Acta Cardiol Sin 2019;35:301–307
Original Article
doi: 10.6515/ACS.201905_35(3).20181025B

Percutaneous Coronary Intervention

A Propensity Score Matching Analysis of Transradial Versus Transfemoral Approaches in Octogenarians Undergoing Percutaneous Coronary Intervention

Yi Xu, Chen Jin, Shubin Qiao, Yongjian Wu, Hongbing Yan, Kefei Dou, Bo Xu and Yuejin Yang

Background: Despite the widespread adoption of the transradial approach for elderly patients undergoing percutaneous coronary intervention (PCI) in clinical practice, data on octogenarians in China are still relatively limited. This study sought to compare both the safety and efficacy of transradial intervention (TRI) and transfemoral intervention (TFI) in octogenarians in China.

Methods: We identified 254 octogenarians who underwent PCIs in Fuwai Hospital, Beijing, China between January 1, 2006 and April 30, 2011. TRI was used in 184 patients and TFI was used in 70 patients. Incidence rates of in-hospital and 1-year clinical outcomes were compared between the two groups. Ono-to-one propensity score matching (PSM) was performed to control for potential bias. A total of 48 pairs were matched.

Results: Baseline and procedural characteristics were balanced between the TRI and TFI groups. Patients undergoing TRI had significantly fewer access site complications (10.3% vs. 20.0%, p = 0.040), although this difference did not remain significant in propensity score-matched patients (10.4% vs. 22.9%, p = 0.100). After PSM, the patients undergoing TRI were less likely to have major post-PCI bleeding (0 vs. 12.5%, odds ratio 0.47, 95% confidence interval 0.37-0.58, p = 0.026). There were no statistical differences in the incidence rates of major adverse cardiac events (a composite of cardiac death, myocardial infarction, and target vessel revascularization) and their components both during hospitalization and at 1-year.

Conclusions: Compared with TFI, TRI was safer and more feasible for octogenarians undergoing PCI.

Key Words: Coronary artery disease • Octogenarian • Percutaneous coronary intervention • Transfemoral intervention • Transradial intervention

INTRODUCTION

Transradial interventions (TRI), as opposed to traditional transfemoral intervention (TFI), has been increasingly adopted for percutaneous coronary intervention (PCI) due to its potential advantages. Previous studies have demonstrated fewer access site-related bleeding and vascular complications, shorter length of stay, and better satisfaction in patients undergoing TRI.[1-11]

Due to extended life expectancy and stagnation of birth rates, our society is aging rapidly. Elderly patients with coronary artery disease represent a growing population who will benefit from PCI. Nevertheless, they have also been reported to have higher risks of access site-related complications, postprocedural bleeding, and

Received: November 2, 2017 Accepted: October 25, 2018
Fuwai Hospital, National Center of Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China.
Corresponding author: Dr. Yuejin Yang, State Key Laboratory of Cardiovascular Disease, Fuwai Hospital, National Center of Cardiovascular Diseases, Chinese Academy of Medical Sciences and Peking Union Medical College, No. 167, Beilishi Rd., Beijing, 100037, China. Tel: +86 10 88398760; Fax: +86 10 68331730; E-mail: yangyjfw@126.com

mortality.[12-15] Several studies have shown the safety and efficacy of TRI in octogenarians,[16-19] but data on TRI in octogenarians in China are still limited. Using data from the Fuwai database, a single-center registry based on the largest heart center in the People's Republic of China, we sought to examine the safety and efficacy of TRI in octogenarians in China.

MATERIALS AND METHODS

Our study population consisted of a consecutive cohort of octogenarians who underwent PCI between January 1, 2006 and April 30, 2011, at Fuwai Hospital in Beijing, China. We identified 254 patients, of whom 184 had TRI and 70 had TFI. The Institutional Review Board of Fuwai Hospital, Peking Union Medical College, approved the study and waived the requirement for informed consent.

The primary endpoints were in-hospital and 1-year major adverse cardiac events (MACE), defined as a composite of cardiac death, myocardial infarction, and target vessel revascularization. Secondary endpoints included each component of in-hospital and 1-year MACE, access site complications, and major bleeding.

