. A microcatheter is advanced in the common subintimal space and an externalization wire is placed. Finally, a PCI of the lesion is performed [5-7].

Since the introduction of coronary artery bypass grafting (CABG) in the 1960's, with the first anastomosis of the left internal mammary artery (LIMA) to a coronary artery [8] and the first saphenous vein bypass from the ascending aorta to a coronary artery [9] performed in 1964, multiple types of grafts have been used, with the majority of procedures using the left or right internal mammary artery, a saphenous vein graft, or a combination of these grafts. Although internal mammary arteries are the preferred bypass grafts [10], other non-thoracic arteries have been used as an arterial conduit, such as the radial artery, the inferior epigastric artery, and the right gastroepiploic artery (GE artery) [11]. The latter has shown good patency and low morbidity when used as a bypass graft to the right coronary artery (RCA), although anastomosis of the GE artery to the left anterior descending artery (LAD) should be avoided because of poor long-term results [12]. Because of technical reasons, its use is limited to cases in which intrathoracic arteries and saphenous veins are not usable [13]. In approximately 3% of CABG, the GE artery is used [14].

Although CTO PCI has been used in patients with a history of coronary artery bypass surgery, it remains challenging and controversial in unusual bypass constructions, such as bypass with the GE artery, mostly due to lack of evidence and experience in this rare situation.

A few cases of CTO PCI through the GE bypass have been described. Mbiki et al performed PCI of the LAD, using the GE graft as a retrograde approach [15], while other authors described CTO PCI of the RCA through the GE graft. Dai et al reported a successful recanalization of the RCA using the reverse CART technique with additional use of intravascular ultrasound [16], while Galassi et al reported successful recanalization using the knuckle technique [17].

This report is of a 63-year-old man who presented with angina due to right coronary chronic total occlusion 6 years following coronary artery bypass grafting, successfully treated using the reverse controlled antegrade and retrograde subintimal tracking technique (reverse CART technique) via the gastroepiploic artery.

Case Report

A 63-year-old man with arterial hypertension and well-controlled diabetes was referred to our institution for class III angina, despite optimal treatment. He quit smoking 10 years ago and there was no history of substance or alcohol abuse. The patient underwent a first CABG 27 years ago. The LAD was bypassed with a left internal mammary arterial graft (LIMA). He later had PCIs of the RCA and left circumflex artery (LCX).

Six years ago, a redo-CABG was performed with a GE artery graft distal to a chronically occluded mid-RCA. The right GE artery was used as an 'in situ' graft, with partial mobilization of the vessel and performing an anastomosis of the distal part of the vessel with the distal RCA. The proximal part of the GE artery remained in the original position [18].

Current medications included metformin, aspirin, beta-blocker, a statin, ACE-inhibition, a nitrate patch, and oral nitrates 3 times a day. Diagnostic angiography revealed a chronic total occlusion (CTO) of the distal RCA and proximal LAD, and patent stents in LCX. The LIMA graft on LAD was patent. The GE artery graft on RCA was not filmed. Electrocardiography (ECG) showed a Q-wave in lead III, but on echocardiography, systolic function was preserved and only slight hypokinesia was present in the inferobasal wall. An ECG-triggered coronary and vascular computed tomography scan (CT scan) was performed to evaluate the patency of the GE artery graft, and suggested a severe stenosis at the level of the anastomosis between the GE artery graft and the posterior descending (PD) artery

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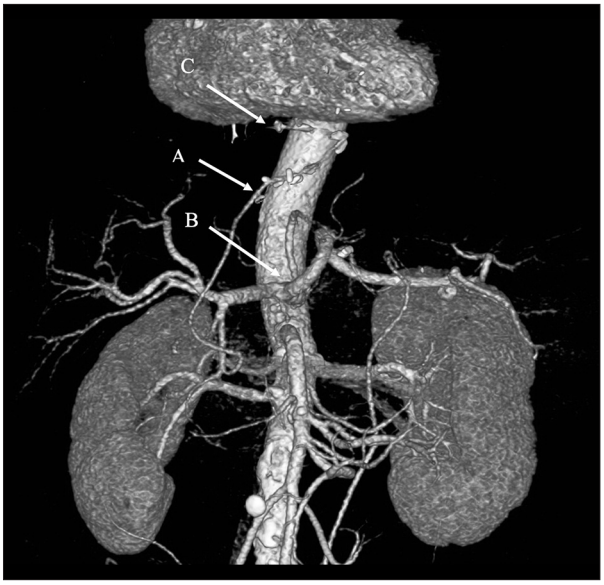

Figure 1. Three-dimensional (3-D) reconstruction on computed tomography angiography (CTA). A) The gastroepiploic artery. B) The celiac trunk. C) The anastomosis of the gastroepiploic artery at the right coronary artery (RCA).

