



Original Article

## TECHNICAL SUCCESS OF PERCUTANEOUS CORONARY INTERVENTION OF CHRONIC TOTAL OCCLUSION

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### ABSTRACT

**Objective:** To evaluate the technical success of percutaneous coronary intervention (PCI) of chronic total occlusion (CTO).

**Materials and methods:** This observational study was conducted at the Cardiology Department, Punjab Institute of Cardiology, Lahore from January to June 2010. Seventy patients fulfilling inclusion and exclusion criteria were studied. All PCIs of CTOs were performed by experienced cardiologists. A fluoroscopy time of 30 minutes was allocated to wire the lesion. The primary end point was procedural success. If the angioplasty guide wire failed to progress, or secondary end point occurred which was complications such as coronary dissection, perforation or hemodynamic instability the procedure was abandoned and declared unsuccessful. The procedure was concluded on achievement of the primary end point or any of the secondary end points.

**Results:** Mean age of patients was  $52.7 \pm 9.9$  years, mean height was  $167.22 \pm 6.4$  cm and mean weight was  $76.3 \pm 9$  kg. Out of 70 patients 57 (81.4%) were males and 13 (18.6) females. Regarding coronary artery risk factors 22 (31.4%) were diabetic, 39 (55.7%) hypertensive, 34 (48.6%) smokers, 17 (24.3%) with family history of ischemic heart disease and 13 (13%) had previous history of ischemic heart disease. Diseased artery was left anterior descending (LAD) in 32 (45.7%), left circumflex (LCX) in 9 (12.9%) and right coronary artery (RCA) in 29 (41.4%). Regarding lesion characteristics of CTO distal vessels were visualized in 56 (80%), antegrade flow was elicited in 45 (64.3%), retrograde flow in 25 (35.7%), and calcification was observed in 9 (12.9%) patients. Stump shape was tapering in 46 (65.7%) and flat in 24 (34.3%). Collaterals were present in 36 (51.4%), bridging collaterals were observed in 13 (18.6%) and side branch within 2 mm of lesion was present in 42 (60%). Length of lesion was < 10mm in 4 (5.7%), 10-20mm in 30 (42.9%) and > 20mm in 36 (51.4%) patients. Guide wire crossed the lesion with balloon support in 54 (77%) patients. Thrombolysis in myocardial infarction (TIMI) III flow was achieved in 54 (77%) and technical success was 54 (77%). Residual stenosis of > 30% was observed in 16 (22.9%).

**Conclusion:** Percutaneous coronary intervention is a safe and useful procedure for the revascularization of coronary chronic total occlusion lesions. Further more the radial artery might be a feasible vascular route in PCI for CTO.

**Key Words:** Coronary artery disease; Chronic total occlusion; Percutaneous coronary intervention; Bridging collaterals; Tapering stump.

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### INTRODUCTION

Percutaneous coronary intervention (PCI) of chronic total occlusion (CTO) is one of the major challenges in interventional cardiol-

ogy.<sup>1</sup> The true prevalence of CTO in the general population is unknown because a certain proportion of patients with CTO are either asymptomatic or minimally symptomatic and never undergoes coronary angiogram.<sup>1</sup> CTO is a common problem seen in 10-30% of patients undergoing PCI.<sup>2</sup> The currently accepted indication for re-canalization of a chronic coronary occlusion is ischemic symptoms or inducible ischemia related to the occluded vessel.<sup>6</sup> The re-canalization of a chronic total coronary occlusion leads to relief of angina and to recovery of left ventricular function with a

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favorable effect on survival<sup>3</sup>. Primary success rate is relatively low, as re-canalization of CTO is a complex procedure due to inability to cross the occlusion with the guide wire. Moreover, the overall procedure and fluoroscopy time is longer and equipment use is higher than PCI of non-occluded Vessels and with a high recurrence rate.<sup>4-5</sup>

PCI of chronic coronary occlusions can be performed with a success rate of 88.9–90.8%, but with a higher rate of restenosis than after angioplasty of non-occluded vessels.<sup>7</sup>

This study was designed to evaluate the outcome of PCI of CTO lesions in terms of technical success. Furthermore to identify factors leading to successful PCI i.e. tapered stump, smaller missing segment.

The study will clarify our understanding of PCI to CTO in terms of patient selection who will benefit most from intervention and in whom intervention should not be performed. Successful PCI for CTO has shown to alleviate anginal symptoms, improve left ventricular ejection fraction, decrease the need for coronary bypass graft surgery (CABG) and prolong life.<sup>8</sup>

### **MATERIALS AND METHODS**

This observational study was conducted at the Cardiology Department, Punjab Institute of Cardiology, Lahore from January to June 2010. After fulfilling the inclusion criteria and taking informed consent 70 patients were studied. All patients were explained about protocol of study. Patients were included using non probability, purposive sampling technique.

