Immediate Results of Percutaneous Coronary Intervention for Unprotected Left Main Coronary Artery Stenoses: Transradial versus Transfemoral Approach

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Background: The effectiveness of a transradial approach for percutaneous coronary intervention (PCI) is comparable to that of a transfemoral approach. However, few studies have systematically compared the clinical effectiveness of a transradial approach with that of a transfemoral approach for unprotected left main coronary artery (ULMCA) stenoses. We compared success rate, vascular complications and early (in-hospital and six-month) outcomes of transradial PCI for ULMCA stenoses with those of a transfemoral approach.

Methods: This retrospective study included 131 patients undergoing PCI for ULMCA stenoses between December 2000 and October 2006: 116 (88.5%) patients underwent a transradial approach and fifteen (11.5%) underwent a transfemoral approach.

Results: Both angiographic and procedural success were achieved in 114 (98.3%) patients in the transradial group and fourteen (93.3%) patients in the transfemoral group ($p = 0.876$). Patients in the transfemoral group required more debulking procedures with large guiding catheters and had larger minimal luminal diameter following PCI than those in the transradial group. Transradial PCI produced fewer in-hospital major adverse cardiac events (MACE) (7.8% vs. 33.3%, $p = 0.003$) and a lower vascular complication rate compared to the transfemoral approach (1.7% vs. 26.6%, $p < 0.001$). Six-month MACE was lower in the transradial group than the transfemoral group without statistical significance (8.0% vs. 23.1%, $p = 0.299$).

Conclusions: A transradial approach for ULMCA diseases produced an equal success rate and a lower vascular complication rate when compared to a transfemoral approach. It should be considered as an acceptable alternative to the transfemoral approach for PCI in ULMCA diseases.

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Key words: left main coronary artery, percutaneous coronary intervention, transradial, transfemoral

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A transradial approach is increasingly common in this era of rapidly developing techniques and devices for percutaneous coronary intervention (PCI). The clinical outcomes and procedural success of a transradial approach are reportedly comparable to those of a transfemoral approach.(1-3) Further, the vascular complication rate is lower(1,2) and the compliance of patients is even better than for a transfemoral approach.(4)

PCI can be routinely performed using a transradial approach if no contraindication, such as poor radial pulse, positive Allen test or unstable hemodynamics, are noted, and is also feasible in selected patients with acute myocardial infarction.(5-7) A few studies of small populations have explored the application of PCI in unprotected left main coronary artery (ULMCA) disease, although coronary artery bypass graft (CABG) is still recommended as the standard treatment for ULMCA diseases according to established guidelines.(8) Nevertheless, PCI and CABG exhibit no significant difference in short- and intermediate-term clinical outcome of ULMCA disease.(9,10) However, a higher rate of target lesion revascularization (TLR) without increased mortality has been observed in PCI. Only one study has compared transradial and transfemoral approaches for protected and ULMCA stenoses.(11) Therefore, patients treated with PCI via either a transradial approach or transfemoral approach for ULMCA diseases in our institute were retrospectively analyzed to elucidate whether a transradial approach produced a short-term clinical outcome comparable to that of a transfemoral approach.

METHODS

Study population

Patients undergoing transradial or transfemoral coronary stenting for left main coronary artery stenosis of ≥50% in our institute between December 2000 and October 2006 were enrolled for retrospective analysis. Patients with ST-elevated acute myocardial infarction (MI) were excluded. In this study, PCI was performed if the lesion was considered suitable for PCI and not eligible for CABG with one of the following criteria: very high risk for CABG, age >75 years, limited life expectancy, the patient refused CABG or was regarded as unstable for CABG by surgeons.(12)

PCI procedures

Operators were free to choose the radial or femoral artery for assessment. In one-stage PCI, the femoral artery would be utilized if a larger-size guiding catheter was considered necessary for further intervention after initial transradial diagnostic catheterization. The transfemoral approach was performed on a unilateral femoral artery if adequate femoral pulse was palpable. Local anesthesia was achieved with an injection of 6-10 ml 2% Xylocaine in the groin region. The femoral artery was punctured with an 18-gauge needle and a J-curved Teflon-coated wire was advanced through the iliac artery. After advancing a 6 French (Fr) arterial introducing sheath into the artery, 5000 units of unfractionated heparin were administered into the femoral artery. The transradial approach was performed after normal Allen test in all patients. The palm was placed upward with the wrist in the hyperextended position. Local anesthesia of 1 ml 2% Xylocaine was administered subcutaneously. Radial arterial puncture was performed with a 20-22 gauge needle proximal to the styloid process and then cannulated with a 6 Fr arterial introducing sheath, followed by administration of a mixture of 5000 units unfractionated heparin, 200 μg nitroglycerin and 2.5 mg verapamil through the introducing sheath. In some cases, the arterial introducing sheath was replaced by a 7 Fr or larger size sheath to facilitate the intended PCI procedure if the radial artery diameter was sufficient. The PCI procedure for ULMCA was performed by experienced operators using techniques described by Iakovou *et al*. after administering additional 5000 units of heparin.(13) After the procedure was completed, the radial arterial sheath was immediately removed and gauze fixed dressings were applied for hemostasis. The femoral introducing sheath was left for 2-4 hours until activated clotting time was <180 seconds. Adequate external compression and further gauze pressure dressings with sand bag compression were applied for at least 4 hours to achieve hemostasis.

