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TECHNICAL NOTE

# Retrograde Totally Endovascular Recanalization of Occluded Mesenteric Arteries Through the Pancreaticoduodenal Arcade

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**Introduction:** Failed antegrade endovascular recanalization of occluded mesenteric arteries has traditionally been dealt with by open mesenteric bypass or by hybrid solutions. This article describes a totally endovascular retrograde approach for recanalization of occluded mesenteric arteries through the pancreaticoduodenal arcade.
**Surgical technique:** A femoral or brachial approach is used to gain access to the patent visceral artery. A micro-catheter is advanced in a retrograde fashion into the distal main stem of the occluded artery through the gastroduodenal artery and inferior pancreaticoduodenal arcade. A combination of .014″ and .018″ wires is used to cross the occlusion in a retrograde fashion and to land into the aortic lumen. The guide wire is then snared through the brachial access, establishing a through and through wire. A micro-catheter is then advanced on the through and through wire across the occlusion from the brachial access. The distal occluded artery is then catheterized by advancing a second wire parallel to the through and through wire. The remaining procedure is performed as a standard antegrade approach.
**Discussion:** The totally endovascular retrograde approach through collaterals can be helpful for the recanalization of mesenteric artery occlusions. This technically complex procedure should be reserved for cases in which the traditional antegrade approach has failed.

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## INTRODUCTION

In recent years endovascular techniques have gained an important role in the treatment of chronic mesenteric ischemia (CMI).[1] Single vessel treatment is the most commonly applied strategy for re-establishing flow in the superior mesenteric artery (SMA) and/or the celiac trunk (CT). However, endovascular recanalization of chronically occluded mesenteric arteries by the traditional antegrade approach can at times be very challenging. Besides the traditional surgical reconstruction, a less invasive hybrid technique consisting of retrograde puncture of a surgically exposed SMA has been suggested in cases in which a standard endovascular antegrade approach fails.[2] As both these techniques can be demanding, an alternative retrograde endovascular approach has been proposed through collaterals between the SMA and CT.[3] This article describes a series of different scenarios in which this approach can be applied successfully.

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## SURGICAL TECHNIQUE

Four patients with CMI caused by SMA occlusion and highly stenotic CT, and one patient with an acute occlusion of a tight stenosis of the CT during the endovascular repair of a thoraco-abdominal aneurysm underwent endovascular recanalization in a hybrid suite under general anesthesia. The patient characteristics and procedure details are summarized in Tables 1 and 2.

The lesions were all primarily approached from a percutaneous brachial artery access. Although efforts were made to cross the lesion intraluminally, a subintimal dissection was created in all cases of occluded SMA without re-entry into the true lumen. A femoral or an additional brachial access was then used to gain access with a .035″ catheter to the other patent visceral artery (CT in the four cases of SMA occlusion and SMA for the CT occlusion). A 135 cm long micro-catheter (Progreat 2.7 Fr, Terumo Medical Corporation, Elkton, MD, USA) was advanced in a retrograde fashion into the distal main stem of the occluded artery through the gastroduodenal artery and inferior pancreaticoduodenal arcade. A combination of .014″ and .018″ wires were used to cross the occlusion in a retrograde fashion until a 300 cm long PT2 .014″ guide wire (Boston Scientific, Marlborough, MA, USA) could be advanced into the aortic lumen. This guide wire was then snared through the brachial access,

**Table 1.** Patient characteristics.

| Case # | Age | Sex | Previous medical history | Actual history | Previous attempts |
|---|---|---|---|---|---|
| 1 | 81 | F | COPD, EVAR of AAA, HT, stent CT | Chronic postprandial pain, weight loss | Antegrade (twice) |
| 2 | 77 | F | COPD, IC | Acute abdominal pain, sepsis, right hemicolectomy | Antegrade, hybrid[a] |
| 3 | 86 | F | HT, IC | Chronic postprandial pain, diarrhea | Antegrade |
| 4 | 63 | M | AAA (45 mm), CVI, IHD, PCI, RF | Chronic postprandial pain, weight loss | Antegrade |
| 5 | 61 | F | COPD, ICD, IHD, stenosis CT | TAAA Crawford type IV | None |

AAA = abdominal aortic aneurysm; CMI = chronic mesenteric ischemia; COPD = chronic obstructive pulmonary disease; CT = celiac trunk; CVI = cerebrovascular incident; EVAR = endovascular aneurysm repair; HT = hypertension; IC = intermittent claudication; ICD = implantable cardioverter defibrillator; IHD = ischemic heart disease; PCI = percutaneous coronary intervention; RF = renal insufficiency; TAAA = thoraco-abdominal aortic aneurysm.