Figure 2. Three-dimensional (3-D) reconstruction on computed tomography angiography (CTA). A) The right coronary artery (RCA). B) The anastomosis of the gastroepiploic artery bypass. C) The gastroepiploic artery bypass.

(**Figures 1, 2**). Since the patient had incapacitating symptoms despite optimal medical therapy, an attempt to open the RCA CTO was scheduled.

Access was obtained via the right radial (6-French sheath) and right femoral artery (6-French sheath). Selective injection of the GE graft, which was catheterized by an interventional

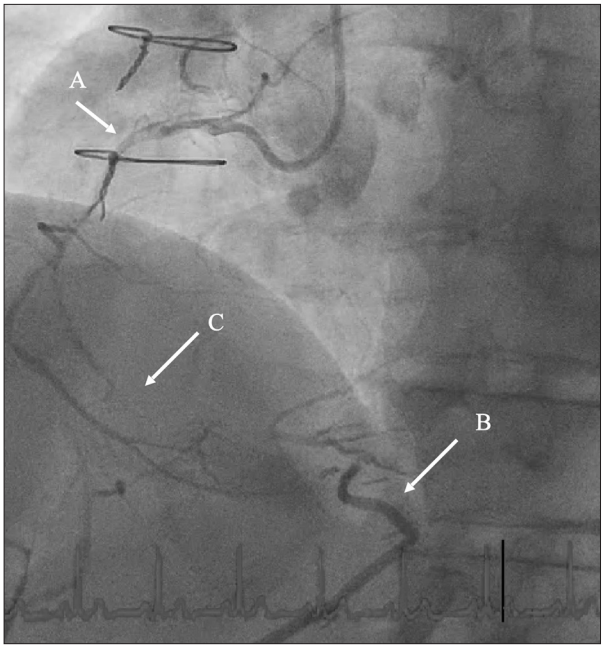

Figure 3. Angiography. A) Dual injection of the right coronary artery (RCA). B) The gastroepiploic graft. C) Chronic total occlusion (CTO) of the RCA is shown.

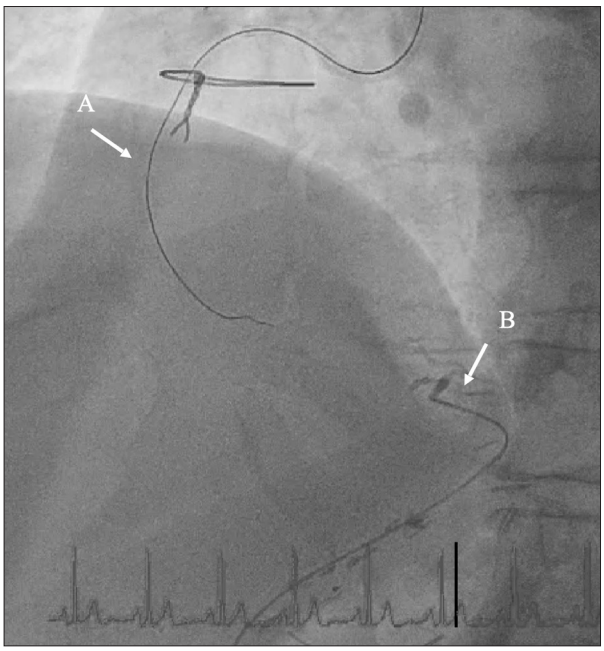

Figure 4. Angiography. A) The advancement of antegrade wire through the right coronary artery (RCA). B) The Corsair microcatheter is shown in the gastroepiploic graft.