Access site complications were defined as local hematoma that prolonged hospital stay, mediastinal hematoma, retroperitoneal hematoma, aneurysm, and arteriovenous fistula. Bleeding was defined according to the Bleeding Academic Research Consortium (BARC) definition,[20] and a bleeding event with BARC grade ≥ 3 was considered to indicate major bleeding. Th patients' baseline, angiographic, and procedural characteristics were obtained from the medical record system and the catheterization laboratory's database. In-hospital outcomes were validated by medical record review. Follow-up work was performed by trained personnel at Fuwai Hospital via phone visits at 6 months and 1 year after discharge.

Continuous variables were expressed as mean $\pm$ standard deviation and compared using the Student's *t* test. Categorical variables were described using frequencies and percentages and compared using the chi-square test or Fisher's exact test, as appropriate. Clinical outcomes between the TRI and TFI groups were analyzed by logistic regression and expressed as odds ratio (OR)/hazard ratio (HR) and 95% confidence interval (CI).

Since treatment decisions in real-world practice are not made based on randomization, 1:1 propensity score matching (PSM) was performed to control for potential bias. Propensity scores were calculated using a logistic regression model with access route as the dependent variable. Independent variables included age; gender; prior history of myocardial infarction (MI), coronary artery bypass grafting (CABG) surgery, PCI, stroke, diabetes mellitus, hypertension, or hyperlipidemia; clinical diagnosis; left ventricular ejection fraction (LVEF) before PCI; hemoglobin level before PCI; creatinine concentration before PCI; use of anticoagulant agents; single-, double-, or triple-vessel lesions; left main disease; lesion type (de novo, intrastent, or restenosis); lesion location (ostial or bifurcation lesion); sheath size; number of treated lesions; number of stents used; and the use of drug-eluting stents. In order to prevent poor matches, the caliper was set as 0.05. A total of 48 pairs were matched, and the C-statistics for the propensity score model was 0.69. The paired *t* test for continuous variables and paired chi-square test or Fisher's exact test for categorical variables were then performed within the matched pairs of patients. Data were analyzed according to the intention-to-treat principle (before potential crossover). All statistical analyses were performed using IBM SPSS software, version 22.0 (IBM Corp, Armonk, New York) and a 2-sided $p < 0.05$ was considered to be significant.

RESULTS

A total of 254 patients underwent PCI between January 1, 2006 and April 30, 2011. TRI was performed in 184 patients (72.4%). The baseline and procedural characteristics of the patients are shown in Tables 1 and 2. Compared with TFI, the patients undergoing TRI had fewer prior MI and CABG and were more likely to have triple-vessel lesions ($p < 0.05$). They also had higher mean LVEF (mean 60.1% vs. 56.8%, $p = 0.004$), with 12.0% being lower than 50% ($p = 0.617$, compared with the TFI group). A $\leq$ 6F sheath was more frequently used in the TRI patients (98.4% vs. 84.3%, $p < 0.001$). There were no significant differences between the two groups with regards to other baseline and procedural characteristics. After PSM, all characteristics were well-balanced between the TRI and TFI patients.

Table 1. Baseline characteristics of octogenarians undergoing transradial (TRI) and transfemoral intervention (TFI)

