

SUCCESS RATE OF PERCUTANEOUS CORONARY INTERVENTION IN PATIENTS WITH CHRONIC TOTAL OCCLUSION OF CORONARY ARTERIES

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Abstract

BACKGROUND: Chronic total occlusion of coronary arteries (CTO) remains one of the most challenging lesion subsets in interventional cardiology even with the development of medical devices and operator expertise. This study sought to determine the overall success rate of percutaneous coronary intervention (PCI) for this lesion in the center and to examine the relationship between variables such as patients' characteristics, clinical risk factors, lesion characteristics and procedural success rate.

METHODS: Clinical and coronary angiographic data of 58 patients with CTO who underwent PCI between May 2004 and November 2006 in Ghaem Hospital were retrospectively analyzed. A P value of less than 0.05 was considered statistically significant. Analyses were performed using the software packages SPSS (11.5 version).

RESULTS: In this study, there were 58 CTO lesions in 41 men (70.7%) and 17 women (29.3%) with a mean occlusion time of 5 months.

The overall success rate of PCI was 77.6%. There was no significant correlation between the success rate of PCI and the patient's age, sex, clinical risk factors, history of recent MI and duration of occlusion ($P > 0.05$). The success rate was not affected by target vessel, location of lesion, presence of stump, presence of side branch at the site of occlusion and TIMI flow of artery ($P > 0.05$). The success rate of PCI was decreased with increase in the length of occlusion and presence of bridging collaterals ($P < 0.05$).

CONCLUSION: The length of occlusion and presence of bridging collaterals affected the success rate adversely. Whereas the patients' characteristics, clinical risk factors and other characteristics of coronary artery lesion had no statistically significant effect on success rate of PCI. Despite the technical difficulty of PCI in CTO lesions, this procedure can be done safely with relatively high success rate.

Keywords: Chronic total occlusion (CTO), percutaneous coronary intervention (PCI), coronary arteries.

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Introduction

Approximately 30-50% of patients with coronary artery disease are shown to have at least one occluded artery through angiography, but only 7-15% of chronic total occlusions are treated by percutaneous coronary intervention.^{1,2} The 'bypass angioplasty investigation' studies have indicated that the presence of CTO is the most important factor when selecting bypass as the choice of coronary vascular

reconstruction.³ Although the most important factor in procedural failure is the inability to cross the occlusion with the guide wire and to reach the distal true lumen end, other factors may prevent balloon cross and final recanalization.^{4,5} However, there is an increasing body of evidence showing that successful revascularization of occluded coronary vessels subtending viable myocardium is associated with survival enhancement, improvement of left ventricular

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function and quality of life.⁶ More recently, new guide wires, techniques and specific devices have led to a higher procedural success rate, and nowadays recanalization may be achieved in 70-80% of cases in the hand of expert operator.⁷

This study aimed to determine the success rate of percutaneous coronary intervention for chronic total occlusion of coronary arteries in our center and to examine the relationship between variables such as patients' characteristics, clinical risk factors, lesion characteristics and success rate of procedure.

Materials and Methods

In this observational study, clinical and coronary angiography data of 58 patients with CTO who underwent PCI between May 2004 and November 2006 in a single center were retrospectively analyzed.

Patients with total occlusion of more than 3 months, estimated from clinical events including MI, sudden onset or worsening of the symptoms or previous angiography were included. The indication for PCI treatment of CTO was the demonstration of viable myocardium in the territory of the occluded vessel by echography or scintigraphic provocative tests.

Exclusion criteria were as following; estimated duration of occlusion less than 3 months, chronic total occlusion of bypass vessels, general contraindication of PCI.

The clinical data were collected using the patients' profiles and angiographic data by observation of their films.

This data were classified based on patients age, sex, clinical risk factors, history of MI, duration of occlusion and angiographic data including the lengths of occlusion, presence or absence of stump, bridging collateral, presence of side branch at the site of occlusion, type of affected artery, location of lesions and TIMI flow 0 or 1.

Definitions

1- Total occlusion: Abrupt termination of the epicardial vessel with TIMI flow 0 or 1.

2- Chronic total occlusion (CTO): total occlusion more than 3 months estimate from clinical events including MI, sudden onset or worsening of the symptoms or proven by previous angiography.

3- Stump or nipple: Is located just before the occluded segment and can guide the advancement of guide wire.

4- Ostial location: lesion within 3mm of vessel origin. Successful procedure: post procedural residual stenosis of less than 30%.

Before patients' selection for PCI, the procedural cost and effectiveness, probable risks and complications were explained for patients.

