

The Suitability of Percutaneous Transradial Coronary Intervention for Chronic Total Occlusion (CTO) – An Experience at PIC

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Abstract

Background: Intervention of chronic total coronary artery occlusion is quite challenging. The usual vascular route used in PCI for CTO in most cardiac catheterization laboratories is through femoral artery. In this study we evaluated the feasibility of transradial coronary intervention in CTO.

Study Design: Interventional descriptive study.

Place and Duration of Study: Department of cardiac catheterization and interventional cardiology of Punjab

Institute of Cardiology, Lahore from July 2007 to January 2009.

Methods: We examined 170 lesions in patients with positive Allen's test. Patients with negative Allen's test and chronic renal failure patients on dialysis were excluded. Chronic total occlusion (CTO) were divided into early (< 3 months) and late (> 3 months) occlusions. Transradial PCI was performed via right radial artery with 6Fr arterial sheath and 7500 to 10,000 IU of heparin was administered during procedure. Statistical analysis was performed using SPSS 12.0 and different variables were expressed in frequencies or percentages and groups were assessed by student's t-test. p-value of < 0.005 was considered significant.

Results: The baseline clinical characteristics of 170 cases in success and failure groups were compared with no significant differences in coronary artery disease risk factors. The clinical diagnosis was unstable angina in 68 (40%), stable angina in 52 (30.6%) and other presentations like heart failure in 50 (29.4%) cases. The site of occlusion was left anterior descending in 89 (52.35%), right coronary artery in 61 (35.88%) and left circumflex in 20 (11.76%) cases. The duration of chronic occlusion was 1.5 ± 1 month in success group and 3.5 ± 3 months in failure group, showing significantly longer duration in failure group ($p < 0.01$). The success rate of transradial PCI was approximately 68.23% (116 of 170 cases). The lesion characteristics that correlated with successful PCI included lack of side branches, bridging collaterals,

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tapered occlusion and occlusion of less than 15mm. The main cause of failure was failure to pass guide wire in 44 (81.48%). In 10 cases, PCI was crossed over to femoral artery due to poor guiding catheter support, subclavian / radial artery tortuosity. Procedure related complications occurred in 6 cases with coronary artery dissection in 4 cases and perforation in 2 cases.

Conclusion: The transradial approach is suitable vascular route in coronary interventions for CTO with the use of newer PCI equipments.

Key words: Coronary artery intervention, chronic total occlusion, arterial access.

Introduction

The femoral artery is the usual vascular route used in PCI for CTO in most cardiac catheterization laboratories. However, when the femoral artery is used as the approaching vessel, local hemorrhage is a common complication.¹ The indications for transradial PCI are expanding due to the miniaturization of devices used, improvements in devices and techniques, and accumulated experience in transradial approach. There has been growing interest in transradial PCI because of decreased complications at the puncture site, patient convenience, earlier discharge.^{2,3}

Percutaneous coronary intervention for chronic total occlusions has been limited due to a low success rate and a high restenosis rate. The complication rate of PCI is low and the success rate has increased in recent years due to improved procedural techniques and devices.^{4,5} Successful recanalization improves clinical symptoms and cardiac function and increases the long – term survival in CTO.^{1,6,7}

Therefore, we evaluated the suitability of transradial coronary intervention in CTO by reviewing the success rate, selection of devices, such as guiding catheters and guide wires, and complications in patients with CTO.

Materials and Methods

A total number of 170 consecutive lesions were analysed who presented in the out patients department of Punjab Institute of Cardiology. All the patients had positive Allens test¹¹ who underwent PCI for CTO from July 2007 to January 2009. The patients with

negative Allens test and chronic renal failure patients requiring hemodialysis in future were excluded from the study.

A CTO was defined as a lesion exhibiting a Thrombolysis in Myocardial Infarction (TIMI) flow grade of 0-1 in a native coronary artery, with a duration of occlusion of more than one month.⁸ Determination of age of CTO was done by using clinical information, such as past history of myocardial infarction, pattern of chest pain or findings of total occlusion from previous coronary angiogram.

Early chronic total occlusion was defined as total occlusion of a one to three month duration while late chronic total occlusion was defined as total occlusion with a duration longer than three months.⁸ The lesion characteristics at the site of occlusion were classified as tapered or abrupt flat end.⁹ The length of occlusion was measured from the occlusion to the distal portion of vessel filled by collateral flow or by the length of stenosis seen after passing the wire or predilated balloon catheter.¹⁰

The success of transradial PCI was defined as completion of the procedure via radial approach without cross over to femoral approach without significant residual stenosis or major cardiovascular complications like dissection, perforation etc.

