

Procedural Success of Percutaneous Coronary Intervention in Complete Versus Functional Coronary Occlusion: A Single-Center, Single-Operator Experience

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Abstract

Background- Chronic total occlusion (CTO) of the coronary arteries includes a wide spectrum of lesions with a TIMI flow grade of 0 to 1 and more than four weeks' duration. The procedural success rate of percutaneous coronary intervention (PCI) in CTO not only depends on the anatomy and morphology of the lesion but also, and most importantly, on the angiographic TIMI flow grade of the lesion. The aim of this study was to show the procedural success rate of PCI for different subtypes of CTO, according to the angiographic TIMI flow grade of lesions.

Method- From March 2000 to March 2001, PCI was performed in 60 cases with at least one CTO lesion. Forty-six of the patients were male (76.66%), and their mean (\pm SD) age was 53.3 (\pm 10.37) years (range 35-72 years). Among these cases, 31 (51.66%) had complete total occlusion (TIMI flow grade 0) and were designated as Group I, and 29 (48.33%) had functional total occlusion (TIMI flow grade I) and were designated as Group II.

Results- The procedural success rate in complete total occlusion (Group I) was 64.5% and in functional total occlusion (Group II) was 96.6% ($P=0.002$, $CI=95\%$). The total success rate was 80% ($n=48$) without any major procedural complications (MI, urgent CABG, or death).

Conclusion- Although there are a few predictors for procedural success for PCI in CTO lesions, it seems that the TIMI flow grade (0 or 1) of the lesion is the most important and independent predictor for procedural success (procedural success was defined as final residual stenosis less than 50% with balloons and less than 20% with stents on visual assessment, and the absence of major complications (*Iranian Heart Journal 2008; 9 (4): 6 -12*).

Key words: coronary artery disease ■ total occlusion ■ percutaneous coronary intervention ■ TIMI flow grade

Chronic total occlusion (CTO) accounts for 5% to 15% of all angioplasty procedures in high volume catheterization laboratories.¹⁻⁶ Percutaneous coronary intervention (PCI) of CTO still remains one of the major challenges in the field of interventional cardiology. However, advances in technology of devices and operator experience have increased the procedural success rate.

The procedural success rate with conventional guidewires varies from 50% -78%,^{2,4,7-12} depending on the anatomical and morphological characteristics of CTO, duration of the occlusion (age of occlusion), and the TIMI flow grade of the lesion (0 or 1).

There is no definite definition for CTO, and all the definitions that have been presented are arbitrary.

The more acceptable definition for CTO is a total occlusion of more than one month's duration,^{2,11,13-15} with a TIMI flow grade of 0-1^{2,4,7,11} and without a visible contrast agent at the site of the occlusion (no luminal continuity).^{4,6,10,12,14,16-18} Patients with a TIMI flow grade of 0 are sub-grouped as complete total occlusion.^{8,14,21} Patients with a TIMI flow grade of I are sub-grouped as functional total occlusion.^{6,10,12,14,16,21} Functional total occlusion is a total occlusion with a faint late antegrade flow in the absence of a discernible

lumen at the site of the occlusion, and the occurrence of major filling of the distal vessel predominantly by collateral channels.^{10,12,14,21}

A few predictors for the procedural success rate in CTO, such as the length of the occlusion, duration of the occlusion (more than 3 months), amount of lesions or artery calcifications, bridging collaterals, tapered or stump-like occlusion, and presence or absence of side branches at close proximity to the occlusion have been mentioned so far.^{4,12,15,18,22} However, there are few reports regarding the effect of the TIMI flow grade on the procedural success rate.^{10,12}

The present study compared the procedural success rate of PCI in CTO according to the angiographic TIMI flow grade (0 or 1) of occlusions. This is, therefore, a unique study with respect to the identification of the TIMI flow grade as an important and independent predictor for the procedural success rate of PCI in CTO.

Method

From March 2000 to March 2001, PCI was performed in 475 patients by a single operator. Of these cases, 60 (12.5%) cases had at least one chronic total occlusion. According to the angiographic TIMI flow grade of the lesions, the patients with CTO were divided into two subgroups: Group I included 31 (51.66%) patients who had a TIMI flow grade of 0 (complete total occlusion), and Group II included 29 (48.33%) patients who had a TIMI flow grade of I (functional total occlusion).

Definitions

CTO was defined as a lesion with 100% occlusion, i.e. no angiographic luminal continuity at the site of the occlusion, with a TIMI flow grade of 0 or I, and with ≥ 1 month's duration of the occlusion.