Definitions

High pressure inflation was defined as maximal balloon inflation pressure ≥16 atmosphere (atm). Angiographic success was defined as grade 3 Thrombolysis In Myocardial Infarction (TIMI) flow achieved on angiography at the target lesion and bifurcation of distal ULMCA with residual diameter stenosis < 30%. Procedural success was defined as angiographic success achieved without procedure-related death, Q wave MI, stroke, repeat PCI or emergent CABG during hospitalization. Non-Q wave MI was defined as elevation of total creatinine kinase exceeding twice the upper limit of the normal value with positive muscle-brain (MB) form in the absence of pathological Q waves on electrocardiography. Deaths were classified as cardiac or non-cardiac, and deaths of unknown causes were classified as cardiac-related. The definition of renal insufficiency was a serum creatinine level > 1.4 mg/dL and that of hyperlipidemia was a serum total cholesterol level > 200 mg/dL. The European system of cardiac operative risk assessment (EuroSCORE) was used to stratify the risk of death at 30 days and patients were identified as high risk if the EuroSCORE was ≥ 6.[14]

Study endpoints

Study endpoints were angiographic success, procedural success, vascular complications and early (in-hospital and six-month) outcomes. Local vascular complications included local hematoma, regional ischemic changes, peripheral artery occlusion, arteriovenous fistula, pseudoaneurysm, and bleeding complications meeting TIMI major and minor criteria for bleeding complications.[15] In-hospital and short-term major adverse cardiovascular events (MACE) included post-procedural MI (Q wave or non-Q wave), repeat PCI, CABG, acute (within 24 hours) or subacute (within one month) thrombosis, stroke, pulmonary edema, ventricular tachyarrhythmia and death occurring during hospitalization or six months following PCI.

Statistical analysis

Continuous variables were presented as mean ± standard deviation (SD) and categorical variables as percentages. Data were analyzed by chi-square for categorical variables and independent sample *t* test for continuous variables. A *p* value < 0.05 was considered statistically significant. The software package SPSS 11.0 (SPSS Inc., Chicago, Illinois, U.S.A.) was used for statistical analysis.

RESULTS

Baseline characteristics

One hundred and thirty-one patients who underwent elective PCI for ULMCA stenoses were enrolled in this study, including 116 (88.5%) patients who underwent a transradial approach and fifteen (11.5%) who underwent a transfemoral approach. Forty-nine (42.2%) patients in the transradial group and six (40%) patients in the transfemoral group had undergone prior PCI (*p* = 0.869). Table 1 lists baseline characteristics. No significant differences in age, weight, height, body mass index or gender were noted, although the transradial group included a

Table 1. Baseline Clinical Characteristics

	Transradial (n = 116)	Transfemoral (n = 15)	*p* value
Age (years)	67.4 ± 10.4	65.6 ± 10.6	0.526
Weight (kg)	64.8 ± 10.7	59.2 ± 12.1	0.063
Height (cm)	160.9 ± 8.2	157.0 ± 5.9	0.077
Body mass index	25.00 ± 3.55	23.90 ± 3.93	0.307
Male (%)	89 (76.7%)	8 (53.3%)	0.052
Hypertension (%)	79 (68.1%)	14 (93.3%)	0.043
Diabetes mellitus (%)	44 (37.9%)	7 (46.7%)	0.514
Current smoking (%)	25 (21.6%)	5 (33.3%)	0.823
Hyperlipidemia (%)	83 (71.6%)	9 (60.0%)	0.357
Renal insufficiency (%)	28 (24.1%)	5 (33.3%)	0.440
Prior MI (%)	26 (22.4%)	4 (26.7%)	0.712
Prior stroke (%)	13 (11.2%)	5 (33.3%)	0.019
PVD (%)	16 (13.8%)	1 (6.7%)	0.440
Prior PTCA (%)	49 (42.2%)	6 (40%)	0.869
LVEF < 40% (%)	14 (12.1%)	2 (13.3%)	0.888
Grade 3-4 mitral regurgitation	7 (6.0%)	1 (6.7%)	0.923
CHF NYHA Fc III & IV (%)	15 (12.9%)	3 (20%)	0.454
EuroSCORE - mean	7.3 ± 3.7	8.7 ± 5.1	0.307
Low risk (1-2) (%)	5 (4.3%)	0	0.715
Moderate risk (3-5) (%)	37 (31.9%)	5 (33.3%)	
High risk (≥ 6) (%)	74 (63.8%)	10 (66.7%)	
Clinical presentation as revascularization indication (%)			0.329
Stable angina (%)	21 (18.1%)	5 (33.3%)	
Unstable angina (%)	74 (63.8%)	6 (40.0%)	
NSTEMI (%)	14 (12.1%)	3 (20%)	
CHF (%)	7 (6.0%)	1 (6.7%)	
CABG eligibility (%)	90 (77.6%)	11 (73.3%)	0.712

