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ORIGINAL ARTICLE

Transradial *Versus* Transfemoral Approach for Percutaneous Coronary Intervention in Elderly Patients in China: A Retrospective Analysis

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Key words: coronary artery disease; cost-benefit analysis; percutaneous coronary intervention; aged; transradial intervention; transfemoral intervention

Objective To compare hospital costs and clinical outcomes between transradial intervention (TRI) and transfemoral intervention (TFI) in elderly patients aged over 65 years.

Methods We identified 1229 patients aged over 65 years who underwent percutaneous coronary intervention (PCI) in Fuwai Hospital, Beijing, China, between January 1 and December 31, 2010. Total hospital costs and in-hospital outcomes were compared between TRI and TFI. An inverse probability weighting (IPW) model was introduced to control potential biases.

Results Patients who underwent TRI were younger, less often female, more likely to receive PCI for single-vessel lesions, and less likely to undergo the procedure for ostial lesions. TRI was associated with a cost saving of CNY7495 (95%CI: CNY4419-10 420). Such differences were mainly driven by lower PCI-related costs. TRI patients had shorter length of stay (1.9 days, 95%CI: 1.1-2.7 days), shorter post-procedural stay (0.7 days, 95%CI: 0.3-1.1 days), and fewer major adverse cardiac events (adjusted odds ratio = 0.47, 95%CI: 0.31-0.73). There was no statistical significance in the incidence of post-PCI bleeding between TRI and TFI ($P>0.05$). Such differences remained consistent in clinically relevant subgroups of acute myocardial infarction, acute coronary syndrome, and stable angina.

Conclusion The use of TRI in patients aged over 65 years was associated with significantly reduced hospital costs and more favorable clinical outcomes.

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TRANSRADIAL intervention (TRI) is being increasingly adopted for percutaneous coronary intervention (PCI) due to its potential advantages over transfemoral intervention (TFI). Previous studies have demonstrated fewer access site-related bleeding and vascular complications, shorter length of stay, and better satisfaction in patients undergoing TRI.¹⁻⁹

Elderly patients with coronary artery disease (CAD) are a growing population who will benefit from PCI. Nevertheless, they are also reported to have a higher risk of access site-related complications and post-procedural bleeding.¹⁰⁻¹³ So far several studies have evaluated the safety and efficacy of TRI in elderly patients,¹⁴⁻¹⁸ but none of them have taken the economic consequences into consideration. Using data from the Fuwai PCI database, a single-center registry from the largest heart center in the People's Republic of China, we sought to compare both hospital costs and clinical outcomes between TRI and TFI in elderly patients aged over 65 years.

PATIENTS AND METHODS

Patients

Our study population consisted of a consecutive cohort of 1490 patients aged over 65 years who underwent PCI between January 1 and December 31, 2010, at Fuwai Hospital, Beijing, China. We excluded patients who underwent >1 PCI procedure during hospitalization ($n=126$), who presented with chronic total occlusion ($n=32$) or cardiogenic shock ($n=5$), who were enrolled in other clinical trials ($n=31$), who underwent a pre-procedural intra-aortic balloon pump ($n=21$), or who had missing information on cost data ($n=46$). After these exclusions, our study population consisted of 1229 patients, of whom 1033 (84.1%) had TRI and 196 had TFI.

The institutional review board of Fuwai Hospital, Chinese Academy of Medical Sciences, approved the study and waived the requirement for informed consent.

Hospital costs

The primary outcome was hospital costs, which was defined as the total cost of an in-hospital stay from the day of admission through discharge. All cost data were obtained from the hospital's accounting system and were further divided into the following categories: PCI-related costs, medication costs, examination costs, transfusion costs, and hospitalization costs inclusive of bed, physician fee, and nursing services.

Clinical outcomes

Since it would be impractical to solely study economic consequences in real-life clinical practice, we also compared clinical outcomes between TRI and TFI. That included post-PCI bleeding events, major adverse cardiac events (MACE),

length of stay, and post-procedural stay. Bleeding was defined according to the Bleeding Academic Research Consortium (BARC) definition.¹⁹ For the purpose of our study, BARC ≥ 2 or ≥ 3 bleeding were reported. MACE was a composite of death, myocardial infarction, revascularization, and BARC ≥ 3 bleeding during the index hospitalization. Post-PCI bleeding and MACE were validated by medical record review.