Procedural success was defined as the restoration of the TIMI flow grade II or III with a residual stenosis of less than 50% by balloons and less than 20% by stents, as assessed by visual assessment at the end of the procedure, and without in-hospital major

adverse cardiac events (death, MI, or urgent CABG surgery).

Interventional procedure

All the patients were treated with aspirin (100-325mg daily) or ticlopidine (250mg twice daily) at least 48-72 hours before the procedure, and unfractionated heparin 10,000 units (70u/kg body weight) at the beginning of the procedure. All the patients received intracoronary nitroglycerin after opening the occlusion with a balloon, and most of them received calcium blockers from at least 24 hours before the procedure.

After the insertion of a 7 or 8F sheath into the right femoral artery (most often) by the Seldinger method (standard technique), PCI was performed using a 7F guiding catheter. Conventional or hydrophilic (0.014 inch) guidewires were used for crossing the coronary occlusion, most of the time, with the support of a small balloon (1.5 or 2×10 or 15mm). In most cases after predilating the occlusion with a balloon, stenting was done. At the end, the femoral sheath was removed after 6 hours.

End points

The primary end points of this study were procedural success rate and in-hospital major complications (death, MI, or urgent CABG surgery).

Inability to cross the lesion with a guidewire was the main reason for the failed procedures, followed by inability to cross the lesion with a balloon in a few cases.

Statistical analysis

Statistical analysis was performed using SPSS program (v. 11.5). The categorical variables were examined using the Pearson, chi-square, and Fisher exact tests in both groups. The continuous variables were presented as mean \pm SD, and were examined using the Student *t*-test. The discrete variables were expressed as frequencies. All the reported P-values were 2-sided, and a P-value <0.05 was considered statistically significant.

Results

PCI was performed in 60 patients with chronic total occlusion between March 2000 and March 2001. Of these patients, 31 (51, 66%) had complete total occlusion (TIMI flow grade 0, Group I) and 29 (48, 33%) had functional total occlusion (TIMI flow grade 1, Group II).

The basic and angiographic characteristics of both groups are presented in Table I.

Table I. Basic and angiographic characteristics of both groups

Characteristics	Group I n=31(100%)	Group II n=29(100%)	pValue
age ± SD	53.29±10.19	53.86±10.23	0.82
Male sex	23 (74.8)	23 (79.3)	0.64
Target vessels(CTO)	26 (83.9)	18(62)	0.20
LAD	4(12.9)	7(24.1)	NS
RCA	1(3.2)	2(6.9)	NS
LCX	0 (0)	1 (3.4)	NS
D1	0 (0)	1 (3.4)	NS
D2			
Type of lesions	26 (83.9)	17 (58.6)	0.84
C	1(3.2)	7 (24.1)	NS
B	3 (9.7)	3 (10.3)	NS
B&C	1(3.2)	2(6.9)	NS
A&C			
TIMI flow grade	0	I	-

There was no significant difference between the two groups regarding age, sex, target vessels, and type of lesions. There were more LAD and more type C lesions in Group I compared with Group II (83.9% versus 62% and 83.9% versus 58.6%, respectively), but they were not statistically significant (P=0.20 and P=0.84, respectively).

Procedural results

The procedural success rates in Group I and Group II were 64.5% (n=20) and 96.6% (n=28), respectively (P=0.002).

Stenting was done in the majority of the cases in both groups (18 of 20 successful cases in Group I and 23 of 28 successful cases in Group II).

The procedural results are presented in Table II.

Table II. Procedural success rate in both groups

Result	Group I n= 31 (100%)	Group II n= 29(100%)	P Value
Initial success rate in totally occluded vessels	20 (64.5)	28 (96.6)	0.002
In hospital MACE*	0	0	NS*
Initial success in non-occluded vessels	5 (100)	6 (100)	NS

NS = Non-significant, MACE = major adverse cardiac event

PCI for other vessels, non-totally occluded vessels, were performed in the same session in five cases in Group I (in 3 cases for diagonals and in 2 cases for LCX) and in six cases in Group II (in 2 cases for diagonals, in 1 case for LCX, in 2 cases for OM and in 1 case for RCA, Table II).

In-hospital MACE (death, MI, or urgent CABG surgery) was zero (0%) in both groups (Table III).

In Group I, the reason for failure was inability to cross the lesion with a guidewire in 9 (29%) cases, and inability to cross the lesion with a balloon in 2 (6.4%) cases.

In Group II, only in one (3.4%) case inability to cross the lesion with a balloon was the reason for failure (Table III).

