Feasibility and Safety of a Transradial Approach in Intervention for Chronic Total Occlusion of Coronary Arteries: A Single-center Experience

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Background: The transradial approach for cardiac catheterization has become popular; however, its application in percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) has rarely been reported. This study examines the feasibility and safety of this approach for performing PCI for CTO lesions.

Method: We retrospectively evaluated 419 consecutive patients who underwent PCI for CTO lesions between February 1998 and December 2003 in our hospital; a transradial artery approach was used in 400 patients and a transfemoral artery approach in 19.

Results: The baseline clinical characteristics were similar in the 2 patient groups. The transradial group had more de novo lesions (76% vs 47.37%, $p = 0.012$), fewer in-stent restenotic lesions (11.75% vs 36.84%, $p = 0.006$) and smaller guiding catheters ($p < 0.001$) than the transfemoral group. There was no statistical difference in the procedure success rates (69.25% and 78.95%, $p = 0.369$) between the 2 groups. The incidence of major complications, including death, Q wave myocardial infarction, and emergency coronary artery bypass surgery, was similar in the 2 groups.

Conclusions: The transradial approach for PCI can be a feasible choice for a CTO lesion. If this approach fails because of poor back up support from the guiding catheter, the transfemoral approach can be attempted with a larger guiding catheter.

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Key words: transradial, transfemoral, chronic total occlusion

A transradial approach, as opposed to a femoral artery approach, for percutaneous coronary intervention (PCI) has become increasingly popular because of fewer bleeding complications, increased patient comfort, early ambulation, and shorter hospital stays.[1-7] This approach has been successfully employed in primary PCI for acute myocardial infarction and can involve the use of PercuSurge,[8]

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carotid stenting,[9] renal stenting,[10] and left main stenting.[11] However, routine use of a transradial approach for PCI in chronic total occlusion (CTO) has rarely been reported. Angioplasty for recanalization of a CTO vessel has remained technically challenging,[12,13] although a successful procedure in selected patients can avoid major bypass surgery and improve the patient's cardiac function, clinical symptoms, quality of life, and long term survival rate.[12-15] To examine the feasibility and benefits of a transradial approach to PCI in CTO lesions, we reviewed our clinical experience with this technique and compared it with results obtained using a transfemoral approach.

METHODS

Patients

From February 1998 to December 2003, 419 consecutive PCI procedures on 419 patients with CTO lesions in a native coronary artery were performed. The selection of a transradial or a transfemoral artery approach for PCI was at the discretion of the individual operator. This study protocol was approved by our institutional review board and conformed to the ethical guidelines of the 1975 Declaration of Helsinki. All patients had provided written informed consent prior to the procedure.

Definition

A CTO lesion was defined as a lesion with total occlusion exhibiting a Thrombolysis in Myocardial Infarction (TIMI) flow grade 0-1 in a native vessel for more than 3 months. The age of the CTO was determined on the basis of clinical information, such as a history of myocardial infarction, chest pain and previous angiographic findings. The lesion length was measured from the total occlusion site to the collateral flow, or the length of significant stenosis after predilatation. Procedure success was defined as wiring across the CTO lesion with a resultant residual diameter stenosis < 30% and TIMI 3 flow following angioplasty or stenting without any major cardiovascular complications (Type C, D, or E dissection,[16,17] myocardial infarction, emergency coronary artery bypass surgery [CABG] or death). Crossover to a femoral artery approach was considered a failure of the transradial approach. Clinical success was defined as successful PCI with the patient discharged alive. Patients were deemed to have hypertension if they had a systolic blood pressure above 140 mmHg or diastolic blood pressure above 90 mmHg on two occasions or were taking antihypertensive medications, to have diabetes mellitus if they had two abnormal fasting plasma determinations > 126 mg/dL or were currently taking any hypoglycemic agents, to be smokers if they smoked cigarettes daily or occasionally, or to have an old myocardial infarction if they had a history of an ST-elevation or non-ST elevation myocardial infarction more than 2 months previously.

Transradial PCI

The operator determined whether to use the left or right radial artery for transradial PCI. The forearm and hand of the selected side were shaved and stabilized and the skin area around the selected puncture site was sterilized and anesthetized. A 6 Fr radial artery sheath (Terumo, Tokyo, Japan) was inserted into the radial artery using the Seldinger technique. On insertion of the sheath, 5000 units of heparin was routinely administered. After the diagnostic procedure, an additional bolus of 5000 units of heparin was administered just before starting PCI.

Engagement of the left coronary artery (LCA) or right coronary artery (RCA) for diagnostic angiography was generally attempted using a Kimny mini guiding catheter (Boston Scientific, Natick, MA, U.S.A.), because a single Kimny catheter can be used to engage either the LCA or RCA orifice and can also serve as a guiding catheter for PCI. If further support was required during PCI, the Kimny guiding catheter was replaced with another guiding catheter.