Characteristics	All patients			Propensity score-matched patients		
	TRI, n = 184 (%)	TFI, n = 70 (%)	p	TRI, n = 48 (%)	TFI, n = 48 (%)	p
Age, year*	82.1 ± 2.6	81.6 ± 1.7	0.171	81.9 ± 2.2	81.7 ± 1.9	0.593
Female	59 (32.1)	23 (32.9)	0.904	16 (33.3)	18 (37.5)	0.670
Medical history of						
Myocardial infarction	41 (22.3)	27 (38.6)	0.014	16 (33.3)	18 (37.5)	0.670
Prior CABG	2 (1.1)	16 (22.9)	< 0.001	2 (4.2)	4 (8.3)	0.677
Prior PCI	39 (21.2)	20 (28.6)	0.214	14 (29.2)	13 (27.1)	0.820
Stroke	14 (7.6)	7 (10.0)	0.813	7 (14.6)	7 (14.6)	1
Diabetes mellitus	44 (23.9)	21 (30.0)	0.321	12 (25.0)	12 (25.0)	1
Hypertension	119 (64.7)	50 (71.4)	0.308	31 (64.6)	30 (62.5)	0.832
Hyperlipidemia	87 (47.3)	28 (40.0)	0.297	17 (35.4)	16 (33.3)	0.830
Diagnosis						
STEMI	41 (22.3)	20 (28.6)	0.294	15 (31.2)	18 (37.5)	0.519
NSTEMI	12 (6.5)	4 (5.7)	0.536	3 (6.2)	3 (6.2)	1
Unstable angina	84 (45.7)	28 (40.0)	0.418	21 (43.8)	17 (35.4)	0.404
Stable angina	44 (23.9)	18 (25.7)	0.765	8 (16.7)	10 (20.8)	0.601
Others	3 (1.6)	0 (0)	0.671	1 (2.1)	0 (0)	1
LVEF, %*	60.1 ± 9.3	56.8 ± 7.6	0.004	57.2 ± 9.8	56.7 ± 7.8	0.817
LVEF < 50%	22 (12.0)	10 (14.3)	0.617	10 (20.8)	7 (14.6)	0.423
Hemoglobin, g/L*	125.4 ± 15.2	125.5 ± 18.8	0.971	129.6 ± 15.6	124.0 ± 19.7	0.138
Creatinine, μmol/L*	90.8 ± 35.1	93.9 ± 20.3	0.572	87.1 ± 21.5	93.6 ± 24.2	0.272
GP IIb/IIIa usage	7 (3.8)	2 (2.9)	0.715	3 (6.2)	2 (4.2)	1
LMWH usage	120 (65.2)	46 (65.7)	0.941	36 (75.0)	30 (62.5)	0.186
Fondaparinux sodium usage	4 (2.2)	4 (5.7)	0.221	2 (4.2)	2 (4.2)	1

CABG, coronary arterial bypass grafting; GP, glycoprotein; LMWH, low molecular weight heparin; LVEF, left ventricle ejection fraction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; SD, standard deviation; STEMI, ST-segment elevation myocardial infarction.
* Presented as mean ± SD.

Table 2. Angiographic and procedural characteristics of octogenarians undergoing transradial (TRI) and transfemoral intervention (TFI)

Characteristics	All patients			Propensity score-matched patients		
	TRI, n = 184 (%)	TFI, n = 70 (%)	p	TRI, n = 48 (%)	TFI, n = 48 (%)	p
Procedural success	181 (98.4)	70 (100)	0.563	47 (97.9)	48 (100)	1
Left main disease	21 (11.4)	15 (21.4)	0.065	6 (12.5)	9 (18.8)	0.399
Diseased coronary vessels						
Single vessel	37 (20.1)	10 (14.3)	0.286	6 (12.5)	5 (10.4)	0.749
Double vessel	58 (31.5)	16 (22.9)	0.174	13 (27.1)	12 (25.0)	0.816
Triple vessel	89 (48.4)	44 (62.9)	0.039	29 (60.4)	31 (64.6)	0.673
Lesion type						
De novo	179 (97.3)	65 (92.9)	0.144	46 (95.8)	46 (95.8)	1
Intra stent	5 (2.7)	3 (4.3)	0.688	2 (4.2)	1 (2.1)	1
Restenosis	0 (0)	2 (2.9)	0.075	0 (0)	1 (2.1)	1
Lesion location						
Ostial lesion	22 (12.0)	8 (11.4)	0.907	11 (22.9)	5 (10.4)	0.100
Bifurcation lesion	60 (32.6)	21 (30.0)	0.690	12 (25.0)	11 (22.9)	0.811
Chronic total occlusion	22 (12.0)	5 (7.1)	0.266	7 (14.6)	4 (8.3)	0.336
Sheath size ≤ 6F	181 (98.4)	59 (84.3)	< 0.001	45 (93.8)	47 (97.9)	0.617
Number of treated lesion*	1.3 ± 0.5	1.4 ± 0.7	0.171	1.3 ± 0.5	1.4 ± 0.7	0.135
Number of stents used*	1.7 ± 0.8	1.7 ± 1.1	0.938	1.7 ± 0.7	1.7 ± 1.1	0.829
DES usage	174 (94.6)	62 (88.6)	0.106	45 (93.8)	40 (83.3)	0.109
Intravascular ultrasound	10 (5.4)	2 (2.9)	0.520	4 (8.3)	0 (0)	0.117
IABP support	14 (7.6)	7 (10.0)	0.611	4 (8.3)	3 (6.2)	1
Total procedure time, minute*	38.2 ± 22.5	41.4 ± 20.2	0.303	37.3 ± 18.5	40.8 ± 19.5	0.375
Contrast volume, ml*	155.8 ± 72.0	147.0 ± 63.7	0.388	158.5 ± 67.0	150.9 ± 69.8	0.606
Dissection	1 (0.5)	1 (1.4)	0.476	0 (0)	1 (2.1)	1
Acute thrombosis	1 (0.5)	3 (4.3)	0.065	0 (0)	3 (6.2)	0.242