Abbreviations: CABG: coronary artery bypass graft; CHF: congestive heart failure; LVEF: left ventricular ejection fraction; MI: myocardial infarction; NSTEMI: non-ST segment elevation myocardial infarction; NYHA Fc: New York Heart Association functional class; PTCA: percutaneous transluminal coronary angioplasty; PVD: peripheral vascular disease.

higher proportion of males (76.7% vs. 53.3%, p = 0.052). Coronary artery disease (CAD) risk factors, including diabetes mellitus, current smoking, hyperlipidemia and renal insufficiency, did not significantly differ between the two groups but the incidence of hypertension was higher in the transfemoral group (93.3% vs. 68.1%, p = 0.043). The incidence of prior MI, prior percutaneous transluminal coronary angioplasty and peripheral vascular disease did not significantly differ between the two groups except for a higher incidence of prior stroke in the transfemoral group (33.3% vs. 11.2%, p = 0.019). The two groups did not significantly differ in left ventricular ejection fraction <40%, grade 3-4 mitral regurgitation, congestive heart failure (CHF) New York Heart Association Function Class (NYHA Fc) III or IV and clinical indications for revasculization. Unstable angina was the most common clinical presentation in both groups (transradial vs. transfemoral: 63.8% vs. 40.0%, p = 0.329). Seventy-four (63.8%) patients in the transradial group and ten (66.7%) patients in the transfemoral group were stratified as high risk according to EuroSCORE (p = 0.715). Ninety (77.6%) patients in the transradial group and eleven (73.3%) in the transfemoral group were eligible for CABG (p = 0.712).

Angiographic characteristics

Table 2 lists the angiographic characteristics in the transradial and transfemoral groups in this series. Ninety-nine (85.6%) patients in the transradial group and thirteen (86.6%) in the transfemoral group had ULMCA stenosis with multi-vessel CAD (p = 0.346). Thirty-three (28.4%) patients in the transradial group and none in the transfemoral group had concomitant occluded coronary vessels of the left anterior descending, left circumflex or right coronary artery. All except three (2.6%) patients in the transradial group had a de novo lesion. Bifurcation lesions were observed in eighty-six (74.1%) patients in the transradial group and twelve (80%) in the transfemoral group (p = 0.632). Ninety-five (90.5%) patients in the transradial group and fourteen (93.3%) patients in the transfemoral group were classified as B2 or C lesion according to American Heart Association (AHA) lesion classification system (p = 0.384). Mean minimal lumen diameter (MLD), mean reference vessel diameter (RVD), stenosis diameter and lesion length before PCI did not significantly

