Novel treatment (new drug/intervention; established drug/procedure in new situation)

Reverse STAR for retrograde recanalisation in a chronic total coronary artery occlusion present for 21 years

Sukhjinder Nijjer, Carlo Di Mario

Department of Cardiology, Royal Brompton Hospital, London, UK

Correspondence to Sukhjinder Nijjer, s.nijjer@yahoo.co.uk

Summary

Reopening chronic total occlusions (CTOs) has been shown to alleviate anginal symptoms as well improve left ventricular ejection fraction. In patients with previous coronary artery bypass grafts, management of CTOs may avoid the need for repeat surgery. A variety of techniques have been described including subintimal tracking and re-entry (STAR) and CART approaches. The anatomy and the length of time that a CTO is present can determine whether it can be reopened. The present report describes a variation on the STAR technique used to open a CTO present for 21 years.

BACKGROUND

A variety of methods have been proposed for the management of chronic total occlusions (CTOs). The subintimal tracking and re-entry (STAR) technique, previously used in the management of peripheral vascular disease, was first used in treating coronary artery CTOs by Colombo *et al.*^{1 2} A retrograde approach via collaterals has gained interest thanks to the pioneering work of dedicated Japanese doctors, with Surmely *et al* giving the first systematic description of the techniques used to complete recanalisation once the wire has successfully reached the distal occluded vessel via a collateral (controlled anterograde and retrograde subintimal tracking; CART technique).³ This report describes a case of extremely severe calcification of the occluded segment in which the retrograde wire could not pass the occlusion directly and no balloons could be used to create a controlled subintimal dissection allowing passage of the anterograde wire. Recanalisation was eventually achieved with a combination of retrograde approach and STAR technique. This case demonstrates that persistence and a repertoire of skills are required in opening CTOs. While many different techniques for managing CTOs have been described, flexibility in approach and the ability to combine techniques is essential to help patients with difficult lesions.

CASE PRESENTATION AND INVESTIGATIONS

A 71-year-old Indian man, with a history of myasthenia gravis, hypercholesterolaemia and hypertension presented with angina on effort in 1987. Angiography demonstrated chronically occluded right coronary artery (RCA) and critical lesions of the left anterior descending (LAD) and circumflex (LCx) arteries. Coronary artery bypass grafting (CABG) was performed (1987) with a left internal mammary artery (LIMA) to LAD artery and two saphenous vein grafts (SVG) to the marginal branch of the LCx and RCA.

Recurrent angina developed in 2005 and was initially managed medically. Following angiography elsewhere, he underwent stent implantation on the vein graft for the marginal branch. Residual symptoms remained and a repeat

angiogram in November 2007 in Canada demonstrated occlusion of the mid RCA and the proximal LAD with a 40% eccentric stenosis of the proximal LCx. The LCx was the donor of a large collateral to the occluded RCA. Fractional flow reserve was normal through this lesion. No intervention was performed because the LIMA and SVG to the LCx were patent with no significant proximal stenosis. Again, occlusion of the RCA midsegment and proximal LAD was demonstrated. The SVG for the RCA was totally occluded.

He came to our attention because of persistent class 3 angina, exacerbated in the last few months. He had recently had a transient ischaemic attack and was against further surgery. An echocardiogram (ECG) showed no Q-waves in the inferior leads. Echocardiography demonstrated a moderately dilated left ventricle with a normal ejection fraction and mild hypokinesia of basal to mid inferior and inferoseptal segments. A stress echocardiogram demonstrated reversible inferolateral wall motion abnormalities. A recent multislice CT performed in India showed patency of the LIMA and SVG to the LCx.

TREATMENT

Angiography was performed via a right femoral access and revealed a patent LIMA to the LAD and SVG for the LCx. The LAD provided collaterals for a small posterior descending artery (PDA). The proximal LCx lesion had not changed from the previous angiogram. The RCA was occluded in the second segment, with severe calcification leading up to the terminal branches. The SVG to the RCA was not visible. A well developed dominant distal RCA was visualised via well developed but very tortuous epicardial collaterals from the LCx (figures 1 and 2, and video 1). The previously implanted stent in the SVG to marginal branch was widely patent.

Video 1 10.1136/bcr.05.2009.1903v1

There were no new targets to explain the patient's new symptoms. Given that the inferior wall represented a large

Figure 1 The right coronary artery (RCA) prior to treatment. The chronic total occlusion had been documented to be present for 21 years.

ischaemic territory with no evidence of any permanent damage, an attempt to open the RCA CTO was made.

The RCA was cannulated using the left femoral artery using a 7F JR4 SH guide catheter and a Pilot 50 0.014 wire supported by a Finecross microcatheter. An attempt was made for antegrade recanalisation by carving inside the long occluded segment with very stiff wires. A Tornus 0.021 catheter allowed the passage of sequential stiff wires: Confianza Pro 9g 0.014 wire, followed by an 8/12 g and an 8/20 g Confianza wire. This was together with Miracle 0.014 4, 6 and 12 and multiple hydrophilic wires. Despite all this technology, the antegrade approach was unsuccessful with extreme resistance from the occluded segment and no over the wire (OTW) balloon or microcatheter could be passed antegradely into the highly calcified distal RCA.