radiologist using a Simons 4-French catheter, confirmed a severe stenosis of the GE artery graft to the PD artery at the level of the anastomosis (**Figure 3**). Bilateral injection from both the native RCA and the GE artery graft revealed a CTO of distal RCA with a J-CTO score of 2 [19], as the CTO was about 30

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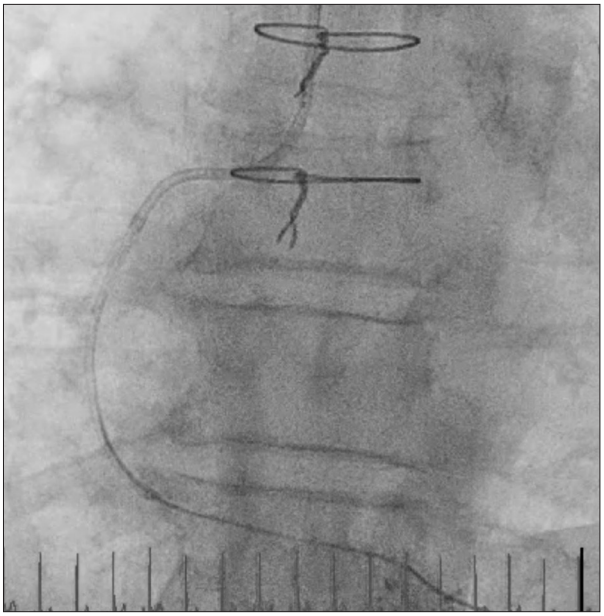

Figure 5. Angiography. The advancement of the Corsair microcatheter in the Guideliner catheter.

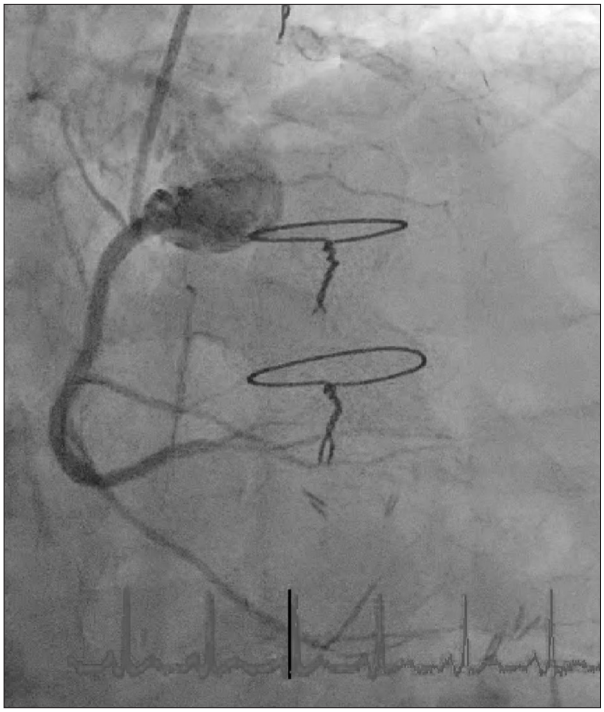

Figure 6. Final angiographic result. The right coronary artery (RCA) is shown following the successful CART procedure.

mm long (>20 mm) and calcified. As the proximal cap was tapered and non-ambiguous, an antegrade approach was attempted first, using a 6-French Amplatzer 0.75 guiding catheter, a Fielder XT-A™ guidewire, and then a Gaia 2nd™ (Asahi Intecc Co., Ltd., Aichi, Japan), both supported by a TurnPike Spiral™ microcatheter (Teleflex, Wayne, PA, USA). This failed and the strategy was switched to a retrograde approach, using a Corsair™ microcatheter (Asahi Intecc Co., Ltd.) which was successfully advanced over a Sion wire (Asahi Intecc Co., Ltd., Aichi, Japan) up to the level of the stenotic anastomosis (**Figure 4**). A Fielder XT-A™ then successfully crossed the anastomosis, after which the Corsair™ microcatheter could be advanced to the distal RCA.