The artery sheath was removed following PCI. The puncture wound was dressed with gauze and adhesive tape, and then compressed manually for 30 minutes with the forearm extended to achieve hemostasis. Patients were permitted to resume ambulatory activities one hour later if they were hemodynamically stable and had no evidence of a hematoma at the puncture site.

Transfemoral PCI

The skin of the inguinal area was shaved, sterilized, and anesthetized. A 7 Fr artery sheath (Argon, Athens, TX, U.S.A.) was inserted into the femoral artery using the Seldinger technique. After the diag-

nostic coronary angiogram was completed, a bolus of 10,000 units of heparin was given immediately before PCI. Judkin (Cordis, Miami, FL, U.S.A.), XB (Cordis), or Amplatz (Cordis), catheters were chosen at the discretion of the operator.

Approximately 6 hours after PCI, when the activated clotting time had decreased to less than 150 seconds, the artery sheath was removed. Manual compression was used to achieve hemostasis, and the wound was dressed with gauze and adhesive tape. Complete bed rest was required for a further 6 hours, with pressure applied to the femoral area using a sand bag.

Various techniques were used in PCI for a CTO lesion, including simultaneous contralateral coronary angiography, double guidewire technique and 5 in 6 guiding catheter techniques. Thus, different guiding catheters, guidewires (soft, stiff, hydrophilic, Miracle series, and tapering tip guidewires), supporting catheters and over-the-wire balloons were employed in different cases. However, decisions on how to cross the CTO lesion and selection of the equipment were at the discretion of the individual operator. The procedure was terminated in the following cases: use of excessive contrast medium; prolonged procedure time; patient intolerance; failure of a guidewire, balloon, or stent to cross the lesion despite optimal support; or complications (e.g., false lumen wiring, perforation, extravasation, tamponade or unstable hemodynamics).

Statistics

Data are expressed as the mean ± standard deviation (SD) or percentage (%). Categorical data or continuous variables between the groups were compared using the chi-square test and Fisher's exact test. The size of the guiding catheter used was compared between groups using the Mann-Whitney U test. A probability value of less than 0.05 was considered statistically significant.

RESULTS

The transradial approach was used in 400 of the 419 patients who received PCI to the CTO vessel and the transfemoral approach was used in 19. Table 1 summarizes the clinical characteristics of the 2 patient groups in this study. There were no differences between the 2 groups with regard to gender distribution, age, history of hypertension, diabetes mellitus, smoking, myocardial infarction, left ventricular ejection fraction, lipid profile, and number of diseased vessels. A Kimny mini guiding catheter was used more frequently in the transradial group than in the transfemoral group (60.25% vs none, $p < 0.001$).

Table 1. Clinical Characteristics of Patients Undergoing Angioplasty with Transradial and Transfemoral Approaches

	TR (n = 400)	TF (n = 19)	*p* value
Male	341 (85.25%)	17 (89.47%)	1.000
Age (years)	61.5 ± 10.7	60.6 ± 13.2	0.831
Hypertension	252 (63%)	10 (52.63%)	0.362
Diabetes Mellitus	128 (32%)	4 (21.05%)	0.316
Current smoker	169 (42.25%)	9 (47.37%)	0.659
Old MI	179 (44.75%)	11 (57.89%)	0.261
LVEF (%)	60 ± 16	59 ± 15	0.450
Total Cholesterol (mg/dl)	199 ± 41	190 ± 57	0.160
Triglycerides (mg/dl)	183 ± 162	220 ± 151	0.232
Kimny guiding catheter	241 (60.25%)	0 (0%)	< 0.001
CAD vessel			0.473
1-vessel CAD	105 (26.25%)	5 (26.32%)	
2-vessel CAD	109 (27.25%)	5 (26.32%)	
3-vessel CAD	172 (43.0%)	7 (36.84%)	
LM CAD	14 (3.5%)	2 (10.52%)	

Data are expressed as the mean (± SD) or number (%) of patients.
Abbreviations: CAD: coronary artery disease; LM: left main coronary artery; LVEF: left ventricular ejection fraction; MI: myocardial infraction; TR: transradial; TF: transfemoral.

Table 2 summarizes the lesion characteristics in the 2 groups. There were no significant differences in target vessel distribution, lesion types, angioplastic procedure success rate, clinical success rate and length of hospital stay between the 2 groups. The transradial group had a higher ratio of de novo lesions (76% vs 47.37%, $p = 0.012$), lower ratio of in-stent restenotic lesions (11.75% vs 36.84%, $p = 0.006$) and smaller guiding catheters ($p < 0.001$) than the transfemoral group. However, the procedure success rates was not statistically different between groups (69.25% vs 78.95%, $p = 0.369$).

