

Success rate of Percutaneous Coronary Intervention of Chronic Total Occlusion in Ibn Al-Baitar Hospital for cardiac surgery and Al-Nassryia cardiac center

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Abstract

Back ground: Chronic total occlusion (CTO) of coronary arteries remains one of the most challenging lesion subsets in interventional cardiology even with the development of medical devices and operator expertise. Successful revascularization results in improved in angina status ,increased exercise capacity and reduces the need for lat CABG surgery .

Objectives: This study sought to determine the overall procedural success rate of percutaneous coronary intervention (PCI) for CTOs and to examine the relation between variables such as; patients' characteristics, risk factors, lesion characteristics and procedural success rate.

Methods: In this study ,clinical and coronary angiography data of (80) patients with CTO who underwent PCI between May 2009 and May 2010 in Ibn Al-Baitar Hospital for cardiac surgery and Al-Nassryia cardiac center were prospectively analyzed . The clinical data were collected using the patients files and angiographic data by review of their films.

Results: There were (80) Patients with CTO ,They included 62 men (77.5%) and 18 women (22.5%) ,Age range 36-76 year with mean age 55±8.75 and male to female ratio was 3:1 .The procedural success rate of PCI was 66 patients

(82.5%). All 23patients(100%) with lesion length less than 15 mm had successful PCI compared to 43 out of 57 patients in whom the lesion was more than 15mm (75.4%) p value < 0.01. The procedure was successful in 54 patients out of 60 with tapered stump(90%) compared to 12 out of 20 patients with abrupt stump(60%) p value <0.005.In CTO lesion with angulations less than 45 degree ,the procedure was successful in 27 patients out of 28 (96.4%)compared to 39 out of 52 patients in whom the angulations was more than 45 degree 52(75%) p value<0.01. The most common cause of procedural un success was inability of guide wire crossing through the totally occluded segments which represented 11(78.5%), Inability to cross the lesion with a balloon in 2 patients(14.2%) and inability to dilate balloon in one patient (7.1%) P<0.001.

Conclusion: Percutaneous coronary intervention of chronic total occlusion is an effective therapeutic procedure with high success rate 82.5%. The length of chronic total occlusion ,degree of angulations and stump morphology are strong predictors of success procedure.

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

Al – Kindy Col Med J 2012; Vol. 8 No. 1P

Introduction

Over the past 20 years, chronic total occlusion (CTO) lesions have represented the most difficult anatomy for treatment , with lower success rates and higher complication rates.⁽¹⁾ CTO can be found in the third of patients referred for diagnostic invasive coronary angiography⁽²⁾.CTO of the Coronary arteries defined as, "an obstruction of a native coronary artery for more than 30 days with no luminal continuity and with Thrombolysis In Myocardial Infarction (TIMI) and flow grade 0 or 1 which has been present for at least six weeks ^(3,4) .The temporal criterion

used to define a CTO requires the range from >2 weeks to >3 months^(5,6).

Restoration of flow in the CTO is associated with improvement in anginal pain, left ventricular function and long term survival especially in patients with reversible ischemia in the relevant myocardial territory^(8,9,10,11). Newer technology, primarily new wires, has improved the ability to cross these previously uncrossable lesions, thereby improving the acute success rates of opening them. ^(8-12,13). Not surprisingly, the incidence of CTOs seems to increase with patient age, especially in the left anterior

descending (LAD) coronary artery distribution⁽¹⁴⁾.

In Dara et al. study, out of 132 Iraqi patients, the procedural success rate was in 98 patients (79%) and the most common determinant for failure were bridging collaterals⁽¹⁵⁾. The technical probability of achieving successful recanalization of CTO lesions without complications, as well as the anticipated restenosis rate, must be heavily weighed in the decision-making process⁽¹⁶⁾.

This study aimed to determine the success rate of percutaneous coronary intervention for chronic total occlusion of coronary arteries in two cardiac centers and to examine the relation of different variables such as patients' clinical characteristics, conventional risk factors, lesion angiographic characteristics and success rate of procedure.