All patients with chronic total occlusion having TIMI flow grade 0-1 undergoing PCI were included.

Patients with renal dysfunction, raised serum creatinine >1.4 mg/dl, history of prior PCI, history of prior CABG were excluded.

Chronic total occlusion was defined as obstruction of a native coronary artery with no luminal continuity and TIMI flow grade 0-1. The duration of occlusion had to be more than 3 months, estimated from clinical events such as myocardial infarction, sudden onset or worsening of symptoms or proven by previous angiography.

Technical success was defined as restoration of TIMI flow grade 3 with residual stenosis <30% on coronary angiography.

All patients received a loading dose of 600 mg of clopidogrel and then 75 mg/d for 9 months in addition to 150 mg/d aspirin. During the proce-

dure, intravenous heparin boluses were administered. All the PCIs of CTOs were performed by experienced cardiologist. Local anesthesia was given at the site of arterial puncture. A fluoroscopy time of 30 minutes was allocated to wire the lesion. If the angioplasty guide wire failed to progress, or complications occurred such as coronary dissection, perforation or hemodynamic instability the procedure was abandoned and declared unsuccessful. Selection of angioplasty guide wires and supporting balloons was at the discretion of PCI operators. Operators progressed from soft to stiff wires. Balloon pre-dilatation was mandated before stent placement. Stent assignment was at the discretion of the physician. Bare metal and drug eluting stents were used of available lengths 8-18 mm lengths and 2.5, 3.0, and 3.5 mm diameters. Post dilation was done to optimize angiographic deployment.

The procedure was concluded on achievement of the primary end point or any of the secondary end points.

The primary end point of the study was procedural success.

Secondary end point included failure of guide wire to cross the lesion, perforation, dissection, peri-procedural instability or death.

### **STATISTICAL ANALYSIS**

Data was analyzed on SPSS version 14.0. Nominal variables were presented as the frequencies and percentages and continuous variables were expressed as the mean  $\pm$  standard deviation. Since it was an observational study so no test of significance were applied.

### **RESULTS**

Mean age of study patients was  $52.7 \pm 9.9$  years, mean height was  $167.22 \pm 6.4$  Cm and mean weight was  $76.3 \pm 9$  Kg. Out of 70 patients 57(81.4%) were males and 13(18.6) were females. Regarding coronary artery risk factors 22(31.4%) were diabetic, 39(55.7%) hypertensive, 34(48.6%) smokers, 17(24.3%) with family history of ischemic heart disease and 13(13%) had previous history of ischemic heart disease.

Diseased artery was left anterior descending (LAD) in 32(45.7%), left circumflex (LCX) in 9(12.9%) and right coronary artery (RCA) in 29(41.4%) patients.

Regarding lesion characteristics of CTO, distal vessels were visualized in 56 (80%), antegrade flow was present in 45(64.3%), retrograde flow in 25(35.7%) and calcification was present in



9(12.9%).

In PCI of RCA lesions JR Guider was used and in left system cases XB 3 Guider was used. Predictors of successful PCI i.e. stump shape was tapering in 46(65.7%) and flat in 24(34.3%). Table 3. Collaterals were found in 36(51.4%), bridging collaterals were present in 13(18.6%), side branch within 2 mm of site of occlusion was observed in 42(60%) patients. Length of lesion was <10mm in 4(5.7%), 10-20mm in 30(42.9%) and >20mm in 36 (51.4%) patients. Guide wire crossed the lesion with balloon support in 54(77%). TIMI III flow was achieved in 54(77%) and technical success was 54(77%), residual stenosis of >30% was observed in 16(22.9%). Table 4.

**DISCUSSION**

In the current study the procedural success rate

**Table 1. Baseline characteristics**

LAD=Left anterior descending; LCX=Left circumflex; RCA=Right coronary artery

**Table 2. Angiographic lesion characteristics of CTO**

VARIABLES	NUMBERS (PERCENTAGES) (n=70)
Distal vessels visualized	56 (80%)
Antegrade flow	45(64.3%)
Retrograde flow	25(35.7%)
Calcification	9(12.9%)

**Table 3. Predictors of successful PCI.**

**Table 4. Procedural characteristics**

was 77%. The success rate of PCI was higher than the success rates reported in the meta-analyses (53-68%)<sup>9</sup> but similar to the 70-75% reported by a few authors,<sup>10-13</sup> probably because the proportion of late chronic lesions was high in the present study. Puma et al<sup>14</sup> in their meta-analysis, reported that chronicity is the most important factor in predicting successful intervention and that the success rate in late chronic occlusion was significantly lower than that in early chronic occlusion.