All procedures were performed according to current standard. The patients admitted to the hospital on day or a day before intervention.

All patients received either long term or a loading dose of 250-500mg aspirin that continued with 160-250mg daily. A loading dose of 450-600 mg clopidogrel (unless patients were already pretreated) was administered optimally 48 hours before procedure, followed by 75mg daily for one month in bare metal stent implantation and 9-12 months in patients with drug-eluting stent insertion.

Alternatively, ticlopidin therapy, with a dose of 250 mg twice daily, was begun 3 days before procedure and continued for one month in patients with bare metal stent implantation.

A bolus dose of 5000 to 10000 units unfractionated heparin was injected during procedure and followed by intravenous infusion of 700-1000 units per hour for 12 to 18 hours after procedure.

All PCI procedures were performed using standard femoral approach.

In our study, we used 6-7 fr. Guiding catheters, most commonly right judkins for right coronary artery and left judkins for LAD and LCX arteries. Occasionally left Amplat's guiding catheter was used in some patients. Bilateral coronary angiography via the two femoral arteries has been performed when the distal vessel was mainly filled by retrograde collaterals to identify entry point, vessel path-way, exit point and distal true lumen, if necessary in some patients. Lesion length was assessed from the beginning of the occlusion to distal antegradely filling from bridge collateral or retrogradely filling from collaterals provided by a coronary artery other than the CTO vessel.

Both hydrophilic coated and stiff guide wires were used and selection of guide wires was based on lesion characteristics of CTO.

The balloon catheters with smallest profile were always used at the initial predilation and stent implantation was performed for all patients with successful procedure.

Data are expressed as mean \pm standard deviation (SD) for continuous variables. Categorical variables were compared by X² test. A Student's t-test was used to test differences among continuous variables.

A P value of less than 0.05 was considered statistically significant. Analyses were performed using the software packages SPSS (11.5 version).

Results

Table 1 shows the patients clinical characteristics. In this study, total number of patients who underwent PCI for chronic total occlusion was 58. Of these 41 patients were male (17.7%) and 17 cases were female (29.3%). The mean age of patients was 52.28 years. 10 patients (17%) had diabetes mellitus, 14 patients (24%) were hypertensive, 23 cases had hyperlipidemia (39%) and the same numbers (23) were smokers (39%). seven cases had no CAD risk factors (12%). 32 patients had a history of previous MI (55%). Duration of CTO ranged from 3-36 months and averaged 5 months. The target vessel was left anterior descending (LAD) coronary artery in 28 patients (48.2%) and left circumflex (LCX) and obtus marginal (OM) in 11(18.9%).¹⁹ patients (37.2%) had CTO in right coronary artery.

Location of the CTO lesion was ostial in 3 patients, proximal in 30 (51.7%), midportion in 17 (29.3%), and distal in 8 (13.8%). Mean length of the occluded segments was 22.14 mm \pm 5.4. Table 2 summarized the angiographic characteristics of these patients.

TIMI flow was 1 in 26 patients (44.8%) and 0 in 32(55.2%). Side branch was present at occluded segment in 45 patients (77.6%). There was stump in 39 patients (67.2%) and bridging collaterals was seen in only 6 patients (10.3%).

PCI was done in 41 of 58 patients successfully (77.6%). The most common cause of procedural failure was inability of guide wire crossing through the totally occluded segments in 14 patients (82.3%) and balloon catheter in 3 cases (17.7%).

There was no significant correlation between the patients sex, age and success rate of PCI.

Also there was no significant correlation between presence of diabetes mellitus, hypertension, hyperlipidemia, smoking and history of previous MI in these patients and success rate of PCI.

The most success rate of PCI was on LAD (89.3%) and the least success rate was on LCX-OM (63.6%). However, there was no statistically significant difference between them (P = 0.10).

The mean length of occlusion was 21.2 \pm 5.4mm in successful procedure group in comparison with 25.3 \pm 3.7 mm in unsuccessful cases. This difference was statistically significant (P < 0.05).

There was PCI success rate of 16.7% in patients with bridging collateral versus 84.6% in cases without

it .This finding showed a significant correlation between absence of bridging collateral and success rate of PCI in these patients (P < 0.05).

88.5% of patients with coronary artery TIMI flow 1 and 68.8% of cases with TIMI flow 0 had successful revascularization with PCI, but this difference wasn't statistically significant (P = 0.07). In this study, no significant relationship found between the CTO location and success rate of PCI.

Success rate of PCI was 76.9% in patients with stump at CTO location and 78.9% of group without stump. This difference is statistically not significant (P = 0.8).