[a] Retrograde puncture after surgical exposure.

establishing a through and through wire. A Headhunter Slip Cath (Cook Medical Inc., Bloomington, IN, USA) and micro-catheter were then advanced on the through and through wire from the brachial access across the occlusion. If there were any difficulties in advancing the catheters, a pre-dilatation of the occluded vessel was performed with a 3 mm balloon. The distal SMA/CT was then catheterized by advancing a .018″ Advantage wire parallel to the through and through wire inside the Headhunter catheter. After removal of the through and through wire, the Headhunter catheter was parked in the distal SMA/CT, and the .018″ guide wire exchanged for a Supracore .035″ guide wire (Abbott, Abbott Park, IL, USA). The remaining procedure was performed using a standard antegrade approach and completed by placing a balloon expandable stent/stents grafts across the occlusions.

## DISCUSSION

The retrograde technique described in the current report is a feasible and useful solution that allows recanalization of the SMA or CT when antegrade and/or hybrid approaches have failed. All patients had complete remission of their symptoms in the immediate post-operative period. No bowel resection or endovascular re-intervention to the recanalized vessel was necessary. A post-operative CT scan was performed in four out of five patients after a median time of 27.5 days, showing patency of the recanalized vessel in three out of four cases. An occlusion of the recanalized CT was detected in the patient treated during the endovascular exclusion of a thoraco-abdominal aneurysm. All patients remained free from symptoms after a median follow up of 350 days.

In most CMI patients endovascular treatment offers the benefit of shorter hospitalization compared with open revascularization. Therefore it should be considered as the first treatment option, especially in patients suffering from severe malnutrition.[4] The antegrade approach should always be the first choice as it has a high success rate (up to 93%)[5] and avoids laparotomy, thereby reducing the invasiveness of the operation in these usually frail patients. If an antegrade approach fails, a retrograde recanalization can be used to take advantage of the known softness of the distal cap of the occlusive plaque.[6] This approach has been widely applied using distal retrograde punctures in lower limb and SFA revascularizations.[7] However, in the case of CMI this requires a laparotomy with the aforementioned disadvantages. As chronic occlusive disease of one of the visceral arteries often results in enhancement of the pancreaticoduodenal collateral pathway, this route can be used to gain access to the distal cap of the occlusion. However, this requires meticulous scrutiny of pre- and intra-operative imaging (Figs. 1 and 2) to assess the feasibility of the technique. Technically, the increased tortuosity that is usually present leads to a decrease in pushability during recanalization. In addition, the friction of the remaining wire within the catheter increases when releasing the through and through wire. In this situation, it has been found that supporting the wire with micro-catheters from both the antegrade and retrograde approaches before withdrawal is highly beneficial. Furthermore, the use of the Headhunter Slip Cath with its hydrophilic coating and its

**Table 2.** Procedural data.

| Case # | Treatment | Operation time, min[a] | Fluoroscopy time, min[b] | Radiation, μGym$^2$ | Contrast volume, mL[b] | Primary technical success[c] | Clinical success |
|---|---|---|---|---|---|---|---|
| 1 | Stent graft + stent | 382 (133) | 179 | 27,914 | 273 | Yes | Yes |
| 2 | Stent | 115 (44) | 57 | 37,969 | 72 | Yes | Yes |
| 3 | Stent graft + stent | 280 (148) | 113 | 10,179 | 185 | Yes | Yes |
| 4 | Stent | 394 (106) | 138 | 24,553 | 267 | Yes | Yes |
| 5 | Stent graft + stent | 393 (39) | 168 | 76,892 | 183 | Yes | Yes |

[a] For the entire procedure and the retrograde part (in parenthesis).

[b] Calculated for the entire procedure.

[c] Successful completion of the procedure with no residual stenosis and no significant pressure gradient across the stented segment.