Percutaneous Interventional Strategies in the Treatment of Chronic Total Coronary Occlusions

K W Lau, Z P Ding, U Sigwart, L Lam

ABSTRACT

Chronic total coronary occlusions which make up 10% to 20% of all interventional procedures in high-volume centres remain a vexing problem for invasive cardiologists for 2 main reasons. First, they are only successfully recanalised in about 60% of attempts with most failures resulting from an inability to cross the lesions. Laser guidewire appears to be a promising innovation in overcoming this obstacle. Second, after initially successful recanalisation with conventional balloon angioplasty (PTCA), a high restenosis rate (range, 45% to 75%) is observed. Stent placement, by conferring maximal luminal expansion, appears to have resolved this problem to a large extent; both observational and randomised studies indicate that after stent placement, restenosis rate is at least halved that of PTCA.

Keywords: Chronic total occlusion, balloon angioplasty, stents, restenosis

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INTRODUCTION

Chronic total coronary occlusions (CTOs) account for 10% to 20% of all percutaneous interventional procedures in high-volume centres. Although conventional percutaneous transluminal coronary angioplasty (PTCA) has been used for the treatment of chronic total occlusions (CTO) over the past 2 decades, it is plagued by 2 major limitations; namely that of a high failure rate in crossing the occluded lesion and a high restenosis rate after initially successful PTCA. In this review article, we examine the strategies in circumventing these 2 problems.

STRATEGIES IN CROSSING CTO

Failure to cross CTO with conventional guidewires, including standard (extra stiff) and hydrophilic-coated guidewires and despite "splinting" of the distal end of the guidewire with the balloon catheter to lend additional stiffness to the former, is perhaps the single most important impediment to subsequent successful lesion dilation. Crossing success rate is only about 50% to 70%. Several predictive factors for crossability failure have been defined in the past; these include increasing age and length of lesion, presence of low-resistance side-branches in the immediate vicinity of CTO, absence of "rat-tail" (tapered) lesion morphology, total CTO with TIMI 0 flow as opposed to "functional" CTO with some antegrade (TIMI 1) flow and presence of bridging collaterals[1]. The inability to cross these lesions obviously precludes subsequent definitive percutaneous intervention, such as PTCA, atherectomy, laser angioplasty and stenting as these devices require delivery over a guidewire. Newer innovative devices, including low-speed rotational angioplasty system[2] and laser guidewire[3,4] were thus introduced in the hope of bettering this success rate. In the BAROCCO study[2] which randomised 100 patients to either conventional guidewire approach or to low-speed rotational angioplasty, the overall primary success rate in crossing CTO was marginally but not significantly superior in the former than the latter strategy (66% vs 52%). Rotational angioplasty, however, was more successful than conventional guidewire technique in recanalising stump CTO (61% vs 38%, $p < 0.05$). In contrast, early reports with the laser wire system have yielded more promising data than rotational angioplasty. In the U.S.[3] and European TOTAL[4] trials, success rate in crossing CTOs with the steerable forward debulking laser guidewire after failed conventional guidewire technique was attained in about 60% of procedures. The laser wire, however, was associated with a high incidence of coronary perforation. This complication, fortunately, is relatively benign provided it is immediately recognised, the wire withdrawn and no attempt is made to pass any device over it; failure to do so will result in cardiac tamponade and even death.

Infrequently, after successful crossing of CTO with a guidewire, the lesion (especially if it is heavily calcified or fibrotic) is resistant to passage of the balloon catheter or balloon dilation despite high inflation pressures. In such situations, recanalisation is achievable with

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Table I. 6 month angiographic restenosis rates of stent placement in chronic total occlusions.

Reference	Patients/lesions restudied	Angiographic restudy rate (%)	Number of RS (Occl)	Restenosis (reoccl) rate (%)
Medina (15)	23/23	77	5 (2)	22 (9)
Goldberg (16)	50/51	88	10 (1)	20 (2)
Sirnes (17)	57/57	97	18 (7)	32 (12)
Belle (18)	22/22	92	7 (0)	32 (0)
Suttorp (19)	34/35	90	14 (8)	40 (23)
Rau (20)	120/121	84	35 (8)	29 (7)
Anzuini (21)	76/82	93	24 (3)	32 (4)
Rubartelli (22)	50/56	89	16 (4)	32 (8)
Lau (23)	43/49	87	14 (2)	32 (5)
Pooled	**475/496**	**96**	**143 (35)**	**30 (7)**

Occl, occluded lesions; RS, restenosed lesions; reoccl, reocclusion.

rotational atherectomy or laser angioplasty, followed by additional treatment strategy to optimise the luminal outcome (discussed below).

