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Original Article

Microcatheters for antegrade recanalization of chronic total coronary occlusions: Feasibility and safety of the corsair - A retrospective registry-based single operator experience

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ABSTRACT

Background: The Corsair collateral channel dilator was designed for retrograde passage in cases of coronary chronic total occlusion (CTO). Its antegrade use is discouraged and the number of published studies regarding such use is limited. Our single-operator experience examines the feasibility and safety of the Corsair in antegrade recanalization of chronic CTOs in a large cohort.

Methods: We queried the European Registry of Chronic Total Occlusion (ERCTO) for all microcatheters used in antegrade recanalizations between 2008 and 2016. We also retrospectively assessed all 722 coronary interventions for CTOs (624 antegrade, 98 retrograde) between January 2008 and December 2016, performed by a single operator who primarily applied the Corsair as antegrade microcatheter. Patient, procedure, and outcome data was analyzed.

Results: In 17,787 cases performed by 93 operators contributing to the ERCTO database, there were 3294 with information on microcatheter type. The FineCross MG (73.9 %) was the most commonly used microcatheter. The Corsair was used in only 1.2 % (excluding patients in the single-operator cohort). In the same period 45.7 % (n = 285) of all 624 antegrade cases handled by our single operator were performed using the Corsair, with no exclusions due to anatomical or morphological criteria. The procedural success rate was 93.7 %. There were 2 cases of cardiac tamponade, 5 cases of minor perforation, and one catheter tip fracture.

Conclusions: The Corsair is rarely used for antegrade recanalization. In this single-operator experience, the antegrade use of the Corsair was safe. The success rate was high, although causative conclusions cannot be drawn.

1. Introduction

Recanalizations of chronic total coronary occlusions (CTOs) are being attempted with increasing frequency, and success rates of up to 90 % in the hands of experienced operators have been reported.[1,2] In comparison with non-occlusive lesions, percutaneous coronary interventions (PCI) for CTOs are burdened by increased procedural time, increased radiation exposure, a requirement for more contrast dye, higher rates of complications, higher procedural costs, and ultimately lower procedural success rates.[3]

The standard approach to CTOs is an initial antegrade attempt. Since the introduction of the retrograde approach in 2006,[4] paired with the introduction of microcatheters for retrograde use and the development of the more effective reverse controlled antegrade and retrograde tracking (CART) technique, many experienced operators are quicker to apply the more demanding and complicated retrograde technique - some in up to 50 % of procedures.[5,6]

The FineCross MG microcatheter (TERUMO, Tokyo, Japan) is reported to be the most widely used microcatheter for antegrade procedures.[7] In 2008, the Corsair (ASAHI Intecc, Aichi, Japan) microcatheter was released for retrograde collateral crossing; its use in an antegrade manner was discouraged because of its fragility and ease of being broken upon crossing hard occlusions. Nevertheless, in 2012 Obata et al reported a preliminary study of 31 cases with an antegrade crossing success of 85 % using the Corsair as

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compared to only 63 % in 27 patients using the FineCross MG.[8] No further experience has been reported to date.

The goal of our analysis was to examine use of the Corsair channel dilator in a large registry and to elucidate the safety and feasibility of its use as a default antegrade microcatheter (despite its design for the retrograde approach) in a large cohort of patients treated by a single operator.

2. Methods

2.1. Registry and patient cohort

We retrospectively analyzed microcatheter use of all antegrade cases of operators contributing to the European Registry of Chronic Total Occlusion (ERCTO). The ERCTO is a multicenter registry of PCI procedures applied for CTO that prospectively monitors procedural success, technical information, and patient outcomes. Data pertaining to patients in our single-operator cohort (below) were excluded from this analysis, because of the high rate of Corsair use in our cohort (outlier).

Separately, we assessed all procedural data from a single operator. Retrograde cases were excluded. Procedural and in-hospital follow-up that had been entered into a prospective database was analyzed. Multiple CTOs in one patient treated in a single session were considered separate cases.[9]

Chronic total occlusion was defined according to the definition of the Euro CTO Club as the presence of TIMI 0 flow within an occluded segment of the coronary artery with an estimated occlusion duration of >3 months.[3] Viable myocardium in the CTO area was assessed by echocardiography, stress echocardiography, MRI, or ECG, whereby large regions without Q-waves in the respective leads were considered viable. Procedural success was defined as a final residual stenosis of <30 % with a normal flow to the distal vessel, no occlusion of major side branches, and no major complications.

In-hospital follow-up was available for all patients. Major in-hospital complications were defined as death, emergency coronary artery bypass graft surgery, stroke, myocardial infarction (new Q-waves or increase of creatinine kinase values to at least 3 times the pre-PCI value), or cardiac tamponade. All major complications were documented independently of the operator by a documentation assistant and then entered into the database. Angiographic procedures were reviewed by an independent operator to assess the J-CTO score.[10]

All procedures were performed by the same CTO operator with previous experience of more than 2500 CTO procedures and an average of 108 CTO cases per year. The Corsair has beenavailable and used since May 2008. There were 65 cases with the Corsair Pro. The Corsair Pro XS was not used.