Table 2. Angiographic Characteristics

	Transradial (n = 116)	Transfemoral (n = 15)	p value
Diseased vessel			0.346
LMCA only (%)	5 (4.3%)	2 (13.3%)	
LMCA & one vessel (%)	12 (10.3%)	0 (0%)	
LMCA & two vessels (%)	28 (24.1%)	5 (33.3%)	
LMCA & three vessels (%)	68 (58.6%)	8 (53.3%)	
LMCA, ramus & three vessels (%)	3 (2.6%)	0 (0%)	
Occluded LAD (%)	9 (7.8%)	0 (0%)	0.324
Occluded LCX (%)	8 (6.9%)	0 (0%)	0.449
Occluded RCA (%)	16 (13.8%)	0 (0%)	0.057
Bifurcation lesion (%)	86 (74.1%)	12 (80.0%)	0.632
De novo lesion (%)	113 (97.4%)	15 (100%)	0.529
AHA lesion classification			0.384
B1 (%)	11 (9.5%)	1 (6.7%)	
B2 (%)	72 (62.1%)	12 (80.0%)	
C (%)	33 (28.4%)	2 (13.3%)	
TIMI flow			0.797
II (%)	10 (8.6%)	1 (6.7%)	
III (%)	106 (91.4%)	14 (93.3%)	
Pre-MLD (mm)	1.18 ±0.62	0.939 ±0.53	0.160
Pre-RVD (mm)	3.61 ±0.63	3.77 ±0.79	0.378
Diameter stenosis (%)	67.2 ±16.0	70.3 ±21.6	0.498
LM stenosis <75%	78 (67.3%)	8 (53.3%)	0.441
75 - 94.9%	36 (31.0%)	7 (46.7%)	
≥95%	2 (1.7%)	0 (20%)	
Lesion length (mm)	16.03 ±9.95	11.67 ±7.72	0.104
Post-MLD (mm)	3.70 ±0.58	4.10 ±0.67	0.014
Post-RVD (mm)	4.09 ±0.55	4.42 ±0.65	0.032
Residual stenosis (%)	10.0 ±9.9	8.0 ±6.8	0.449
Acute gain (mm)	2.51 ±0.82	3.17 ±0.66	0.004
Stent-to-reference ratio	0.97 ±0.16	1.05 ±0.23	0.228
Dissection on final angiogram			0.864
No dissection	110 (94.8%)	14 (93.3%)	
Type A (%)	5 (4.3%)	1 (6.7%)	
Type B (%)	1 (0.9%)	0 (0%)	
Angiographic success (%)	114 (98.3%)	14 (93.3%)	0.876
Complete revasculization (%)	56 (48.3%)	9 (60.0%)	0.393

Abbreviations: AHA: American Heart Association; LAD: left anterior descending artery; LCX: left circumflex artery; LMCA: left main coronary artery; MLD: minimal lumen diameter; RCA: right coronary artery; RVD: reference vessel diameter; TIMI: Thrombolysis In Myocardial Infarction.

differ between the two groups. Left main artery stenosis diameter was divided into <75%, 75-95% and ≥95% according to the Duke prognostic CAD index.[16] Thirty-eight (32.8%) patients in the transradial group and seven (46.7%) in the transfemoral group had a stenosis diameter of at least 75% (p = 0.441). Angiographic success was achieved in 114 (98.3%) patients in the transradial group and fourteen (93.3%) patients in the transfemoral group (p = 0.876). Residual stenosis and stent-to-reference ratio did not significantly differ between a transradial and transfemoral approach following PCI. The MLD, RVD and acute gain following PCI were significantly greater in the transfemoral group than in the transradial group (p = 0.014, 0.032 and 0.004, respectively). In the transradial group, final angiogram showed type A dissection in five patients (4.3%) and type B dissection in one patient (0.9%), respectively, while one patient (6.7%) in the transfemoral group had type A dissection (p = 0.864). Fifty-six (48.3%) patients in the transradial group and nine (60%) in the transfemoral group achieved complete revascularization (p = 0.393).

Procedural characteristics

Table 3 summarizes procedural characteristics. Secondary-session PCI for ULMCA after either diagnostic catheterization or PCI to segments other than the left main artery was performed in 20 (17.2%) patients in the transradial group and 3 (20%) patients in the transfemoral group (p = 0.792). Procedural success was equal to angiographic success in both groups (transradial vs. transfemoral: 98.3% vs. 93.3%, p = 0.876). Eighty-four (72.4%) patients in the transradial group were accessed via the left radial artery due to preference of the operators or magnitude of radial pulsation of the patients. The right femoral artery was more frequently (86.7%) utilized in the femoral approach group. Ninety-nine (85.3%) patients were cannulated with 6 Fr catheters in the transradial group and a range of catheter sizes from 6 Fr to 10 Fr was used in the transfemoral group for debulking procedures (p<0.001). A Judkins left catheter was selected for eleven (73.3%) transfemoral PCI patients. Kimny radial or mini-radial catheters were used in seventy (60.3%) transradial approach patients (p<0.001). An intra-aortic balloon pump (IABP) was implanted in six (5.2%) patients in the transradial group and three