STRATEGIES IN REDUCING RESTENOSIS

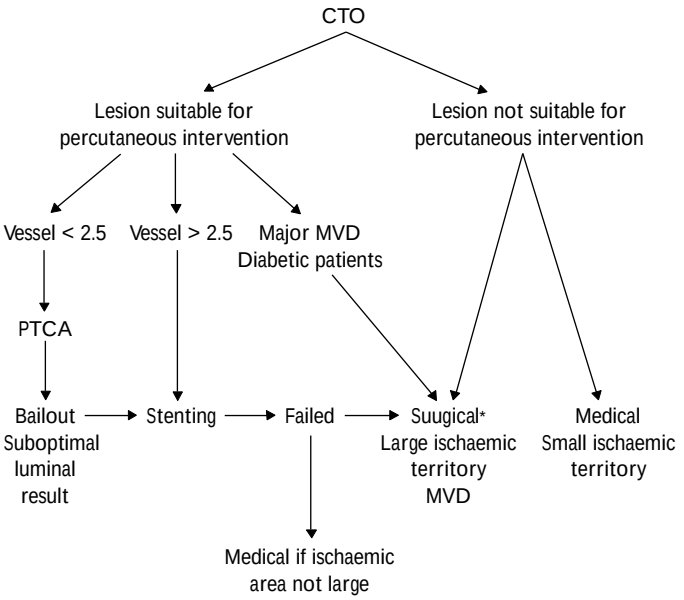
The second major drawback of PTCA is that after an initially successful recanalization of CTOs, a higher restenosis rate is often encountered compared with that after successful PTCA of subtotal stenoses (45% to 75% (including a reocclusion rate of 15% to 40%) vs. 30% to 40%, respectively)[1,4-8]. In contrast to PTCA (or any other intracoronary device), stent placement provides a greater immediate luminal gain which in turn allows for more intimal hyperplasia before the onset of restenosis[9-11], and counteracts vascular remodeling by providing a rigid endovascular scaffold[11, 12]. It is thus not surprising that of the 2 techniques, stenting has been shown to yield superior midterm angiographic and clinical results in the treatment of both subtotal stenoses and chronic total occlusions[13-20]. Maintained patency of chronic total occlusions after initial successful recanalization is desirable as it yields improvement in global and regional left ventricular function and avoids adverse left ventricular remodeling in patients with previous myocardial infarction[18]. At least 9 recent studies[15-23] with a reasonably high 5 to 6-month angiographic restudy rate in a total of 475 chronic total occlusions have suggested that intracoronary stenting may significantly enhance the midterm patency rate compared with stand-alone PTCA; the average instent restenosis rate in these studies was 30% (range, 20% to 40%) with a recurrent occlusion rate of 7% (Table I). The advantages of stenting over PTCA in CTOs were recently confirmed in 2 randomised trials comparing the 2 techniques in a head-to-head fashion in 224 patients[17,22]. The angiographic restenosis rates in the stent and PTCA groups were 31.6% versus 73.7% ($p < 0.001$), respectively, in the SICCO trial[17], and 32% vs 68%, ($p<0.001$), respectively, in the GISSOC trial[22]. This reduction in restenosis expectedly conferred a better clinical outcome in the stented patients. Furthermore, we found that, unlike PTCA, there was no increased risk of restenosis after stent placement in CTOs compared with subtotal stenoses[23]. To examine this aspect and to minimize the confounding factors which may influence the risk of restenosis, we performed a manual case-matching of several important clinical, angiographic and stent-related variables in a prospectively collected series of patients who underwent stent placement for the treatment of chronic total occlusions and subtotal stenoses. Our study indicated that there was no difference in either the 5-month mean instent diameter stenosis ($41 \pm 33\%$ vs. $35 \pm 33\%$, respectively, $p = 0.453$) or the instent restenosis rate (32.6% vs 27.9%, respectively, $p = 0.638$) between the CTO vs. the subtotal stenosis patients. Stent occlusion rate was also found to be low in both groups (5% to 7%). Stent placement thus appears to negate the increased proclivity for restenosis in CTOs by providing maximal lumen expansion.

Another strategy which has shown promise in lowering the risk of restenosis is that of brachytherapy. Preliminary data from the latter treatment using the either localised gamma or beta irradiation within the coronary circulation in small patient samples have shown inhibition of neointimal proliferation and vascular contraction, and ipso facto, prevention of restenosis after de novo PTCA or recurrence after the occurrence of instent restenosis[24,25].

CONCLUSION

Catheter-based treatment of CTOs persists to be a vexing problem for interventional cardiologists; overall acute success rate despite new devices continues to be significantly lower than that of subtotal stenoses. On the other hand, the advent of stents has significantly improved the midterm angiographic-clinical outcome

Fig. 1 Algorithm for treatment of chronic total coronary occlusion (CTO)



* Minimally invasive surgery if appropriate otherwise, conventional bypass surgery. PTCA, percutaneous transluminal coronary angioplasty; MVD, multivessel disease

compared with stand-alone PTCA. Having said that, it must be borne in mind that there remains a subset of patients with CTO where percutaneous interventional therapy remains an inferior option and should be considered for surgical revascularisation (Fig. 1). Such patients include those with CTO in the presence of multivessel disease and/or diabetes, particularly when the vessel size is small (< 2.6mm in diameter) and diffusely diseased; instent restenosis and repeat revascularisation rates in these patients have been demonstrated to be significantly higher than other patient subsets after stent placement[26,27].

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