DES, drug-eluting stents; IABP, intra-aortic balloon pump; SD, standard deviation.
* Presented as mean ± SD.

Six patients (2.4%) failed TRI procedures and were converted to TFI. No patients in the TFI group crossed over to the TRI group. A vascular closure device was used in 30 patients (42.9%) in the TFI group.

Data on bleeding and complications from PCI are shown in Table 3. The incidence rates for BARC ≥ 2 (10.9% vs. 24.3%, p = 0.007) and BARC ≥ 3 (2.7% vs. 10.0%, p = 0.022) post-PCI bleeding were both significantly lower in the TRI group than the TFI group. Moreover, access-site-related major bleeding was less frequently observed among the TRI patients (1.1% vs. 7.1%, p = 0.018). Non-access-site-related major bleeding also tended to be less frequent in the TRI group, but this did not reach statistical significance. The TRI group had fewer access site complications (10.3% vs. 20.0%, p = 0.040). Despite these differences, the transfusion rate was similar between the two groups. In the propensity score-matched patients, rates of BARC ≥ 2 (12.5% vs. 29.2%, p = 0.044) and BARC ≥ 3 (0 vs. 12.4%, p = 0.026) bleeding remained significantly lower, while the rate of access site complications did not (10.4% vs. 22.9%, p = 0.100).

The in-hospital outcomes are shown in Table 4. The rates of MACE, cardiac death, myocardial infarction, and target vessel revascularization were similar in the two groups both before and after PSM. However, the TRI pa-

Table 3. Bleeding and complications of octogenarians undergoing transradial (TRI) and transfemoral (TFI) intervention

Complications	All patients			Propensity score-matched patients		
	TRI, n = 184 (%)	TFI, n = 70 (%)	p	TRI, n = 48 (%)	TFI, n = 48(%)	p
BARC ≥ 2 bleeding	20 (10.9)	17 (24.3)	0.007	6 (12.5)	14 (29.2)	0.044
BARC ≥ 3 bleeding	5 (2.7)	7 (10.0)	0.022	0 (0)	6 (12.5)	0.026
Access-site-related major bleeding	2 (1.1)	5 (7.1)	0.018	0 (0)	4 (8.3)	0.117
Non-access-site-related major bleeding	3 (1.6)	2 (2.9)	0.618	0 (0)	2 (4.2)	0.495
Access site complications	19 (10.3)	14 (20.0)	0.040	5 (10.4)	11 (22.9)	0.100
Local hematoma	18 (10.3)	10 (14.2)	0.306	5 (10.4)	9 (18.8)	0.247
Mediastinal hematoma	0	0	1	0	0	1
Retroperitoneal hematoma	0	2 (2.9)	0.021	0	1 (2.1)	1
Aneurysm	1 (0.5)	2 (2.9)	0.185	0 (0)	1 (2.1)	1
Arteriovenous fistula	0	0	1	0	0	1
Transfusion	2 (1.1)	4 (5.7)	0.051	0 (0)	2 (4.2)	0.495

BARC, bleeding academic research consortium.