Methods

In this cross-sectional descriptive study, clinical and coronary angiography data of 80 patients with CTO who underwent PCI between May 2009 and May 2010 in Ibn Al-Baitar Hospital and Al-Nassyeria Cardiac center were prospectively analyzed. Patients with total occlusion of more than 3 months, estimated from clinical events including myocardial infarction (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 and general contraindication of PCI.

The data were collected using the patients' files and angiographic films. This data were classified based on patients' age, sex, clinical risk factors (hypertension, family history of ischemic heart disease, smoking, diabetes

and hyperlipidemia), history of MI and duration of occlusion.

Angiographic data including the lengths of occlusion, presence or absence of stump, bridging collateral, presence of side branch at the site of occlusion, location of lesions, calcification, degree of angulations and TIMI flow grade (0-1).

Definitions of total occlusion: Abrupt termination of the epicardial vessel with TIMI flow grade 0 or 1.

The technical success of the procedure was defined as restoration of TIMI flow grade II or III and myocardial blush grade II or III with a residual stenosis of $\leq 20\%$. Procedural success was defined as technical success without in-hospital major adverse cardiac events (MACE).

All patients received either long-term or a loading dose of 300 mg aspirin that continued with 100 mg daily. A loading dose of 600 mg clopidogrel (unless patients were already pretreated) was administered optimally 48 hours before procedure, followed by 75 mg daily for one month in bare metal stent implantation and 12 months in patients with drug-eluting stent insertion. A bolus dose of 5000 to 10000 units unfractionated heparin was given during procedure. PCI procedures were performed using standard femoral technique, the antegrade approach was the strategy applied to open CTO in all cases. Types of catheters was judged by the interventionist to get the best support for procedure. Operators applied step-up approach using wires of moderately increased stiffness at the beginning with a subsequent shift to wires of greater stiffness. The balloon catheters with smallest profile were always used at the initial predilatation and stent implantation was performed for all successful CTO revascularization with preference for DES when available.

Statistical analysis: All data were coded and entered to the computer by using statistical

package for social science (SPSS 14). Summarizing of data done by using No. ,% ,and Mean+ S.D. Association between different variables measured by using Chi-Square tests. $P < 0.05$ consider as a level of significant

Results

There were (80) Patients with CTO ,They included 62 men and 18 women, and male to female ratio was 3:1 .Table (1) shows, Patients with successful PCI were 66(82.5%) when compared to 14 patients(17.5%) with un successful PCI .Success rate found to be higher in female 18 (100%) in comparison to male 48(77.4%). This difference found to be statistically significant ($p=0.032$). In table (2) , The age range in this study between 36-76 with a mean \pm SD (55.95 ± 8.70) . There was no significant difference between the success rate of PCI and patients Age, Diabetes mellitus, Hypertension, Hyperlipidemia, Smoking, family history of ischemic heart diseases, clinical presentation, and History of previous MI.

Comparison between success and failure groups regarding angiographic characteristics in table (3) shows, Success rate was 23(100%) in CTOs lesions of less than 15 mm in length , while the success rate in CTO lesion of more than 15 mm was 43 (75.4%). Tapered stump morphology represented 54(90%)in the success group, while abrupt stump represented 12(60%). There was procedural success rate of 27(96.4%)in patients with angulations less than 45 degree versus 39(75%)in cases with angulations more than 45 degree .The unsuccess procedure in CTO lesions with angulations more than 45 degree and angulations less than 45 degree were 13(25%),1(7%) ;respectively .All These results statistically significantly ($p < 0.01$) . There were no

significant differences in the proportions of side branch just proximal to the CTO, calcification , TIMI flow ,duration of CTO and bridging collaterals between the success group and un success group .

The success rate was higher in patients with multi vessel disease than patients with single vessel disease 31(86%) vs. 35(75.5%). 375ml as median of contrast media has been used in both groups and the median of Fluoroscopic time in success group was 24 minutes while the median time was 29 minute in failure group. All results statistically not significant found in table (4). The median of stent length in CTO-PCI success group was 23 mm. All implanted stents were bare metal stents. In 66 patients (100%) of the success group, one stent ore two stents were implanted.. These finding showed a significant correlation ($P=0.05$).