Complications from PCI in the 2 groups are list-

Table 2. Characteristics of Lesions in Transradial and Transfemoral Angioplasty Groups

	TR (n = 400)	TF (n = 19)	*p* value
Target vessel			0.056
LAD	170 (42.50%)	6 (31.58%)	
LCX	93 (23.25%)	1 (5.26%)	
RCA	136 (34.00%)	12 (63.16%)	
LIMA	1 (0.25%)	0 (0%)	
Lesion type			
Type C	400 (100%)	19 (100%)	1.000
De novo lesion	304 (76.00%)	9 (47.37%)	0.012
Balloon PTCA restenosis	49 (12.25%)	3 (15.79%)	0.718
In stent restenosis	47 (11.75%)	7 (36.84%)	0.006
Guiding catheter size			< 0.001
6 Fr	362 (90.5%)	5 (26.32%)	
7 Fr	32 (8%)	10 (52.63%)	
8 Fr	6 (1.5%)	1 (5.26%)	
9 Fr		2 (10.53%)	
10 Fr		1 (5.26%)	
Procedure success	277 (69.25%)	15 (78.95%)	0.369
Clinical success	276 (69%)	15 (78.95%)	0.358
Hospital stay (days)	3.9 ± 6.6	3.1 ± 1.4	0.141

Data presented are the mean (± SD) or number (%) of patients.
Abbreviations: Fr: Franch; LAD: left anterior descending; LCX: left circumflex; LIMA: left internal mammary artery; RCA: right coronary artery; TR: transradial; TF: transfemoral; PTCA: percutaneous transluminal coronary angioplasty.

Table 3. Complications of Transradial and Transfemoral Angioplasty for Chronic Total Occlusion

	TR (n = 400)	TF (n = 19)	*p* value
Major complications	3 (0.75%)	0 (0%)	1.000
Death	3 (0.75%)	0 (0%)	1.000
Q wave MI	0 (0%)	0 (0%)	
Emergency CABG	1 (0.25%)	0 (0%)	1.000
Minor complications	175 (43.75%)	14 (73.68%)	0.016
Dissection	143 (35.75%)	12 (63.16%)	0.026
A	35 (8.75%)	1 (5.26%)	
B	59 (14.75%)	9 (47.37%)	
C	21 (5.25%)	0 (0%)	
D	26 (6.5%)	2 (10.53%)	
E	2 (0.5%)	0 (0%)	
Non-Q MI	9 (2.25%)	2 (10.53%)	0.084
Subacute thrombosis	0 (0%)	0 (0%)	
Acute occlusion	2 (0.5%)	1 (5.26%)	0.130
No reflow	5 (1.25%)	1 (5.26%)	0.244
Spasm	0 (0%)	0 (0%)	
Arrhythmia	8 (2.0%)	1 (5.26%)	0.344
Perforation	15 (3.75%)	1 (5.26%)	0.531
Tamponade	6 (1.5%)	0 (0%)	1.000
Side branch occlusion	2 (0.5%)	1 (5.26%)	0.130
Blood transfusion > 500 cc	2 (0.5%)	0 (0%)	1.000
Contrast nephropathy	1 (0.25%)	0 (0%)	1.000
IABP use	3 (0.75%)	0 (0%)	1.000

Abbreviations: CABG: coronary artery bypass surgery; IABP: intra-aortic balloon pump; MI: myocardial infarction; TR: transradial; TF: transfemoral.

ed in Table 3. There were no differences between the groups with regard to major complications (death, Q wave myocardial infarction, and emergency CABG) or minor complications (non-Q myocardial infarction, subacute thrombosis, acute occlusion, no reflow, spasm, arrhythmia, perforation, cardiac tamponade, side branch occlusion, blood transfusion, contrast nephropathy, and unstable hemodynamics requiring intra-aortic balloon pump use). The transradial group had a significantly lower dissection rate than the transfemoral group (35.75% vs 63.16%, $p = 0.026$), which resulted in a significantly lower rate of composite minor complications (43.75% vs 73.68%, $p = 0.016$).

DISCUSSION

In our study, the procedure success rate of PCI in CTO lesions in the transradial group appeared lower, but was not statistically different than that in the transfemoral group (69.25% vs 78.95%, $p = 0.369$). However, the complication rates were similar

in the 2 patient groups (Table 3). Thus, a transradial approach for performing PCI for a CTO lesion can be regarded as a safe alternative to the transfemoral approach.