An attempt was made for a retrograde approach. The diagnostic left catheter was replaced by a 6Fr EBU 4.0 Launcher GC (0.071 inner lumen, Medtronic AVE, Santa Rosa, California, USA) and a series of angioplasty wires were passed in the attempt to negotiate the tortuous epicardial collaterals from the LCx to the RCA in a retrograde manner (figure 3). With the support of a Finecross Terumo, a Choice PT wire (Boston Scientific, Natick, Massachusetts, USA) reached the distal RCA vessel. Multiple OTW balloons were used to support the retrograde wire but the

tortuosity of the epicardial collateral prevented their advancement to the distal vessel. Therefore a CART technique could not be used. The advancement of a balloon antegradely for a reverse CART was not appealing because it required a dissection extending beyond the crux, shutting off the PDA.

A new further attempt was made using a retrograde approach and STAR technique. The Finecross was advanced through the epicardial collaterals into the distal stump of the occlusion and a Miracle wire was fashioned into a loop or J shape. This was passed into the distal RCA stump and advanced to create a retrograde subintimal dissection. This was enlarged and extended proximally with the use of multiple J-shaped Pilot wires (figure 4). An antegrade balloon (2.0 and then 3.0 mm) was then advanced into the third segment of the RCA and inflated along the antegrade subintimal wire. After balloon withdrawal a soft Terumo Runthrough wire could then be easily advanced to the distal RCA. Three stents (2×33 mm Cypher and 1×38 mm Taxus Liberte) were used to cover the entire distal and mid RCA, postdilated to 3.5 and 4.0 mm at high pressure (figure 5 and video 2). An excellent angiographic result was achieved.

Video 2 10.1136/bcr.05.2009.1903v2

Figure 2 Tortuous collaterals from the left circumflex (LCx) artery to the right coronary artery (RCA).

Figure 3 Retrograde injection via the collaterals to the distal right coronary artery (RCA). A wire is advanced in a retrograde manner to the distal RCA.

Figure 4 A looped/J-shaped miracle wire is passed in a retrograde manner to the occluded distal right coronary artery (RCA) to create a subintimal dissection, which was extended proximally. The antegrade wire is seen in the subintimal space. This allowed antegrade balloons to be passed for dilation prior to stenting.

Concomitant medication

Intravenous heparin was used to maintain an activated clotting time of >250 s. The patient was given aspirin 75 mg once a day and clopidogrel 75 mg once a day. Clopidogrel was continued for 12 months. A total of 320 ml of Visipaque contrast medium was used.

OUTCOME AND FOLLOW-UP

The patient had no immediate or medium-term complications. Repeat echocardiography showed a moderately dilated left ventricle (LV; LV end diastolic diameter 6.15 cm, LV end systolic diameter 3.88 cm) with normal systolic function. The basal to mid inferior and inferoseptal segments were mildly hypokinetic and this was unchanged from prior echocardiograms. Right ventricular and valvular function was normal.

He was well when reviewed in clinic after 9 months and had persistent subjective improvement in his symptoms (Canadian Cardiovascular Society (CSS) class 1). His oral nitrates had been discontinued.

DISCUSSION

Successful percutaneous recanalisation of CTOs have been shown to improve survival, improve left ventricular function, reduce anginal symptoms and improve exercise tolerance.³ A variety of techniques are now established to open CTOs and novel techniques continue to be developed.⁴

The STAR approach has been shown to achieve recanalisation in patients with CTOs older than 3 months, in which conventional techniques or approaches using dedicated CTO wires had failed.² Others have reported success with

a variety of retrograde approaches or combined antegrade and retrograde approaches.^{3–7}

Here, we report a use of the STAR technique performed in a retrograde manner via collateral branches. This represents a modification of previously described techniques but this report is unique because a lesion documented to be present for 21 years was recanalised. Surmely *et al*,⁸ demonstrated their similar controlled antegrade and retrograde subintimal tracking (CART approach) in lesions up to 7 years old.

Together with this case, there is support for tackling lesions considered truly chronic and thus provide impetus for percutaneously managing patients that would otherwise require repeat surgery.

The chronicity of the lesion is demonstrated in the difficulty of achieving wire passage in an antegrade fashion. A variety of CTO wires were used, with escalating weights but it was clear little progress was being made. Flexibility in approach and lateral thinking is essential when dealing with CTOs. Here, reasonable collaterals from the LCx allowed a retrograde approach. Clearly, collaterals should be visible on angiography and not be overtly tortuous. There remains a risk of tamponade should the collateral rupture.

The safety of opening CTOs continues to improve with the development of new techniques and equipment.⁸ This case report is limited by it being a single carefully selected case and that the procedure was performed by a highly experienced operator. Similarly well selected cases should be offered percutaneous coronary intervention after full discussion in a multidisciplinary manner. Thorough assessment using perfusion scanning and cardiac MRI may be required.

Figure 5 Three stents (two 33 mm Cypher and one 38 mm Taxus Liberté) were used to cover the entire distal and mid right coronary artery (RCA). They were postdilated to 3.5 and 4.0 mm. An excellent angiographic result was observed.

Learning points

- ▶ Opening chronic total occlusions (CTOs) is a therapeutic option in carefully selected patients with ongoing ischaemic symptoms when repeat coronary artery bypass grafting (CABG) surgery is not an option.
- ▶ CTOs vary in age but even very old lesions can be amenable to angioplasty.
- ▶ A variety of techniques and operator skill will be required to open CTOs. The literature shows that high volume operators have shorter procedure times, less complications and higher success rates.^{4 5}

Competing interests None.

Patient consent Obtained.

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