Transradial PCI

PCI was performed via right radial artery. The 6 French arterial sheath was selected. All patients received 7500 – 10000 U intra venous heparin according to body weight. The CTO lesion was approached with a 1.5 – 2.0 mm balloon over 0.014 flexible guide wires. If the flexible guide wire was unable to cross the lesion, the guide wire was changed to hydrophilic wire or more stiffer wires like cross IT100 XT (Guidant).

The procedure was terminated if more than 400 ml of contrast was used, if the guidewire was placed in false lumen, or if the procedure time exceeded one hour. The arterial sheath was removed two hours after the procedure and a compression dressing with a gauze was placed at the punctured site.

Statistical analysis was performed, using the SPSS 12 statistical program. Different variables were expressed in frequencies or percentages and groups were assessed by student's t-test.

Results

The baseline and angiographic characteristics of 170 cases in the success and in the failure groups are listed in table 1. No significant difference was noticed in coronary risk factors like diabetes, hypertension, smoking, or low density lipoprotein cholesterol between the two groups.

The clinical diagnosis was unstable angina in 68 (40%) cases, heart failure in 50 (29.4%) and stable angina in 52 (30.6%) cases.

The duration of chronic total occlusion was 1.5 ± 1.0 months in success group and 3.5 ± 3.0 months in the failure group, showing a longer duration in the failure group ($p < 0.01$). Success was seen in 53 of the 63 cases (84.14%) with the early chronic total occlusion and in 63 of the 107 cases (58.9%) with the late chronic total occlusion showing a significant difference ($p 0.017$) as shown in table 2 and 3.

Single vessel disease was present in 82 (48.23%) cases and multi-vessel disease was present in 89 (52.35%) cases. There was total occlusion in 89 (52.35%) cases in LAD, 61 (35.88%) in RCA and in 20 (11.76%) in LCx.

Outcomes of Transradial PCI

PCI was performed on OPD basis with 170 cases approached through right radial artery. The success

rate of transradial PCI was 68.23% (116 of 170 cases). The procedure was unsuccessful in 54 cases (31.76%). The causes of failure were to pass the guide wire through the lesion in 44 cases (81.48%), failure of balloon to pass the lesion in 2 case (3.7%), failure due to poor guider support in 4 cases (7.4%), failure to pass the catheter due to radial artery spasm or subclavian artery tortuosity or loops of radial artery in 4 cases (7.4%). Due to radial artery spasm, tortuosity and bad guiding catheter support the PCI was crossed over to femoral artery approach in 10 cases (5.9%).

The lesion characteristics associated with procedural success were lack of side branches, absence of bridging collaterals, occlusion of less than 15 mm and tapered occlusion end. The 6 French guiding catheters were used in all the cases. The average number of the guiding catheters used per case was 1.2 ± 0.5 and approximately 134 (78.82%) procedures were done using initially selected guiding catheters. When there was lesion in LAD or circumflex; XB (Extra backup) catheter in 98 cases, Judkins in 11 cases were used. When the target lesion was in RCA; Judkins was used in 53 cases and Amplatzer right or left in 8 cases.

The average number of guidewires used was 1.5 ± 0.6 . Most commonly BMW guide wire (Abbott) in 95 cases (55.88%) followed by hydrophilic Pilot – 50, Whisper MS (Guidant) in 41 cases (24.11%) and Cross – IT 100 XT in 34 cases (20%) were used as final attempting wire.

Table 1: Clinical Characteristics of the Transradial PCI Success and Failure Groups.

	Transradial PCI success (n = 116)	Transradial PCI failure (n = 54)
Age (yr)	51.3 ± 9.3	59.2 ± 11.3
Male (%)	70 (60.3)	43 (79.6)
Hypertension (%)	76 (65.51)	35 (64.81)
DM (%)	35 (30.1)	25 (46.29)
Previous MI (%)	30 (25.78)	18 (33.33)
Smoker (%)	55 (47.41)	24 (44.44)
Duration of CTO (Mo)		
Early chronic (< 3)	53	10
Late chronic (≥ 3)	63	44
Clinical diagnosis (%)		
Unstable angina	58 (50)	10 (18.51)
Stable angina	32 (27.58)	20 (37)
Heart failure	26 (22.41)	24 (44.44)

Procedure related complications occurred in six cases (3.5%) with coronary perforation in two cases and coronary artery dissection in four cases. There were no deaths or significant local vascular complications.

Discussion

In transradial coronary intervention, the success of a CTO depends on experience, type of lesion, indications for intervention and the devices used for the procedure. These all are critically important to the outcome of the procedure.

Successful transradial PCI was achieved in 116 of 170 cases (68.23%) and, in 10 cases, the catheters were crossed over to the femoral artery due to radial or subclavian arteries tortuosity. The success rate of transradial PCI was similar to the success rates reported in the meta – analysis (53 – 68%).¹¹

Puma et al.,⁸ in their meta analysis, reported that chronicity is the most important factor in successful intervention. The success rate in late chronic occlusion was significantly lower (37%) than that in early chronic total occlusion (75%) which was also observed in this study.