Regarding causes of failure shows in figure I , The most common cause of procedural un success group was inability of guide wire crossing through the totally occluded segments which represented 11(78.5%) . Other cause of PCI failure were Inability to cross the lesion with a balloon in 2 patients(14.2%) and inability to dilate balloon in one patient (7.1%).All these results statistically significant($P < 0.001$) . The Hemodynamic complications in this study shows, Minimal complications occurred in the success group, In the failure group, coronary perforation occurred in two patients, dissection occurred in one patient and no reflow was more frequent when compared with success group (71.5% and 0% respectively). All these results statistically significant ($p < 0.05$) except for dissection, there was no significant association.

Table (1) Distribution of procedural success rate according to gender

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Gender	Success group No.(%)	Un success group No. (%)	Total No. (%)	P value
Male	48(77.4)	14(22.6)	62(100)	0.032
Female	18(100)	0	18(100)	
Total	66(82.5)	14(17.5)	80(100)	

*NS= Not significant

**One patient might have more than one clinical data

Table(2) clinical characteristics of patients with Chronic Total Coronary Occlusions .

Clinical Variables	CTO-PCI success NO(%)	CTO-PCI failure NO(%)	CTO-PCI total NO(%)	P value
Age(yrs ,mean \pm SD)	55.78 \pm 8.78	56.71 \pm 8.57	55.95 \pm 8.70	
Hypertension	47(82.4)	10(17.6)	57(100)	NS*
Diabetes mellitus (DM)	31(83.7)	6(16.3)	37(100)	NS
Family history of CAD	8(100)	0(0)	8(100)	NS
Hyperlipidemia	11(100)	0(0)	11(100)	NS
Prior MI	23(82.1)	5(17.9)	28(100)	NS
Smoking Active Ex-smoker	53(80.3) 5(83.3)	13(19.7) 1(16.7)	66(100) 6(100)	NS
Stable angina	13(81.2)	3(18.8)	16(100)	NS
Unstable angina	53(82.8)	11(17.2)	64(100)	NS
Total	66(100)**	14(100)	80(100)	

Table (3) Angiographic analysis of CTO Characteristics Relevant to Technical Success.

Variables	Success Group No.(%)	Un success Group No.(%)	Total No.(%)	P Value
Target vessel				
LAD	39(79.5)	10(20.5)	49(100)	0.17
RCA	16(80)	4(20)	20(100)	
LCX	11(100)	0(0)	11(100)	
Duration (months)				
Determinable>3	32(80)	8(20)	40(100)	0.61
Un determinable	34(89.4)	6(10.6)	38(100)	
Length (mm)				
>15	43(75.4)	14(24.6)	57(100)	0.01
<15	23(100)	0(0)	23(100)	
TIMI flow				
Grad 0	46(82.1)	10(17.9)	56(100)	0.5
Grad 1	20(83.3)	4(16.7)	24(100)	

Calcification, Present Absent	14(70) 52(86.6)	6(30) 8(15.4)	20(100) 60(100)	0.09
Stump morphology Abrupt Tapered	12(60) 54(90)	8(40) 6(10)	20(100) 60(100)	0.005
Sid branch from stump Present Absent	16(72.7) 50(86.2)	6(27.3) 8(13.8)	22(100) 58(100)	0.13
Angulations >45 <45	39(75) 27(96.4)	13(25) 1(3.6)	52(100) 28(100)	0.01
Bridge collateral Present Absent	15(75) 51(85)	5(25) 9(15)	20(100) 60(100)	0.2

Table (4) procedural characteristics in the two studied groups

Variables	CTO-PCI Success(66)	CTO-PCI failure(14)	Total (80)	P value
Single vessel disease NO(%)	35(79.5)	9(20.5)	44(100)	0.5
Multi vessels disease NO(%)	31(86.1)	5(15.9)	36(100)	0.4
Fluoroscopic time(min);median	24(15-39)	29(19-30)		
Contrast use(ml);median	375(200-500)	375(200-500)		
CTO-stent length(mm),median	23(13-33)			
No stent	0(0)	14(100)	14(100)	0.05
Stent(one or/and two)	66(100)	0(0)	66(100)	