2.2. Ethics

Informed consent, including consent for data analysis, was obtained for all patients. The prospective registry and subsequent analyses were approved by the institutional ethics committee and was conducted in adherence to the 1964 Declaration of Helsinki and its later amendments.

2.3. PCI procedure

All procedures were performed using femoral access (guiding catheter sizes ranging from 6 to 8 French). In all cases where the distal vessel was not contrasted by ipsilateral collaterals, two sheaths were inserted to allow for contralateral dye injection. All but 12 patients were approached via the same femoral artery employing the parallel sheath technique.[11]

An activated clotting time (ACT) above 250 s was maintained by intra-arterial boluses of unfractionated heparin. After successful crossing with a microcatheter all cases were concluded by balloon dilatation followed byimplantation of drug-eluting stents.

Fig. 1. Corsair tip fracture caused by excessive manipulation in a calcified occlusion.

Table 1
Primary microcatheter used in antegrade procedures in the ERCTO registry documented between 2008 and 2016.

Microcatheter	Total (n = 3294)	Percentage
FineCross	2426	73.9 %
CrossBoss	204	6.2 %
NHancer	198	6.0 %
SuperCross	52	1.6 %
Corsair	39	1.2 %
Echelon	33	1.0 %
StrideSmooth	30	0.9 %
Ventura	30	0.9 %
OTW	24	0.7 %
Other	248	7.6 %

2.4. Materials

The microcatheters (other than Corsair) used most frequently in the single operator experience were the FineCross MG and the 0.014" Quick-Cross (The Spectranetics Corporation, Colorado Springs, CO, USA). Short occlusions were crossed with support of a over-the-wire 1.25 mm × 10 mm Ryujin (TERUMO, Tokyo, Japan) balloon catheter. The Corsair microcatheter was available to us as early as 2008. It is a tungsten braided microcatheter with a hydrophilic coating developed for retrograde channel crossing in CTOs. Its use for antegrade procedures was initially discouraged because of the risk of tip fracture (Fig. 1). The Corsair was used in all types of lesions; there were no exclusions due to anatomic or morphologic criteria.

2.5. Statistics

Continuous variables are expressed as mean values with standard deviation.The statistics program used was 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

A total of 17,787 consecutive antegrade CTO procedures carried out by 93 highly experienced operators were entered into the ERCTO database between 2008 and 2016. In 3294 procedures, information about the type of microcatheter that was used for the antegrade approach was available. The predominant microcatheter used for antegrade cases documented in the ERCTO registry was the FineCross MG catheter. The Corsair was only used in 1.2 % of cases (our data excluded; Table 1).

In the current analysis of procedures carried out by a single operator the Corsair microcatheter was used in 45.7 % of antegrade cases. There was a trend for increased frequency in Corsair use over time starting with 5.3 % use in the years 2008–2009, ramping up 3.8 % in 2010–2011 and culminating in 100 % use in antegrade cases in 2016 (Fig. 2).

Overall success rate was high (93.7 %) and there were few complications. Two cases of cardiac tamponade, and 5 cases of minor perforation were documented in the patient collective with antegrade use of the Corsair catheter. No other major adverse cardiac events were seen in this group (Table 2). There was only 1 case of Corsair fracture in the early phase of implementation, which was most likely due to excessive rotation in the same direction in a calcifiedocclusion (Fig. 1).

4. Discussion

In our analysis of procedures conducted by a single operator, use of the Corsair microcatheter for the antegrade approach was found to be feasible, safe, and successful. According to the subjective rating of the operator, the specific advantage of the Corsair is a superior tactile feedback of the wire that more easily allows discrimination between correct and incorrect lumen entry as compared with other microcatheters. This led to the increased use over time.