The reported success rates in different series of studies of CTO using either a transradial or a transfemoral approach ranged from 64% to 89%.[12,13,18-20] Use of different guidewires may be a contributing factor in the different success rates. This is evidenced by a remarkable success rate of 89% in CTO lesions reported by Saito et al using a tapered tip guidewire.[19] The Asahi Miracle series and tapered-tip guidewires were not available in Taiwan before 2002 and their use remained limited until Taiwan health insurance started reimbursement for use in July 2006. As a result, Miracle series guidewires were used in only 54 cases and a tapered-tip guidewire was tried in only 3 cases (1 conquest, 2 crossNT) in our study. Thus, the limited use of these guidewires in our study may explain our apparently modest success rate compared with the results of other studies.[12,13,18-20]

In the transradial approach, 0.75% of patients had major complications, 3.75% had perforations, and 2.25% had non-Q myocardial infarctions. Similar complication rates using a transradial approach were reported by Kim et al.[18] In the study, we found that the major complication rates were similar in the two groups but the minor complication rates, including dissection, were lower in the transradial group, indicating that the transradial approach to PCI is safe for a CTO lesion.

In our daily practice, a transradial approach has generally been used initially for diagnostic catheterization to evaluate the severity of coronary artery disease. This may explain why the transradial group had a higher ratio of de novo lesions (76% vs 47.37%, $p = 0.012$) and the transfemoral group had a higher ratio of in-stent restenosis (36.84% vs 11.75%, $p = 0.006$) (Table 2). Further, a large guiding catheter was used more often in the transfemoral approach ($p < 0.001$, Table 2) than in the transradial approach. Large guiding catheters can provide stronger backup force for interventional procedures, resulting in a higher success rate, than small guiding catheters. The differences in numbers of de novo lesions and in stent restenosis, as well as the size of the guiding catheter used, could explain the apparently lower, although not statistically different, procedure success rate in the transradial group than in the trasfemoral group. (69.25% vs 78.95%, $p = 0.369$).

Study limitations

There were limitations in the study. First, it was retrospective and was not randomized, because the individual operator decided on the approach. A bias in favor of the transradial approach was evidenced by the fact that most patients in this study underwent this approach. However, this bias simply reflects the current trend of using a transradial approach first and reserving a transfemoral approach only for certain clinical situations. Second, only CTO cases that underwent PCI were included in this study, as some cases were referred for CABG. Third, the disparate difference in the sample size between the two groups may have led to a type II error. The apparently lower success rate in the transradial group versus the transfemoral group may have been statistically significant if the patient number in the latter group had reached 400. However, this success rate with the transradial approach is reasonably acceptable in view of the comparable major, but lower minor complication rates (Table 3) in the study and the generally reported greater patient comfort, earlier ambulation, and shorter hospital stay compared with the transfemoral approach.[1-7] Fourth, the radial artery is smaller than the femoral artery and may not accommodate the large sheath and guiding catheter needed for PCI. As a result of this limitation, the guiding catheters used in the transradial approach are smaller than those in the transfemoral approach. Thus, if a larger guiding catheter is required for stronger support, the transfemoral approach is the appropriate choice.

Conclusion

The transradial approach for PCI is a feasible choice for a CTO lesion. Compared with the transfemoral approach, the transradial approach has an acceptable success rate and a comparable major complication rate but a lower minor complication rate. We suggest that diagnostic coronary angiography and ad hoc PCI to a CTO can be performed first by the transradial approach. If this approach fails due to poor back up support from the guiding catheter, the transfemoral approach can be attempted with a larger guiding catheter.

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經橈動脈進行慢性完全阻塞冠狀動脈介入治療的安全性與可信性：單一醫學中心經驗

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背 景： 經橈動脈進行心導管手術越來越普遍了，但是應用在慢性完全性阻塞的冠脈病灶的介入治療很少被報告。本研究檢視經橈動脈處理慢性完全性阻塞病灶的冠脈介入治療的可信性與安全性。

方 法： 本研究回溯性鑑定本院從 1998 年 2 月到 2003 年 12 月間，連續 419 個病人進行慢性完全性阻塞病灶的冠脈介入性治療。400 例進行經橈動脈介入，19 例進行經股動脈介入。這兩組病人的基本臨床資料大致相似，例外的有經橈動脈介入這組比經股動脈介入這組有較多全新病灶 (76% vs 47.37%，$p = 0.012$)，較少支架內再狹窄病灶 (11.75% vs 36.84%，$p = 0.006$)，較小的引導導管尺寸 ($p < 0.001$)。

結 果： 這兩組間在成功率上沒有統計學上的意義 (69.25% and 78.95%，$p = 0.369$)。兩組間主要併發症 (死亡，Q 波心梗，緊急冠脈繞道手術) 的發生率並沒有差別。

結 論： 經橈動脈處理慢性完全性阻塞的冠脈介入性治療是可行的選擇。如果經橈動脈處理失敗，而原因是引導導管支持力不夠的話，可經由股動脈來使用較大的導引導管。
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關鍵詞： 經橈動脈，經股動脈，慢性完全性阻塞

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