Different factors which can effect success rate of chronic total occlusion includes presence or absence of side branches, bridging collaterals, occlusion length and occlusive morphology.^{8,9}

In transradial PCI for chronic total occlusion, the availability of good guiding catheter support becomes a major concern as the use of 7 Fr guiding catheters through radial approach is usually not feasible.

Transfemoral approach is often preferred over transradial approach in CTO intervention because of better guiding catheter support even with 6 Fr guiding catheters. However, because the catheter materials have improved a great deal these days, and because special curvatures are available to increase support, it is possible to gain good guiding catheter support even with 6 Fr catheters through radial approach.

Table 2: Angiographic Characteristics.

	Transradial PCI success (n = 116)	Transradial PCI failure (n = 54)
Multivessel disease	59 (50.86)	30 (55.55)
Target lesion (%)		
LAD	59 (50.86)	30 (55.55)
LCx	13 (11.2)	7 (12.96)
RCA	44 (37.93)	17 (31.48)
Lesion location (%)		
Proximal	70 (60.34)	24 (44.44)
Mid to distal	46 (39.65)	30 (55.55)
Occlusion morphology (%)		
Tapered	80 (68.96)	24 (44.44)
Abrupt	36 (32.41)	30 (55.55)
Bridging collateral (%)	24 (20.68)	42 (77.77)
Calcification (%)	18 (15.51)	18 (33)
Side branch at CTO (%)	24 (20.68)	23 (42.59)
Lesion length (%)		
≤ 15 mm	60 (51.72)	15 (27.8)
> 15 mm	56 (48.27)	39 (72.2)

Table 3: Procedural Characteristics of early and late CTO.

	Early CTO (n = 63)	Late CTO (n = 107)	P
Final wire (%)			
BMW	55 (87.3)	40 (37.38)	0.03
Hydrophilic wire	5 (7.9)	36 (33.64)	
Cross IT	3 (4.76)	31 (28.97)	
Balloon support	21 (33.33)	68 (63.55)	0.25
Procedural complication (%)	0 (0)	6 (5.6)	0.40
Total procedure time (min)	21 ± 19	37 ± 18	0.98
Total dye volume (mL)	135 ± 95	240 ± 87	0.85
Success rate (%)	53 (84.12)	63 (58.87)	0.01

Ikari et al. reported that due to availability of special guiding catheters it is possible to have better back-up force in both transradial and trans femoral approaches.¹² Some operators have used the technique of deep intubation to achieve greater back-up support.¹³

In our study, the selection of guiding catheters was dependent on the characteristics of lesion and its

duration. A 6 Fr guiding catheter was most frequently used. Transradial PCI for chronic total occlusion was possible with 6Fr XB guiding catheter when left coronary system was involved while 6 Fr Judkins right guiding catheter was mostly used in interventions needed for right coronary system. Loten et al, reported that judkins right and left catheters were most often used for chronic total occlusion intervention in his study.³ The difference in the use of left guiding catheter in our study may be due to the need for better catheter curve that could give sufficient backup support when performing PCI for CTO lesions. Amplatz guiding catheters are excellent alternatives when better guiding catheter support is needed especially while doing right coronary interventions.

The reasons for improved success in the CTO intervention may be due to technical advances like special guiding curves and more common use of hydrophilic wires. Guide wire selection has been modified over the time. During late chronic total occlusions, second generation guide wires were more frequently used.¹⁴

Srivasta et al.¹⁵ observed that newer occlusions are softer lipid laden, whereas older occlusions are harder and fibrocalcific. Therefore, older lesions are less favourable to cross with guide wires. This is the reason why new generation wires are frequently used in these interventions.

Lafevre et al.¹⁶ reported that with the recent use of stiffer hydrophilic guide wires the success rate of transradial PCI for CTO has improved. He used pilot – 50, whisper wire and cross IT 100XT. It is advisable to choose new generation of guide wires actively to decrease the failure rate of CTO intervention. Different new strategies have been applied in the intervention of CTO like laser guide wires, ball ended guide wires and optical coherent reflectometry. These strategies have been used successfully even in patients who have received thrombolytic therapy.¹⁷⁻²⁰

Complications during intervention of CTO occurred in only six patients. No Q wave myocardial infarction or death occurred. Suero et al.¹ reported the rate of complications to be 3.8% nearly the same as in our study. The rate of complications during hospitalization is quite low as in present study.

The main limitation of this study is its observational nature and further randomized control study is required. There was also lack of follow up in this study.

Despite these limitations of the study, transradial

approach for CTO intervention is quite suitable with comparable procedural success.

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