Statistical analysis

The distributions of continuous variables were described using mean and standard deviation. Categorical variables were described with frequencies and percentages. Baseline and procedural characteristics were compared using standardized differences, which was calculated as the difference in means or proportions divided by a pooled estimate of the standard deviation.²⁰ Unlike traditional significance tests such as *t* tests or chi-square tests, standardized differences are not influenced by sample size and are therefore commonly used to compare the distribution of baseline covariates between treatment groups in propensity score analysis. An absolute standardized difference >10 indicates significant imbalance of a covariate.²¹

Since treatment decisions in real-world practice are often made based on prognostic factors rather than randomization, an inverse probability weighting (IPW) method was introduced to control potential biases. In short, the IPW is an extension of the propensity score method.²²⁻²³ The propensity score is the probability of exposure to treatment conditional on observed covariates, and it can be used in comparative effectiveness studies to balance covariates across treatment groups. This can be achieved *via* matching, stratification, regression adjustment, or IPW. In the present study, we used IPW, because the difference in the sample size between TRI and TFI cohort was disparate, which would limit the number of matched pairs or strata and thus influence the result of analyses.²²⁻²³ Moreover, this method has the advantage of allowing adjustment for more confounding factors, and producing less biased estimates to evaluate comparative effectiveness.²² By using the IPW method, weights were obtained from a logistic regression model with access approach (TRI or TFI) as the only dependent variable and all other confounding factors as independent variables. Independent variables included age, gender, heart rate, systolic and diastolic blood pressure, prior history of coronary arterial bypass grafting (CABG), PCI, myocardial infarction, stroke, diabetes mellitus, hypertension, hyperlipidemia, clinical diagnosis [ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), unstable angina, or stable angina], left ventricle ejection fraction

(LVEF) before PCI, primary PCI, creatinine concentration before PCI, arterial sheath size, single-, double-, or triple-vessel lesion, left main disease, lesion type (*de novo*, intra stent, or restenosis), lesion location (ostial or bifurcation lesion), number of treated lesion, number of stents used, stent type (drug-eluting stent and/or bare metal stent), and domestic *versus* imported stents (due to cost differences). Use of intravascular ultrasound (IVUS) was not included in the logistic regression model, since it was used after deciding the access site. Because of their exclusive role in TFIs, vascular closure devices were also not included in the model. Missing continuous variables were replaced with the mean of the variable, and missing categorical variables were imputed with the maximum frequency.

Estimation of TRI *versus* TFI effect was derived by solving the IPW estimating equations after the weights were obtained. The relationship between TRI *versus* TFI and study outcomes were then estimated using IPW regression models, including the generalized linear model with log link for cost, length of stay, and post-procedural

stay, as well as the logistic regression model for other clinical outcomes. Hospital costs and clinical outcomes were analyzed according to intention-to-treat principle (before the potential crossover). Significance tests and confidence intervals (CI) for estimations were based on robust standard errors. Pre- and post-IPW balances of the covariates between TRI and TFI were assessed using standardized difference. Subgroup analyses were performed in clinically relevant subgroups of acute myocardial infarction [STEMI and NSTEMI], acute coronary syndrome [STEMI, NSTEMI, and unstable angina], and stable angina.

All *P* values were 2-sided and *P* < 0.05 was considered statistically significant. All statistical analyses were performed using SAS 9.3 (SAS Institute).

RESULTS

Among 1229 patients aged over 65 years who were eligible for the analysis, there was no crossover from transradial to transfemoral approach.

Baseline and procedural characteristics of TRI and TFI cohorts are shown in Table 1 and 2. Compared with TFI, patients