Table 4. In-hospital and 1-year outcomes of octogenarians undergoing transradial (TRI) and transfemoral (TFI) intervention

Outcomes	All patients				Propensity score-matched patients			
	TRI n = 184 (%)	TFI n = 70 (%)	OR/HR (95% CI)	p	TRI n = 48 (%)	TFI n = 48 (%)	OR/HR (95% CI)	p
In-hospital outcomes								
MACE	10 (5.4)	7 (10.0)	0.52 (0.19-1.41)	0.200	4 (8.3)	5 (10.4)	0.78 (0.44-1.39)	1
Cardiac death	6 (0.4)	3 (1.1)	0.56 (0.09-3.44)	0.535	2 (4.2)	2 (4.2)	1 (0.37-2.72)	1
MI	2 (2.7)	4 (5.7)	0.61 (0.21-1.84)	0.586	3 (6.2)	4 (8.3)	0.87 (0.44-1.70)	1
Target vessel revascularization	4 (2.2)	2 (2.9)	0.76 (0.14-4.22)	0.749	0 (0)	0 (0)	NA	NA
Major bleeding	5 (2.7)	7 (10.0)	0.25 (0.08-0.82)	0.022	0 (0)	6 (12.5)	0.47 (0.37-0.58)	0.026
One-year outcomes								
MACE	8 (4.3)	5 (7.1)	0.61 (0.20-1.85)	0.378	6 (12.5)	5 (10.4)	1.17 (0.36-3.84)	0.793
Cardiac death	4 (2.2)	5 (7.1)	0.30 (0.08-1.11)	0.073	3 (6.1)	5 (10.4)	0.57 (0.14-2.39)	0.442
MI	3 (1.6)	1 (1.4)	1.13 (0.12-10.89)	0.914	2 (4.1)	1 (2.1)	1.91 (0.17-21.02)	0.598
Target vessel revascularization	4 (2.2)	1 (1.4)	1.51 (0.17-13.55)	0.711	3 (6.1)	1 (2.1)	2.88 (0.30-27.68)	0.360

CI, confidence interval; HR, hazard ratio; OR, odds ratio; MACE, major adverse cardiac events (a composite of cardiac death, myocardial infarction, and target vessel revascularization); MI, myocardial infarction; NA, not applicable.

tients were less likely to suffer from major bleeding than the TFI patients during the index hospitalization (OR: 0.47, 95% CI: 0.37-0.58, p = 0.026).

Follow-up work was completed in all 254 patients with a median follow-up time of 362 days [interquartile range (IQR), 354-365 days] and 363 days (IQR, 356-366 days) for the TRI and TFI groups, respectively. The Kaplan-Meier curves for 1-year clinical outcomes are shown in Figure 1. There were no significant differences between the two groups with regards to 1-year MACE and the components (p > 0.05).

DISCUSSION

Due to the advantages of fewer access site-related bleeding and vascular complications, shorter length of stay, and better patient satisfaction, the transradial approach has been widely adopted over the past decade.[1-11] The safety and feasibility of TRI in octogenarians have also been reported.[16-19] Consistent with these studies, we found that the patients undergoing TRI had fewer access site complications and were less likely to suffer from post-PCI bleeding. After controlling for potential bias using propensity score analysis, they were still less likely to suffer from post-PCI bleeding. There were no statistical differences in the incidence rates of MACE and the components both during hospitalization and at 1-year. Taken together with previous studies which were conducted outside China,[16-18] our findings support the current recommendations[21,22] for the use of radial artery access in PCI, and add evidence to promote more widespread adoption of TRI in octogenarians.

Compared with their younger counterparts, octogenarians undergoing PCI are at a higher risk of complications, including access site complications.[14,23,24] A lower risk of access site complications is considered to be one of the major benefits of TRI, however most of the studies supporting this idea have been conducted in younger populations.[25] Coronary artery catheterization from a transradial approach is more technically demanding[26,27] and may become even more difficult in octogenarians who have advanced vascular diseases. However, previous studies on TRI versus TFI in octogenarians have all shown positive results. The OCTOPLUS study, a randomized study on TRI versus TFI in octogenarians, showed a significantly lower rate of hematoma in the transradial group.[17] Jaffe et al.[18] also reported reduced rates of access site bleeding, hematoma, and other vascular complications in octogenarians undergoing TRI. Koutouzis et al.[16] found a similar trend of such benefits with the transradial approach, although the difference was not significant. Consistent with previous data, we found that our TRI patients were less likely to suffer from access site complications (10.3% vs. 20.0%, p = 0.040). However, the difference did not remain significant after PSM (10.4% vs. 22.9%, p = 0.100). This lack of significance was probably due to a limited number of propensity score matched patients, because the rate of access site complications was still numerically lower.