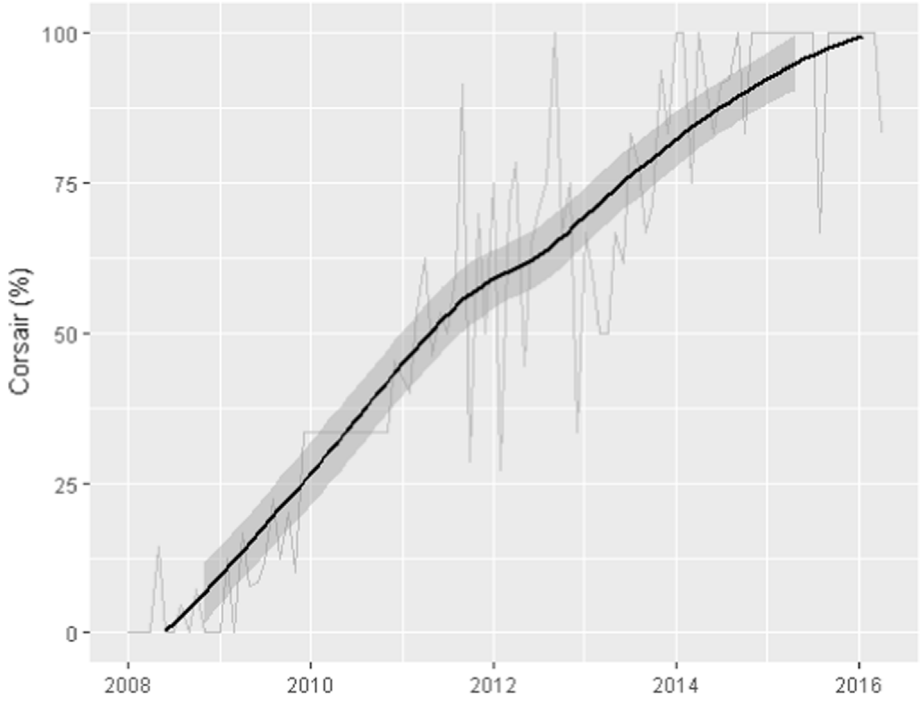

Fig. 2. Increase in the use of theCorsair as antegrade microcatheter over time.

Table 2
Patient and procedural characteristics of single-operator cohort.

	No Corsair	Corsair
N	339	285
Age, mean (y)	65.1 ± 11.6	65.0 ± 10.9
Male (%)	87.6	83.2
Risk Factors		
BMI, mean (kg/m^2)	28.5 ± 3.6	28.9 ± 4.7
Hypertension (%)	89.4	88.4
Diabetes mellitus (%)	31.6	31.9
Current smoker (%)	33.6	27.1
Dyslipidemia (%)	87.6	84.6
Family history (%)	39.2	44.6
Previous CABG (%)	18.0	14.0
Previous PCI (%)	59.0	54.4
Previous myocardial infarction (%)	43.4	41.7
1-vessel disease	18.2	20.8
2-vessel disease	33.5	30.3
3-vessel disease	42.1	54.8
Creatinine (mg/dL)	0.99 ± 0.8	1.13 ± 0.5
LVEF <35 % %	22.6	29.0
CTO artery (%)		
LMT	1.7	0.7
LAD	27.1	16.8
LCX	13.3	11.2
RCA	49.3	62.1
SB	4.7	6.7
BP-Arterial	0.6	0.7
BP-Venous	3.2	1.7
J-CTO score	2.00 ± 0.5	2.38 ± 0.7
Calcification %	52.7	50.2
Blunt stump	40.4	48.0
Bending	31.7	44.6
Occlusion length ≥20 mm	59.5	54.4
Re-try lesion	**16.4**	41.5
Pericardial effusion with tamponade (%)	0.3	0.7
Minor perforation (%)	0.3	1.7
Emergency re-PCI (%)	0.3	0
Q-wave myocardial infarction (%)	0	0
Non-Q-wave myocardial infarction (%)	0	0.3
Death (%)	0.3	0
Operation success (%)	90.6	93.7

N (%) or mean ± SD where indicated. Abbreviations: BMI, body-mass index; CABG, coronary artery bypass grafting, PCI, percutaneous coronary intervention; CTO, chronic total occlusion; LVEF, left ventricular ejection fraction; J-CTO score, J-CTO = Multicenter CTO Registry of Japan score.

Other studies have examined use of the Corsair. A better pushability of the Corsair catheter over the FineCross MG and more favorable flexibility compared with the Tornus (ASAHI Intecc, Aichi, Japan) (and therefore less trauma) was described.[12] A recently published analysis of equipment in the PROGRESS-CTO registry reported use of the Corsair in 44 % of antegrade cases between 2012 and 2015 and 9 % of antegrade cases between 2015 and 2019.[13]

There are several clear limitations to this analysis and the conclusions that can be drawn. This is a single-operator account. A statistical comparison of two groups with and without Corsair was not possible due to the plethora of potential confounders. In general, there are few studies directly comparing different CTO devices or coronary wires and they would inherently be difficult to conduct since success with any device is dependent on the operators' experience overall, the experience with the device in question, and the specific coronary status. Regarding the data showing microcatheter use in the ERCTO registry, there may have been underreporting, since this is not an obligatory data entryfield.

Since failed antegrade attempts maybe successfully completed via the retrograde approach, our data supports the initial use of the Corsair catheter in an antegrade manner and then, if necessary, employing it, as initially designed, as a retrograde device. This strategy should be pursued with caution, since there is a considerable risk of failure of material and consequently tip fracture, which was our initial experience in using the device (Fig. 1), after which the number of rotations with the catheter was meticulously tracked. More than 10 turns in either direction without fluoroscopic tip advancement should not be attempted.

In conclusion, there trograde channel dilator Corsair appears to be a very useful and safe tool for the antegrade CTO approach.

Conflict of interest

The authors declare that there is no conflict of interest.

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