Table 1. Baseline characteristics of elderly patients undergoing TRI and TFI

Characteristics	TRI group	TFI group	Standardized difference
<i>n</i>	1033	96	18.5
Age [§] (yrs)	71.0±8.4	71.7±3.9	
Female [<i>n</i> (%)]	361 (34.9)	98 (50.0)	30.8
Medical history			
Myocardial infarction [<i>n</i> (%)]	174 (16.8)	44 (22.4)	14.1
Prior CABG [<i>n</i> (%)]	12 (1.2)	19 (9.7)	38.3
Prior PCI [<i>n</i> (%)]	179 (17.3)	56 (28.6)	27.0
Stroke [<i>n</i> (%)]	107 (10.4)	27 (13.8)	10.5
Diabetes mellitus [<i>n</i> (%)]	278 (26.9)	72 (36.7)	21.2
Hypertension [<i>n</i> (%)]	711 (68.8)	141 (71.9)	6.8
Hyperlipidemia [<i>n</i> (%)]	623 (60.3)	110 (59.2)	2.3
Diagnosis			
STEMI [<i>n</i> (%)]	131 (12.7)	15 (7.7)	16.7
NSTEMI [<i>n</i> (%)]	45 (4.4)	8 (4.1)	1.4
Unstable angina [<i>n</i> (%)]	554 (53.6)	110 (56.1)	5.0
Stable angina [<i>n</i> (%)]	274 (26.5)	56 (28.6)	4.6
Vital signs			
Heart rate [§] (bpm)	69.1±10.6	69.1±8.7	0.1
Systolic blood pressure [§] (mm Hg)	132.2±17.8	132.7±18.8	2.6
Diastolic blood pressure [§] (mm Hg)	77.3±24.0	76.2±9.9	6.0
LVEF [§] (%)	62.2±7.6	60.8±7.9	17.9
Creatinine [§] (μmol/L)	84.4±20.7	84.1±21.4	1.2

§: Plus-minus values are means±SD.

TRI: transradial intervention; TFI: transfemoral intervention; CABG: coronary arterial bypass grafting; PCI: percutaneous coronary intervention; STEMI: ST-segment elevation myocardial infarction; NSTEMI: non-ST-segment elevation myocardial infarction; LVEF: left ventricle ejection fraction.

Table 2. Procedural characteristics of elderly patients undergoing TRI and TFI

Characteristics	TRI group	TFI group	Standardized difference
<i>n</i>	1033	196	
Artery sheath size [§] (F)	6.0±0.2	6.1±0.3	33.5
Diseased coronary vessels	978	171	
Single vessel [<i>n</i> (%)]	236 (24.1)	31 (18.1)	14.7
Double vessel [<i>n</i> (%)]	344 (35.2)	63 (36.8)	3.5
Triple vessel [<i>n</i> (%)]	398 (40.7)	77 (45.0)	8.8
Left main disease [<i>n</i> (%)]	69 (7.1)	15 (8.8)	6.4
Lesion type			
<i>De novo</i> [<i>n</i> (%)]	1334 (98.4)	252 (95.8)	15.3
Intra stent [<i>n</i> (%)]	17 (1.3)	5 (1.9)	5.2
Restenosis [<i>n</i> (%)]	5 (0.4)	6 (2.3)	16.8
Lesion location			
Ostial lesion [<i>n</i> (%)]	160 (11.6)	47 (17.6)	16.9
Bifurcation lesion [<i>n</i> (%)]	430 (31.4)	95 (35.4)	8.6
Number of treated lesion Median (IQR)	1 (1-2)	1 (1-2)	9.9
Number of stents used Median (IQR)	2 (1-2)	2 (1-2)	4.8
Stent type			9.1
Drug-eluting only [<i>n</i> (%)]	1030 (99.7)	194 (99.0)	
Drug-eluting and bare metal [<i>n</i> (%)]	3 (0.3)	2 (1.0)	
Domestic vs. imported stents			7.0
Domestic only [<i>n</i> (%)]	544 (52.7)	110 (56.1)	
Imported only [<i>n</i> (%)]	462 (44.7)	81 (41.3)	
Domestic and imported [<i>n</i> (%)]	27 (2.6)	5 (2.6)	
Intravascular ultrasound [<i>n</i> (%)]	30 (2.9)	14 (5.3)	16.4
Vascular closure devices [<i>n</i> (%)]	0 (0)	141 (71.9)	226.4

§: Plus-minus values are means±SD.

IQR: interquartile range.

undergoing TRI were slightly younger (average 71.0 vs. 71.7 years); less often female (34.9% vs. 50.0%); less likely to have prior history of myocardial infarction, CABG, PCI, stroke, and diabetes mellitus; and more likely to present with STEMI on admission (all standardized differences >10).