Table 3. Procedural Characteristics

	Transradial (n = 116)	Transfemoral (n = 15)	p value
Procedure time (minutes)	84.6 ± 34.4	83.7 ± 41.1	0.924
Secondary session PCI	20 (17.2%)	3 (20%)	0.792
Ad hoc PCI (%)	62 (53.4%)	1 (6.7%)	0.001
Left radial/right femoral approach (%)	84 (72.4%)	13 (86.7%)	
Catheter size			< 0.001
6 Fr (%)	99 (85.3%)	3 (20.0%)	
7 Fr (%)	16 (13.8%)	3 (20.0%)	
8 Fr (%)	1 (0.9%)	5 (33.3%)	
9 Fr (%)	0 (0%)	2 (13.3%)	
10 Fr (%)	0 (0%)	2 (13.3%)	
Catheter type			< 0.001
Kimny radial or Kimny-mini radial (%)	70 (60.3%)	1 (6.7%)	
Judkins left 3.5, 4.0 or 4.5 (%)	25 (21.6%)	11 (73.3%)	
XB 4.0 or 4.5 (%)	7 (6.0%)	1 (6.7%)	
Amplatz left 1 or 2 (%)	4 (3.4%)	0 (0%)	
EBU (%)	2 (1.7%)	2 (13.3%)	
Ikari left 3.5 (%)	8 (6.9%)	0 (0%)	
Temporal pacemaker (%)	0 (0%)	1 (6.7%)	0.005
IABP support (%)	6 (5.2%)	3 (20.0%)	0.033
IVUS guide (%)	60 (51.7%)	10 (66.7%)	0.275
Lesion modification			
DCA (%)	1 (0.9%)	4 (26.7%)	< 0.001
Rotational atherectomy (%)	1 (0.9%)	2 (13.3%)	
CBA (%)	6 (5.2%)	1 (6.7%)	
Direct stenting (%)	19 (16.4%)	2 (13.3%)	0.762
Stent covering LMCA ostium (%)	50 (43.1%)	8 (53.3%)	0.453
Stent crossing bifurcation (%)	91 (78.4%)	8 (53.3%)	0.033
DES penetration (%)	80 (69.0%)	3 (20.0%)	< 0.001
Number of stents - mean	1.30 ± 0.48	1.13 ± 0.35	0.113
One (%)	82 (70.7%)	13 (86.7%)	
Two (%)	34 (29.3%)	2 (13.3%)	
Stent deployment technique			0.146
One stent without kissing balloon (%)	41 (35.3%)	4 (26.6%)	
One stent with kissing balloon (%)	41 (35.3%)	10 (66.7%)	
Simultaneous kissing stent (%)	1 (0.9%)	1 (6.7%)	
Modified crush (%)	9 (7.8%)	0 (0%)	
Crush (%)	1 (0.9%)	0 (0%)	
Culotte (%)	20 (17.1%)	0 (0%)	
T stent (%)	2 (1.8%)	0 (0%)	
Provisional T stent (%)	1 (0.9%)	0 (0%)	
Stent length (mm)	24.2 ± 7.6	16.9 ± 9.3	< 0.001
Stent width (mm)	3.4 ± 0.3	3.8 ± 0.5	0.001
Maximal pressure (atm)	18.0 ± 4.5	14.7 ± 3.8	0.007
Additional NC balloon dilatation (%)	45 (38.8%)	5 (33.3%)	0.772
High pressure inflation ≥ 16 atm (%)	92 (79.3%)	8 (53.3%)	0.049
Final kissing balloon (%)	73 (62.9%)	10 (66.7%)	0.772
Procedural success (%)	114 (98.3%)	14 (93.3%)	0.876

Abbreviations: CBA: cutting balloon angioplasty; DCA: directional coronary atherectomy; DES: drug-eluting stent; EBU: extra back-up; Fr: French; LMCA: left main coronary artery; IABP: intra-aortic balloon pumping; IVUS: intravascular ultrasound; NC: non-compliant; PCI: percutaneous coronary intervention; XB: extra-backup.

(20%) in the transfemoral group due to hemodynamic instability before PCI ($p = 0.033$). Only one in the transfemoral group required a transvenous temporary pacemaker ($p = 0.005$). Intravascular ultrasound was performed in sixty (51.7%) patients in the transradial group and ten (66.7%) patients in the transfemoral group to evaluate ULMCA lesions or as guidance for PCI. Lesion modification with directional coronary atherectomy (DCA) or rotational atherectomy was performed in six (40%) patients in the transfemoral group and in only two (1.7%) patients in the transradial group; cutting balloon angioplasty was performed in six (5.2%) patients in the transradial group and one (6.7%) patient in the transfemoral group ($p < 0.001$). Nineteen (16.4%) patients in the transradial group and two (13.3%) in the transfemoral group received direct stenting ($p = 0.762$). Stent deployment covering the ULMCA ostium and stenting across the bifurcation were performed in fifty (43.1%) and ninety-one (78.4%) patients in the transradial group, respectively, and in eight (53.3%) and eight (53.3%) patients in the transfemoral group, respectively. Drug-eluting stents (DES) were introduced into eighty (69%) patients in the transradial group and only three (20%) patients in the transfemoral group ($p < 0.001$). The mean number of stents involved in PCI did not significantly differ between the two groups ($p = 0.113$). Stent deployment techniques using one stent with or without a kissing balloon technique and simultaneous kissing stent were similar in the two groups ($p = 0.146$). Thirty-three (28.5%) patients in the transradial group and none in the transfemoral group underwent modified crush, crush, culotte, T stent or provisional stent techniques. Mean stent length and width were 24.2 ± 7.6 mm and 3.4 ± 0.3 mm in the transradial group, respectively, and 16.9 ± 9.3 mm and 3.8 ± 0.5 mm in the transfemoral group, respectively. Mean values of maximal pressure for PCI were 18.0 ± 4.5 atm in the transradial group and 14.7 ± 3.8 atm in the transfemoral group ($p = 0.007$). High pressure inflation was employed in ninety-two (79.3%) patients in the transradial group and eight (53.3%) patients in the transfemoral group ($p = 0.049$). There were no differences in PCI technique, including additional application of non-compliance balloon dilatation and final kissing balloon, between the two groups.