In our study, the factors affecting the success of transradial PCI for CTO were also similar to these previous reports. Although the success of a CTO intervention might be dependent on experience of operator, the lesion type, and indications for intervention, the devices used for the procedure are critically important to the outcome, particularly in the case of transradial intervention. When the radial approach for CTO intervention is attempted, availability of sufficient guiding support becomes a major concern since it is generally not feasible to use a guiding catheter larger than 7 Fr. Accordingly, transfemoral coronary intervention is often preferred over transradial PCI for CTO because 7 or 8 Fr guiding catheters may be used to obtain greater back-up support, as compared to the 6 Fr guiding catheters frequently used in the



transradial approach. However, because catheter materials have improved a great deal, and because special curvature is available to increase support, we were able to achieve sufficient guiding support with a 6 Fr guiding catheter in most cases.

In this study, the selection of guiding catheters was based on the lesion characteristics and the radial artery size. A 6 Fr guiding catheter was most frequently used. The type of guiding catheters used for CTO was similar to those needed for transradial PCI for other coronary lesions. In our study, transradial PCI for a CTO lesion was possible using XB 3.0 guiding catheters in 58.6% when the lesion was in the left coronary artery and in 41.4% Judkins right guiding catheter was used for lesions in the right coronary artery. The Judkins right guiding catheter was used less often, compared with the results reported by Lotan et al<sup>15</sup> who reported that Judkins (JL) guiding catheters were used in 49% of cases for the left coronary artery, while Judkins (JR) guiding catheters were used in 57% of cases for the right coronary artery in transradial PCI.

Kim et al<sup>16</sup> evaluated the feasibility of the transradial coronary intervention (TRCI) in 85 consecutive patients with CTO. Clinical, angiographic and procedural factors were compared between the success and failure groups. An overall success rate of 65.5% (57 of 87 lesions) was achieved with TRCI, and the most common cause of failure was an inability to pass the lesion with a guidewire. A multivariate analysis demonstrated that the most significant predictor of failure was the duration of occlusion. The procedural success rate improved with use of new-generation hydrophilic guidewires. The 6 Fr guiding catheters were used in the majority of the 70 cases (81%). Five cases were crossed over to a femoral artery approach due to engagement failure of the guiding catheter into the coronary ostium because of severe subclavian tortuosity and stenosis in two cases, radial artery looping in one case, and poor guiding support in two cases. There were no major entry site complications.<sup>17</sup>

Park et al<sup>18</sup> reported 195 patients having total occlusion lesions. Percutaneous coronary interventions were attempted in 136 total occlusion lesions in 134 patients. Successful recanalization with stent implantation was accomplished in 89 lesions, with a procedural success rate of 66.4%. One procedure-related death occurred because of no-reflow phenomenon. After excluding 8 patients with bundle branch block, Q and T wave

inversions were observed in 60 (32.1%) and 78 patients (41.7%), respectively. The presence of Q waves was associated with severe angina, decreased left ventricular ejection fraction, regional wall motion abnormality, and T wave inversion, but was not related to procedural success. Percutaneous coronary intervention is a safe and useful procedure for the revascularization of coronary chronic total occlusion lesions. The procedural success rate was not related to the presence of pathologic Q waves, which were associated with severe angina and decreased left ventricular function.<sup>18</sup>

Hoye et al<sup>18</sup> reported a total of 874 consecutive patients treated for 885 CTO lesions. Mean follow-up time was 4.47±2.69 years. Patients were evaluated for the occurrence of major adverse cardiac events (MACE) comprising death, acute myocardial infarction, and need for repeat revascularization with either coronary artery bypass surgery or PCI. Successful revascularization was achieved in 576 lesions (65.1%), in which stent implantation was used in 81%. At day 30, the overall MACE rate was significantly lower in those patients with a successful recanalization. At 5 years, survival was significantly higher in those patients with a successful revascularization. In addition, there was a significantly higher survival free of MACE, with the majority of events reflecting the need for repeat intervention. Independent predictors for survival were successful revascularization, lower age, and the absence of diabetes mellitus and multivessel disease. Authors<sup>18</sup> concluded that successful percutaneous revascularization of a CTO leads to a significantly improved survival rate and a reduction in major adverse events at 5 years. Most events relate to the need for repeat reintervention, and the introduction of drug-eluting stents, with low-restenosis rates, encourage the development of technologies to improve recanalization success rates. However, failed recanalization may be associated acutely with an adverse event, and new technologies must focus on a safe approach to successful recanalization.

## CONCLUSION

Percutaneous coronary intervention is a safe and useful procedure for the revascularization of coronary chronic total occlusions. Further more the radial artery might be a feasible vascular route in coronary interventions for CTO, with comparable procedural success and no access site complications.



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