A 6-French arterial sheath was used for the majority of patients in both groups. Patients undergoing TRI were more likely to undergo PCI for single-vessel lesions, but less likely to receive the procedure for ostial

lesions, or use IVUS during the interventional procedure. The number of treated lesions and the number of stents used, as well as the proportion of domestic to imported stents implanted, were similar between TRI and TFI cohorts. Vascular closure devices (CNY3000, approximately USD455) were used in 71.9% of TFI patients, while all TRI patients used manual compression or a radial compression band that costs less than CNY300 (USD45).

After being adjusted for all observed characteristics

by the propensity score IPW method, all observed characteristics were well balanced between TRI and TFI cohorts (Fig. 1).

Hospital costs and clinical outcomes of TRI and TFI cohorts are shown in Table 3. The average total hospital costs were CNY59 044 (USD8946) for TRI and CNY68 997 (USD10 454) for TFI. After IPW adjustment for all confounders, TRI was associated with a cost saving of CNY7495 (USD1136) (95%CI CNY4419-10420). More than 50% of such difference was due to lower PCI-related costs (adjusted difference CNY4067), which was partially driven by the exclusive use of vascular closure devices in TFI. Similarly, the hospitalization costs (adjusted difference CNY1394), medication costs (adjusted difference CNY1360), and examination costs (adjusted difference CNY671) were all significantly lower in TRI patients ($P=0.0004$, $P=0.0007$, and $P=0.0133$, respectively). There was no transfusion cost, since none of the patients received blood transfusion.

The unadjusted rates of MACE were 2.9% for TRI

and 5.6% for TFI. After IPW adjustment, TRI patients were less likely to suffer from MACE (adjusted odds ratio 0.47, 95%CI 0.31-0.73) than TFI patients during the index hospitalization. There was no statistical significance in the incidence of BARC ≥ 2 or BARC ≥ 3 bleeding between TRI and TFI (all $P>0.05$). Both the length of stay and post-procedural stay were shorter in TRI cohort (length of stay, 6.7 vs. 8.9 days, adjusted difference -1.9 days, 95%CI -2.7 to -1.1; postprocedural stay, 3.6 vs. 4.2 days, adjusted difference -0.7 days, adjusted difference -1.1 to -0.3).

A total of 199 patients underwent PCI for acute myocardial infarction; 863 underwent PCI for acute coronary syndrome; and 330 underwent PCI for stable angina (Table 4). Subgroup analyses showed similar trends of lower hospital costs, fewer MACE, shorter length of stay, and shorter post-procedural stay with TRI, though not all differences were statistically significant in these clinically relevant subgroups.

Figure 1. Comparisons of baseline and procedural characteristics between transradial and transfemoral intervention groups before and after IPW adjustment.

A standardized difference >10 indicates significant imbalance between the two groups.

MI: myocardial infarction; DES: drug-eluting stent; BMS: bare metal stent; IPW: inverse probability weighting.

Table 3. Comparisons of hospital costs and clinical outcomes between the groups of TRI and TFI

Items	TRI group	TFI group	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	P value
<i>n</i>	1033	196			
Hospital costs [mean (95%CI), CNY]					
Total cost	59 044 (54 995-63 392)	68 997 (63 172-75 359)	-9953 (-12 610 to -7171)*	-7495 (-10 420 to -4419)*	<0.0001
PCI-related costs	44 411 (41 604-47 407)	50 363 (46 865-54 122)	-5952 (-7770 to -4057)*	-4067 (-6321 to -1693)*	0.0010
Hospitalization costs	4950 (4241-5777)	6711 (5585-8062)	-1761 (-2344 to -1100)*	-1394 (-2030 to -667)*	0.0004
Medication costs	4653 (4273-5067)	6080 (5015-7372)	-1427 (-2015 to -754)*	-1360 (-2003 to 614)*	0.0007
Examination costs	5028 (4496-5622)	5833 (5144-6615)	-806 (-1243, -327)*	-671 (-1146 to -147)*	0.0133
Clinical outcomes [<i>n</i> (%)]					
MACE	30 (2.9)	11 (5.6)	0.50 (0.35-0.73)	0.47 (0.31-0.73)	<0.001
BARC ≥ 2 bleeding	80 (7.7)	17 (8.7)	0.88 (0.59-1.33)	0.98 (0.64-1.52)	0.940
BARC ≥ 3 bleeding	12 (1.2)	6 (3.1)	0.37 (0.13-1.06)	0.34 (0.12-1.01)	0.051
Length of stay [mean (95%CI), d]	6.7 (6.2-7.3)	8.9 (7.6, 10.4)	-2.2 (-2.8 to -1.4)*	-1.9 (-2.7 to -1.1)*	<0.0001
Post-procedural stay [mean (95%CI), d]	3.6 (3.2-4.1)	4.2 (3.4, 5.1)	-0.6 (-1.0 to -0.1)*	-0.7 (-1.1 to -0.3)*	0.0017