Table III. Interventions and reasons for failure

Result of intervention	Group I n= 31 (100%)	Group II n= 29 (100%)	pValue
Primary stenting	18 (58)	23 (79.3)	0.008
Balloon angioplasty (PTCA)	2 (6.5)	5 (17.2)	NS
Inability to cross with a guide wire	9 (29)	0 (0)	0.008
Inability to cross with a balloon	2(6.4)	1 (3.4)	NS

Discussion

The most challenging issue in the field of interventional cardiology since the advent of angioplasty has been attempting to open chronic totally occluded vessels. Although procedural success has improved over the last two decades, it is still insufficient. In the first decade in the era of PCI, angioplasty was usually performed for non-totally occluded vessels, and rarely was it performed for totally occluded vessels. Even in recent years, PCI is recommended less frequently for chronic total occlusion,⁵ despite the fact that the initial descriptions of PCI for totally occluded lesions were published in the 1990's.^{9,11-12}

The reasons for less frequent recommendations for PCI in patients with CTO compared to non-CTO lesions were lower success rate, higher restenosis rate, and being more time consuming.^{2,4,7,9,11,18,21,23-24} However, in the majority of studies, in-hospital MACE (death, MI, and emergent CABG surgery) was lower in comparison with non-occluded vessels.^{4,7,9,11,12,23}

Several studies have confirmed that successful percutaneous revascularization in patients with CTO is accompanied with long-term symptoms and survival benefits, particularly in lowering the need for revascularization with CABG when the procedure has been completed with stenting after successful balloon angioplasty.^{2,9,11,13,17}

Seven randomized trials: (SICCO,

MORIETAL, GISSOC, SPACTO, STOP, TOSCA, and PRISO) have shown that stenting is superior to balloon angioplasty for CTO, mostly dealing with improvement in reducing restenosis, re-occlusion, and short- and long-term MACE.^{4,9,12,13,15,18,20,25} Also, the introduction of drug-eluting stents with low restenosis rates has improved long-term angiographic and clinical outcomes and increased MACE-free survival significantly compared with bare metal stents.^{3,19,20,29,30}

In recent years, new devices (different guidewires, laser guidewires, rotabators, front-runner crosser, and safe-cross devices) have increased the rate of procedural success in CTO.^{8,15,22,26-28}

A few studies have shown that the presence of collateral bridges, stump morphology, long length, and old age of CTO are the negative predictors for successfully opening a CTO lesion.^{9,11,12,15} Nevertheless, except for the chronicity of CTO (CTO older than six months' age) had no negative effect on their procedural success rate.⁴ On the other hand, some investigators have pointed out that the TIMI flow grade of CTO (0 or I) is an important and independent predictor of the success rate for opening CTO.^{10,12,14,15} The procedural success rate in complete total occlusion, despite utilizing contemporary techniques and sophisticated devices, is around 60%-70%.^{2,15} But the success rate in functional total occlusion despite the presence of the above-mentioned negative predictors (anatomic, morphologic, and age of lesion) is over 75%.¹⁰

The present study is a unique study in that it compares the procedural success rate of PCI in different subtypes of CTOs according to their angiographic TIMI flow grade (0 or 1). Although it has been mentioned by some investigators that the success rate in functional total occlusion (TIMI flow grade 1) is higher than that in complete total occlusion,^{12,14,15} there is only one study that compares the procedural success rate of CTOs according to the TIMI flow grade of lesions.¹⁰ Safian and colleagues compared initial success of 169 patients with complete total occlusion (TIMI flow grade 0) with 102 patients with functional total occlusion (TIMI

flow grade 1). Their primary success rate was 63% for complete and 78% for functional total occlusion ($P < 0.001$). Their initial success rate in complete total occlusion (TIMI 0) was quite close to that in our study (63% vs. 64.5%, respectively); nonetheless, the initial success rate in functional total occlusion (TIMI 1) in our study is higher than that in theirs (96.6% vs. 78%, respectively).

According to their study and ours, other variables had lesser impact on the procedural success rate in comparison with the angiographic TIMI flow grade, and were incomparable with it.

In this study, stenting was done in 69% of the cases, which is comparable to other studies. Inability to cross the lesion with a wire was the most important reason for failure, followed by inability to cross the lesion with a balloon (less frequently), which was comparable with other studies.^{2,4,7,9}

Conclusion

PCI for CTO was feasible and safe. Procedural and in-hospital complications (in-hospital MACE) were very low. The angiographic TIMI flow grade of CTOs (TIMI 0 or 1) was the most important and independent predictor for procedural success.

Conflict of Interest

No conflicts of interest have been claimed by the authors.

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