In-hospital and six-month outcomes

Table 4 displays in-hospital outcomes of the studied patients. No regional ischemic change, radial or femoral artery occlusions, or bleeding events matching TIMI major criteria were noted in either group. Significantly higher incidences of hematoma or ecchymosis over 5 cm (20%), pseudoaneurysm (6.7%) or bleeding events compatible with TIMI minor criteria (6.7%) in the transfemoral group were noted ($p < 0.001$). No subjects had Q wave MI or stroke following PCI but seven (6.0%) patients in the transradial group and two (13.3%) patients in the transfemoral group developed subclinical non-Q

Table 4. In-hospital Outcomes

	Transradial (n = 116)	Transfemoral (n = 15)	*p* value
Local vascular complications	2 (1.7%)	4 (26.6%)	<0.001
Regional ischemic change (%)	0 (0%)	0 (0%)	1.000
Radial/femoral artery occlusion (%)	0 (0%)	0 (0%)	1.000
Hematoma/ecchymosis > 5 cm (%)	2 (1.7%)	3 (20%)	0.001
Arteriovenous fistula (%)	0 (0%)	0 (0%)	1.000
Pseudoaneurysm (%)	0 (0%)	1 (6.7%)	0.005
c/w TIMI minor bleeding criteria (%)	0 (0%)	1 (6.7%)	0.005
c/w TIMI major bleeding criteria (%)	0 (0%)	0 (0%)	1.000
In-hospital CV event (%)	9 (7.8%)	5 (33.3%)	0.003
Post-PCI MI (%)	7 (6.0%)	2 (13.3%)	0.293
Q wave (%)	0 (0%)	0 (0%)	1.000
Non-Q wave (%)	7 (6.0%)	2 (13.3%)	0.293
Repeat PCI (%)	1 (0.9%)	1 (6.7%)	0.084
CABG (%)	0 (0%)	0 (0%)	1.000
Acute/subacute thrombosis (%)	1 (0.9%)	1 (6.7%)	0.084
Stroke (%)	0 (0%)	0 (0%)	1.000
Pulmonary edema (%)	1 (0.9%)	1 (6.7%)	0.084
Ventricular tachyarrhythmia (%)	1 (0.9%)	2 (13.3%)	0.002
Cardiac death (%)	1 (0.9%)	2 (13.3%)	0.002
Total death (%)	1 (0.9%)	2 (13.3%)	0.002
Mean duration of hospitalization (days)	6.9 ± 13.3	7.5 ± 9.1	0.867
1-3 (%)	58 (50.0%)	5 (33.3%)	0.461
4-7 (%)	32 (27.6%)	6 (40.0%)	
8-14 (%)	19 (16.4%)	2 (13.3%)	
≥ 15 (%)	7 (6.0%)	2 (13.3%)	

Abbreviations: CABG: coronary artery bypass graft; CHF: congestive heart failure; CV: cardiovascular; c/w: compatible with; MI: myocardial infarction; PCI: percutaneous coronary intervention; TIMI: Thrombolysis In Myocardial Infarction.

wave MI (p = 0.293) following PCI. One (0.9%) patient in the transradial group and one (6.7%) in the transfemoral group suffered early thrombosis requiring repeat PCI (p = 0.084), and none received CABG. The incidence of pulmonary edema was 0.9% in the transradial group and 6.7% in the transfemoral group (p = 0.084). One (0.9%) patient in the transradial group and two (13.3%) in the transfemoral group suffered cardiac death (p = 0.002). The sole cardiac death in the transradial group occurred to one patient who had non-ST elevation MI and EuroSCORE 18 before PCI. The patient developed exacerbation of CHF and renal failure and died of sepsis one week after PCI. One of the two cardiac deaths in the transfemoral group had initial presentation as acute pulmonary edema and EuroSCORE 18, and expired due to pumping failure with fatal ventricular tachyarrhythmia. The other patient who received DCA suffered acute pulmonary edema with subsequent death one day following PCI. The suspected cause of mortality was acute thrombosis. Mean hospital stay of the transradial group was 6.9 ± 13.3 days and of the transfemoral group was 7.5 ± 9.1 days (p = 0 .867).