MACE: major adverse cardiac events (a composite of death, myocardial infarction, revascularization, and BARC ≥ 3 bleeding); BARC: Bleeding Academic Research Consortium.

*Means significant difference between two groups.

DISCUSSION

In this large retrospective observational study of elderly patients undergoing PCI in China, we found that transradial approach was associated with significantly lower hospital costs, fewer MACE, shorter length of stay, and shorter post-procedural stay. Although TRI was performed more frequently on patients with better prognostic factors and lower risks, such association persisted after accounting for all observed characteristics using the IPW method. Similar trends were observed in clinically relevant subgroups of acute myocardial infarction, acute coronary syndrome, and stable angina. Taken together with previous studies,¹⁻⁹ these results support the current recommendations for adoption of tranradial approach in patients undergoing PCI.²⁴⁻²⁶

The prevalence of CAD is associated with increasing age. Elderly patients, defined by Mehta *et al*²⁷ as aged over 65 years, comprised a large proportion of CAD patients who need PCI.²⁸ But they are also at high risk of procedural complications and post-procedural bleeding due to long-standing hypertension, peripheral atherosclerosis and other severe pre-procedural comorbidities.¹⁰⁻¹³ Several

comparisons have been conducted between TRI and TFI in elderly patients.¹⁴⁻¹⁸ The present one, based on the propensity score IPW method, showed that the rate of MACE in elderly patients underwent TRI were significantly lower than TFI. Moreover, TRI patients had shorter length of stay and were discharged sooner after undergoing PCI. Similar trends were found in subgroup analyses. These findings provide new evidence to support the efficacy and benefit of TRI in elderly patients.

Bleeding complications have been identified as a strong predicting factor of worse outcomes after PCI.²⁹ Several strategies have been suggested to reduce the risk of post-PCI bleeding, including pharmacologic, technological, and procedural approaches.³⁰ As one of the procedural approaches, TRI has been shown to reduce bleeding by both observational^{4, 6, 9} and randomized^{1, 8} studies. Different from these results, we found no statistical significance in the incidence of post-PCI bleeding between the 2 treatment groups in the present study. Considering that TRI patients did numerically have fewer post PCI bleeding (BARC ≥ 2 : 7.7% vs. 8.7%, $P=0.940$; BARC ≥ 3 : 1.2% vs. 3.1%, $P=0.051$), out limited sample size of study population may be the reason why the results are so distinct.

Table 4. Comparisons of hospital costs and clinical outcomes between the groups of TRI and TFI: subgroup analyses by acute myocardial infarction, acute coronary syndrome, and stable angina