Table 1: Patients' clinical characteristics

	CTO-PCI failure (n = 13)	CTO-PCI success (n = 45)	p- value
Age \pm SD (years)	50.5 \pm 11	52.7 \pm 8	-
Male, N (%)	11(85)	30 (70)	0.2
Hypertension	4(30.1)	13(29.9)	0.11
Hyperlipidemia, N (%)	5(39.9)	18(40)	0.22
Current smoker, N (%)	5(39.9)	18(40)	0.22
Diabetes mellitus, N (%)	4(30.1)	9(20)	0.10
Previous MI, N (%)	8(60.1)	24(53)	0.1

Discussion

In our study, the overall success rate of PCI for chronic total occlusion was 77.6% where as in a study which has been done in Poland included 460 patients with CTO lesions, the success rate was 65%.⁸ Other study which has been carried out on 874 patients between 1992 and 2002, the success rate of PCI was 65.1%.⁹

Other authors reported the success rate of PCI for chronic total occlusion to be in the range of 47 to 69%.¹⁰

Only, in one study which has been done in She-nyang of china and included 1263 patients between 1995 and December 2005, the success rate of PCI was higher than that of our study (88.9% vs.77.6%).¹¹

The most common reason for the recanalization failure of the chronically occluded coronary arteries was the inability to pass a guide wire through the occlusion segment into the distal lumen.

In recent years, there have been significant improvements in wire technology, with the development of several specialized wires dedicated to CTO therapy. In accordance with this, in experienced

Table 2: Patients' angiographic characteristics

	CTO-PCI failure (n = 13)	CTO-PCI success (n = 45)	p-value
Length of occlusion ± SD (mm)	25.3 ± 3.7	21.2 ± 5.4	0.013
Stump, N (%)			
No	4(21.1%)	15(78.9%)	0.8
Yes	9(23.1%)	30(76.9%)	
Bridging collateral, N(%)			
No	8(15.4%)	44(84.6%)	0.001
Yes	5(83.3%)	1(16.7%)	
Side branch, N (%)			
No	4(30.8%)	9(69.2%)	0.4
Yes	9(20.0%)	36(80.0%)	
TIMI flow 0, N (%)	10(31.3%)	22(68.8%)	0.07
TIMI flow 1, N (%)	3(11.5%)	23(88.5%)	

hands, CTO recanalization success rate have also increased, and the presence of the angiographic adverse features; many of which were described more than 10 years ago, should not necessarily deter an attempt to recanalize a CTO percutaneous.¹²

In this study of 49 patients, there were 3 predictors of CTO recanalization failure; presence of a blunt stump as seen on angiography, length of occlusion more than 15mm and the presence of heavy calcification.¹³

In our study, the most common cause of procedural failure was impossibility of guide wire and balloon catheter cross through the totally occluded segments similar to the Poland study which reported that the 92% of procedural failure was due to inability of guide wire advancement through the occlusion.⁸

In Shenyang study, procedural failure was due to inability of crossing total occlusion segment by the guide wire (81%) or balloon (19%).¹¹

In the present study, the success rate was not related to the demographic character of patients (age, sex) and their clinical coronary artery disease risk factors (diabetes, hypertension, hyperlipidemia and smoking). This relation hadn't been assessed in the other studies.

Multiple angiographic features have been suggested to be predictive of percutaneous recanalization failure including a longer length of occlusion, longer duration of occlusion, presence of calcification, presence of bridging collaterals, a blunt versus

tapered stump, presence of side branch at the site of occlusion, and vessel tortuosity.¹⁴⁻¹⁶

In our study, only two independent factors affected success rate of PCI adversely; the lesion length and the presence of bridge collaterals whereas in Poland study, factors that affected adversely the outcome were longer duration of occlusion, TIMI flow grade 0, lengthy occlusion, absence of stump, small wall diameter, presence of bridging collaterals, branching at the site of occlusion and massive calcification.⁸

In Shenyang study, the success rate declined with long duration of occlusion, abrupt missing stump, the presence of bridging collaterals, lesion length more than 15mm, presence of moderate to severe calcification and ostial or distal location of CTO lesions.¹¹

The total number of patients which included in this study was 58, less than the other studies. The second major limitation was the type of study, observational, that might have potentially influenced the analysis of results.

Other limitation of this study was the shorter duration of study than the other (2 years vs. about 19 years).

In this study, the overall success rate of PCI was 77.6%.

So, despite the technical difficulty of PCI in CTO lesion, this procedure can be done safely with relatively high success rate.

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