Both antegrade and retrograde wires were directed into the subintimal space, and by knuckling the retrograde Fielder XT-A™ up to segment 2 of the RCA (**Figure 5**) both guidewires ended up overlapping in the subintimal space. This allowed a successful guide-extension-assisted reverse CART technique: A 6-French Guideliner™ (Vascular Solutions, Inc., Minneapolis, MN, USA) was advanced into the subintimal space over a 2.5 balloon (Ryurei TM, Terumo) on the antegrade Fielder XT-A™. After inflation and deflation of the balloon, a retrograde Pilot 200™ guidewire (Abbott Vascular) was able to enter the antegrade Guideliner™. Next, the retrograde Corsair™ microcatheter was advanced over the Pilot 200™ into the Guideliner and further advanced into the Amplatzer 0.75 guiding catheter, where it could be exchanged for the 300 cm RG3 externalization wire (Asahi Intecc Co., Ltd., Aichi, Japan). The RG3 was externalized and PCI was then performed over the externalized wire in a classical antegrade fashion. The lesion was stented with an excellent angiographic result (**Figure 6**). No complications occurred.

At a 2-month follow-up visit, the patient was free of angina and had stopped taking nitrates. To date, the patient remains asymptomatic.

Discussion

This report is of a 63-year-old man who presented with angina due to right coronary chronic total occlusion 6 years following CABG, successfully treated using the reverse CART technique via the GE artery. This case highlights therapeutic options in therapy-resistant patients with complex or unusual coronary anatomy and bypasses.

Our patient presented with persistent incapacitating angina, despite optimal medical treatment, which prompted the need for a different treatment. Diagnostic angiography revealed CTO of the distal RCA with patent stents in LCX and patent LIMA on LAD graft. Regional hypokinesia was seen on ultrasound, and CT angiography confirmed a severe stenosis at the level of the anastomosis between the GE artery graft and the posterior descending (PD) artery, consistent with the zone of hypokinesia. The medical treatment of our patient consisted of aspirin, beta-blockers, statins, ACE-inhibition, anti-diabetic treatment,

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and 2 kind of nitrates, which is consistent with medical therapy in major CTO-registries [2,20].

Although CTO PCI is a well-established treatment option in selected symptomatic patients, endorsed by both American and European guidelines [2,3], there are no dedicated outcome data on CTO PCI in patients with a GE graft on the CTO vessel. CTO PCI via the GE artery has been described before in a couple of case reports. The patients described in these reports had characteristics in common with our patient. They all had a history of CABG using the GE artery as a bypass graft, they had a CTO, and had persistent angina despite optimal treatment. Nevertheless, there were also some differences from our case. Mbiki et al reported the use of the GE graft for the retrograde approach of PCI of a CTO of the LAD [15]. Both Dai et al [16] and Galassi et al [17] performed successful PCI of a CTO of the RCA after CABG with a GE graft, but used slightly different techniques, using intravascular ultrasound (IVUS) in addition to the reverse CART technique or using the knuckle technique, respectively.

CTO PCI in patients with GE artery bypass remains a rarely used treatment, which is infrequently reported. Therefore, therapeutic decisions in symptomatic patients with CTO and GE bypass can be challenging, since reliable scientific data to support this decision are lacking. The patient described in our case report met the criteria of the American and European guidelines to attempt PCI, although these guidelines are not validated for patients with GE grafting and scientific data are lacking. Since this patient remained symptomatic despite optimal medical therapy and since redo-CABG was considered undesirable, the option of PCI CTO through the GE artery graft was explored after multidisciplinary discussion. Our case demonstrates that this technique is feasible and can be used in selected patients. Since there have been few reports on this procedure, further research to support its use and to select patients who might benefit from it is needed. Our patient did not have complications from the procedure, but further research to evaluate the safety of the procedure is also needed. This case and the case reports discussed in this article show that in symptomatic patients, even with complicated coronary history and unusual bypass grafting, CTO PCI should be considered as a therapeutic option. Other case reports show that this is also the case for unusual anatomical locations of CTO, such as CTO of the left main coronary artery [21], although this is beyond the scope of this article.

Conclusions

PCI of a CTO via the GE artery has been occasionally described before, but it remains a rare treatment. This report has shown that retrograde coronary artery recanalization of the CTO using the reverse CART technique via the GE artery bypass graft was safe and effective in this case and that it can and should be considered in selected patients. Further research in this type of patient is needed to evaluate safety and long-term outcomes.

Conflicts of Interest

None.

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