Table 5. Comparison between both groups as regards hemodynamic complications

complication	Success CTO(n=66)	Failure CTO (n=14)	Total (n=80)	P value
Coronary perforation				
Yes	0	2(14.3%)	2 (2.5%)	0.029
No	66(100%)	12(85.7%)	78(97.5%)	
No reflow				
Yes	0	10(71.5%)	10(12.5%)	0.0001
No	66(100%)	4 (28.5%)	70 (87.5%)	
Dissection				
Yes	1 (1.5%)	1 (7.14%)	2 (2.5%)	0.3
No	65(98.5%)	13(92.9%)	78 (97.5%)	

Discussion

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 undergo diagnostic coronary arteriography.⁽¹⁷⁾ Regarding the success rate of our study, It was 82.5% while it was 88.9%, 82.2%, 79% in In HAN Ya-Ling et al ,Sheriff et al and Dara et al respectively^(15,18,20), Other authors reported the success rate of PCI for chronic total occlusion to be in the range of 47 to 69 %.⁽¹⁹⁾, So our result was comparable to other results and the slight difference might be due to selection of patients , availability of materials and operator experiences . In the current study and other studies derived by Olivari et al,Abbott et al and Invanhoe et al^(21,22,23), There was no significant difference in the baseline clinical characteristics between patients who did or did not have successful procedure. 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.^(24,25,26) In this study, the characteristics that had a significant association with technical outcome were the length of CTO, degree of angulations and stump morphology. No other characteristic features was found to be correlated significantly with PCI outcome.

Most prior studies as *Barlis et al*, *Olivari et al* and *Stone et al* have consistently reported that increasing age of the occlusion, ostial occlusion, greater lesion length, presence of a non-tapered stump, origin of a side branch at the occlusion site, excessive vessel and lesion tortuosity, calcification and lack of visibility of the distal vessel course negatively affect the ability to successfully cross a CTO^(17,21,27). Intracoronary bridge collateral was the most important determinant of successful PCI of chronic total occlusion in Dara et al study⁽¹⁵⁾ In one study, only two independent factors affected success rate of PCI adversely; the lesion length and the presence of bridge collaterals⁽²⁸⁾ whereas in Poland study, factors that affected adversely the outcome were longer duration of occlusion, TIMI flow grade 0, length occlusion, absence of stump, presence of bridging collaterals, branching at the site of occlusion and massive calcification⁽²⁹⁾.

In our study, Minimal procedural complications occurred in the success group . most of complications occurred in failure group, Perforation was 2.5% ,no reflow 12.5% and dissection 2.5%, in comparison with Sheriff et al study in which *perforation and no reflow were 5.3% ,2.6% respectively* . In *Kinoshita et al* recent large series(65)patients ,long intimal dissection with creation of a false lumen (24%), dye extravasation (11%)⁽³⁰⁾. Parallel wires technique is the best method to locate the true lumen while minimizing the risk of extensive dissection and perforation^(16,31,32)

Reasons of procedural failure in this study were inability to cross the lesion with a guidewire, inability to cross with a balloon and inability to dilate the lesion in 78.5%, 14.2% and 7.1% respectively. Sheriff et al was reported 4 patients (57.1%)represented inability to cross the lesion with guidewire ,Two patients (28.6%) inability to cross with balloon and one patient (14.3%)represented inability to dilate the CTO lesion. *Olivari et al* had the same reasons of failure with 81%, 11.4% and 7.6% respectively⁽²¹⁾. Failure to pass the wire is the most common cause of procedural failure as concluded in this study as well as other studies. Parallel wires technique is the best method to locate the true lumen while minimizing the risk of extensive dissection and perforation^(16,31,32). One of the major limitation of this study, It was observational, that might have potentially influenced the analysis of results. Other limitation of current study was the shorter duration in compare with others .

Conclusions

Percutaneous coronary intervention to chronic total occlusion is an effective therapeutic procedure , So, despite the technical difficulty of PCI in CTO lesion, this procedure can be done safely with relatively high success rate. (82.5%).The characteristics that have a significant relation

with technical unsuccess are CTO length more than 15 mm, severe angulations more than45 degree and blunt or absent stump, All are strong predictors of procedure failure. Most common cause of procedure failure is inability to cross the lesion with a guidewire.

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Received at: 8th Jun 2011 Accepted at: 7th Des 2011