Table 5 lists MACE six months following PCI. After excluding three in-hospital deaths and two patients lost to follow-up, 113 patients in the transradial group and thirteen patients in the transfemoral group were evaluated. The rate of MACE was higher in the transfemoral group but there was no statistically significant difference (23.1% vs. 8.0%, p = 0.299). Cardiac death occurred in three (2.7%) patients in the transradial group and one (7.7%) in the transfemoral group (p = 0.327). One patient in the transradial group died of gastric cancer. Four (3.5%) patients in the transradial group and two (15.4%) in the transfemoral group received target vessel revascularization (TVR) by PCI (p = 0.468). Only one patient in both groups had transient ischemic stroke one month after ULMCA stenting (p = 0.733). There was neither MI nor thrombosis observed during this period.

Table 5. Six-month Clinical Outcomes

	Transradial (n = 113)	Transfemoral (n = 13)	*p* value
MACE (%)	9 (8.0%)	3 (23.1%)	0.299
Q wave MI (%)	0 (0%)	0 (0%)	1.000
Non-Q wave MI (%)	0 (0%)	0 (0%)	1.000
TVR			
PCI (%)	4 (3.5%)	2 (15.4%)	0.468
CABG (%)	0 (0%)	0 (0%)	1.000
Acute/subacute thrombosis (%)	0 (0%)	0 (0%)	1.000
Stroke (%)	1 (0.9%)	0 (0%)	0.733
Admission due to CHF (%)	0 (0%)	0 (0%)	1.000
Cardiac death (%)	3(2.7%)	1 (7.7%)	0.327
Total death (%)	4 (3.6%)	1 (7.7%)	0.468

Abbreviations: CABG: coronary artery bypass graft; CHF: congestive heart failure; MACE: major adverse cardiovascular events; MI: myocardial infarction; PCI: percutaneous coronary intervention; TVR: target vessel revascularization.

DISCUSSION

This study demonstrated that transradial PCI for ULMCA disease had a procedural success rate comparable to that of transfemoral PCI. Transradial access for PCI is superior to transfemoral access in ease of compression to stop bleeding and facilitate patient mobilization, and the rate of vascular complications are reportedly very low.[1-3] Minor bleeding using a transradial approach occurs in 1% or fewer cases, and almost none have major vascular complications in comparison with 2% in the transfemoral group.[1] Bleeding is also rare in the transradial PCI for protected and unprotected left main diseases.[11] The rate of vascular complications following a transradial approach for ULMCA disease was low in the current study and occurred in only two (1.7%) patients without local bleeding complications. This incidence was similar to that reported in previous studies of PCI for other coronary segments.[1-3]

Transradial PCI does not increase procedure and fluoroscopy time, and hospital stay is even shorter than for a transfemoral approach.[1,2] For left main diseases, Ziakas *et al*. showed that a transradial approach had a procedural success rate comparable to a transfemoral approach without increased procedure time and hospital stay.[11] A 6 Fr guiding catheter was feasible in most cases of PCI, and we used 7 Fr guides on some patients to introduce rotational atherectomy or kissing balloon angioplasty via a transradial approach. In the current study, no significant difference in procedure time and hospital stay was observed between transradial and transfemoral approaches. Therefore, a transradial approach can be used as an alternative to a transfemoral approach for

ULMCA PCI.

In this study, DCA was more frequently applied in the transfemoral group by using a larger guiding catheter, and resulted in significantly greater MLD, RVD and acute gain in comparison to the transradial group, as documented in previous studies.[17] The use of DCA is also beneficial for removing plaque and minimizing plaque shift.[18] Several studies have suggested the feasibility and efficacy of performing DCA before stenting, and a low restenosis rate and acceptable acute results in complex coronary lesions have been documented.[19-22] However, angiographic and clinical restenosis rates did not significantly differ between DCA before stenting and stenting alone in the AMIGO trial.[23] The DESIRE/ AMIGO trial also demonstrated slightly higher MACE with debulking before stenting compared to stenting alone at 30-day follow-up but six-month outcomes showed no difference between these two groups.[23,24] In this series, 26.7% of patients in the transfemoral group underwent DCA but only one (0.9%) patient in the transradial group received DCA. Additionally, implantation of DES revealed a better long-term prognosis than DCA alone or DCA prior bare-metal stenting.[25] Due to the large catheter needed and comparable results, DCA is now rarely used in PCI for ULMCA.[26] Thus, a transradial approach with a small catheter and DES implantation is acceptable in most cases.