Bleeding has been identified as a strong predictor of worst outcomes after PCI.[28,29] Several strategies have emerged to reduce the risk of post-PCI bleeding, including pharmacological, technological, and procedural approaches.[30] As a procedural approach, TRI has been shown to reduce bleeding in both randomized[1,9,11] and observational[4,8,10] studies. The updated European guidelines also recommend choosing TRI over TFI for coronary angiography and PCI in order to reduce the incidence of

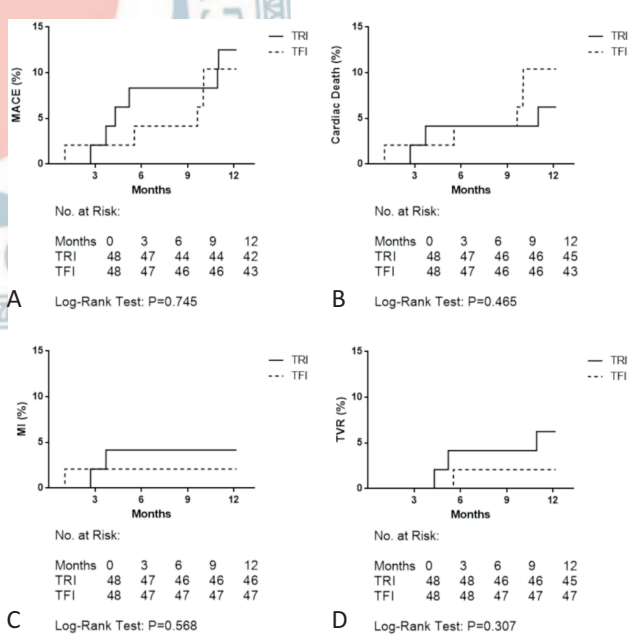

Figure 1. *Kaplan-Meier curves for occurrence of MACE (A), cardiac death (B), MI (C), and TVR (D) between groups of TRI and TFI at 1-year in propensity score-matched patients. MACE, major adverse cardiac events (a composite of cardiac death, myocardial infarction, and target vessel revascularization); MI, myocardial infarction; TFI, transfemoral intervention; TRI, transradial intervention; TVR, target vessel revascularization.*

bleeding.[31] The physiological reasons for recommending TRI are evident: radial arteries are superficial and readily compressible in clinical practice. Consistent with previous analyses, we found that rates of BARC ≥ 2 and BARC ≥ 3 post-PCI bleeding were significantly lower in the patients undergoing TRI both before and after PSM. TRI was also associated with reduced post-PCI major bleeding (OR: 0.47, 95% CI: 0.37-0.58, p = 0.026). These findings further support the idea that using the transradial approach in octogenarians can lead to improved outcomes after PCI.

Some limitations of this study should be acknowledged. First, it was limited by its nonrandomized nature. Treatment decisions in real-world practice are often made based on prognostic factors rather than results of randomization. Although propensity score matching was performed to control for potential bias, it still cannot be considered a substitute for a randomized prospective study. Second, this study only included data from a single center, although this is the largest and most experienced center in China. Importantly, the benefit of TRI over TFI likely depends on the operators' experience and their training with the radial technique,[26,32,33] both of which may differ from site to site. Thus, the generalizability of our findings to other less-experienced centers remains to be further established.

CONCLUSIONS

In this retrospective study of TRI versus TFI in Chinese octogenarians based on propensity score analysis, TRI showed the advantages of safety and feasibility over TFI. A wider adoption of TRI in octogenarians has the potential to improve outcomes in the treatment of coronary artery diseases.

DECLARATION OF CONFLICT OF INTEREST

All the authors declare no conflict of interest.

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