The transradial group had a lower rate of in-hospital MACE than the transfemoral group (7.8% vs. 33.4%, $p = 0.003$). The incidence of post-PCI MI, repeat PCI, acute thrombosis and pulmonary edema were also lower in the transradial group but there was no statistical significance. Limited case number in the transfemoral group and too few in-hospital events in both groups might affect the statistical difference. In-hospital results of transradial PCI in this series were consistent with previous studies demonstrating a low TLR rate[27] but the incidence of in-hospital MACE was higher in the transfemoral group. In addition to DCA, a high penetration rate of DES in the transradial group is another possible cause. Palmerini *et al*. found that patients with left main disease treated with DES had a 25% relative risk reduction in the rate of death, MI and TLR compared to those treated with bare-metal stents.[9] The DES penetration rate was as high as 69% in our transradial group but only 20% in the transfemoral group ($p < 0.001$). Moreover, high pressure inflation can reduce subsequent MACE and also the incidence of stent thrombosis.[28-31] As more patients in the transradial group received high pressure inflation compared to the transfemoral group, this might have reduced the incidence of in-hospital MACE in the current study. Previous studies have shown that parameters that predict in-hospital mortality include age, female gender, pre-procedural MI, peripheral artery occlusive disease, CHF and renal insufficiency.[32-34] No difference was noted in the current study between these two groups except that the transfemoral group had a slightly higher proportion of female patients than the transradial group (46.7% vs. 23.3%, $p = 0.052$). Further investigation is required to adjust for possible confounding factors of PCI for ULMCA.

The transfemoral group had a greater proportion of six-month MACE than the transradial group (23.1% vs. 8.0%, $p = 0.299$), without statistical significance for TVR, stroke, cardiac death and total death. Limited case numbers in the transfemoral group might affect the statistical power. Compared to the study by Ziakas *et al,* in which six-month MACE in the transradial group was 14.8% and in the transfemoral group was 25.5%,[11] we had similar results in the transfemoral group and a lower incidence in the transradial group. This may be related to preferring a transradial approach in usual practice in our institute and more DCA in the transfemoral group.

The major limitation of this study was the non-randomized selection of patients for a transradial or transfemoral approach. Selection bias favoring a larger catheter size in the transfemoral group may have occurred due to increased utilization of debulking procedures. Additionally, the transfemoral group had a limited case number.

In conclusion, a transradial approach for ULMCA disease had an equal success rate and a lower vascular complication rate when compared to a transfemoral approach. Although DCA or rotational atherectomy were more frequently used in the transfemoral group than in the transradial group, no improvement in in-hospital and short-term MACE was revealed in the transfemoral group. Therefore, a transradial approach could be considered as an alternative to a transfemoral approach for performing PCI for ULMCA diseases. Future studies may further elucidate intermediate and long-term outcomes.

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未保護左主冠狀動脈狹窄經皮冠狀動脈治療之早期結果：比較經撓動脈與經股動脈途徑

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背 景：經撓動脈施行經皮冠狀動脈治療是可行的，且與經股動脈比較，有相近的成功率。然而只有少數研究有系統的比較經撓動脈與經股動脈兩種途徑對於經皮冠狀動脈治療未保護左主冠狀動脈狹窄的成效。本份研究的主旨是在比較兩種途徑對於經皮冠狀動脈治療未保護左主冠狀動脈狹窄的成功率、血管併發症及早期結果。

方 法：將 2000 年 12 月至 2006 年 10 月共 131 個接受經皮冠狀動脈治療未保護左主冠狀動脈狹窄之病人納入此回溯性研究。

結 果：本研究共收納 116 個 (88.5%) 接受經撓動脈途徑與 15 個 (11.5%) 接受經股動脈途徑的病患。其中 114 個 (98.3%) 經撓動脈途徑及 14 個 (93.3%) 經股動脈途徑的病患達到血管攝影及治療的成功 ($p = 0.876$)。因爲經股動脈途徑的病患較經撓動脈途徑的病患接受較多減容術，因而需要較大管徑的心導管，且經皮冠狀動脈治療後的最小血管內徑也較大。接受經撓動脈途徑較接受經股動脈途徑施行經皮冠狀動脈治療的病患有較低的院內主要心臟併發症 (7.8% 比 33.3%，$p = 0.003$) 及血管併發症 (1.7% 比 26.6%，$p < 0.001$)。六個月的主要心臟併發症在經撓動脈組較經股動脈組低，但無統計意義 (8.0% 比 23.1%，$p = 0.299$)。

結 論：經撓動脈途徑施行經皮冠狀動脈治療未保護左主冠狀動脈疾病較經股動脈途徑有相同的成功率及較低的血管併發症，因此可作爲股動脈的替代途徑。
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關鍵詞：左主冠狀動脈，經皮冠狀動脈治療，經撓動脈，經股動脈

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