Items	TRI group	TFI group	Unadjusted OR (95%CI)	Adjusted OR (95%CI)	P value
Acute myocardial infarction					
<i>n</i>	176	23			
Total hospital costs [mean (95%CI), CNY]	64 002 (57 669-71 031)	79 265 (66 717-94 173)	-15 263 (-27 826, 368)*	-9812 (-21 200, 4020)*	0.153
MACE [<i>n</i> (%)]	6 (3.4)	1 (4.3)	0.78 (0.32, 1.86)	0.66 (0.26, 1.71)	0.396
BARC ≥ 2 bleeding [<i>n</i> (%)]	19 (10.8)	3 (13.0)	0.81 (0.31, 2.10)	1.51 (0.51, 4.51)	0.460
BARC ≥ 3 bleeding [<i>n</i> (%)]	4 (2.3)	1 (4.3)	0.51 (0.12, 2.23)	0.42 (0.09, 2.06)	0.284
Length of stay [mean (95%CI), d]	9.2 (8.2-10.3)	11.2 (9.2-13.6)	-2.0 (-4.0, 0.5)*	-1.0 (-3.6, 2.5)*	0.525
Postprocedural stay [mean (95%CI), d]	4.9 (4.1-6.0)	6.2 (4.8-8.0)	-1.3 (-2.7, 0.7)*	-0.7 (-2.2, 1.4)*	0.462
Acute coronary syndrome					
<i>n</i>	730	133			
Total hospital costs [mean (95%CI), CNY]	58 225 (54 095-62 671)	71 725 (66 068-77 866)	-13 500 (-17 101, -9661)*	-12,508 (-17,524, -7023)*	<0.001
MACE [<i>n</i> (%)]	20 (2.7)	8 (6.0)	0.44 (0.26, 0.74)	0.41 (0.25, 0.68)	<0.001
BARC ≥ 2 bleeding [<i>n</i> (%)]	60 (8.2)	12 (9.0)	0.90 (0.57, 1.44)	1.12 (0.68, 1.85)	0.657
BARC ≥ 3 bleeding [<i>n</i> (%)]	10 (1.4)	5 (3.8)	0.36 (0.15, 0.82)	0.30 (0.13, 0.74)	0.008
Length of stay [mean (95%CI), d]	6.9 (6.4-7.5)	9.4 (8.1-10.9)	-2.3 (-3.2, -1.7)*	-2.6 (-3.5, -1.5)*	<0.001
Post procedural stay [mean (95%CI), d]	3.7 (3.2-4.1)	4.4 (3.7-5.3)	-0.8 (-1.2, -0.2)*	-1.0 (-1.5, -0.4)*	0.001
Stable angina					
<i>n</i>	274	56			
Total hospital costs [mean (95%CI), CNY]	61 039 (56 774-65 624)	63 460 (55 034-73 177)	-2422 (-8381, 4183)*	3710 (-2818, 11 009)*	0.277
MACE [<i>n</i> (%)]	10 (3.6)	3 (5.4)	0.67 (0.27, 1.69)	0.68 (0.24, 1.90)	0.462
BARC ≥ 2 bleeding [<i>n</i> (%)]	18 (6.6)	5 (8.9)	0.72 (0.28, 1.86)	0.66 (0.18, 2.41)	0.533
BARC ≥ 3 bleeding [<i>n</i> (%)]	2 (0.7)	1 (1.8)	0.40 (0.04, 3.95)	0.73 (0.07, 7.56)	0.791
Length of stay [mean (95%CI), d]	6.1 (5.5-6.7)	8.1 (6.8-9.6)	-2.0 (-2.7, -1.2)*	-0.7 (-1.5, -0.2)*	0.133
Post-procedural stay [mean (95%CI), d]	3.5 (2.9-4.1)	3.8 (3.0-4.7)	-0.3 (-0.7, 0.1)*	-0.2 (-0.5, 0.2)*	0.430

*Means significant difference between two groups.

Despite the advantages of transradial approach mentioned above, so far no study has examined the economic impact of TRI in elderly patients. In our previous analysis of TRI vs. TFI in all age groups, we found that TRI was associated with an average cost-saving of CNY8147.⁹ We also found a cost-saving of CNY7474 in women undergoing TRI.³¹ In the present study, which was performed

solely in patients aged over 65 years, TRI was associated with lower total hospital costs (cost difference CNY7495). More than 70% of such cost differences was attributed to reduced PCI-related costs (cost difference CNY4067). Since patients in both treatment groups had similar arterial sheath size, number of stents, and utilization of more expensive imported stents, these are unlikely to be the

cause of such cost saving. Although IVUS was performed in a greater proportion of TFI patients, its utilization was infrequent (2.2% vs. 5.3%) and was not possible to cause such differences in PCI-related costs either. However, vascular closure devices (CNY3000) were used in 71.9% of TFI patients, costing much more than manual compression or radial compression bands. Therefore, it is likely that the cost difference between TRI and TFI is driven by the differential use of vascular closure devices. In addition, there was also a significant reduction in hospitalization costs (cost difference CNY1394), medication costs (cost difference CNY1360), and examination costs (cost difference CNY671). These differences might be attributable to shorter length of stay, shorter post-procedural stay, as well as lower incidence of MACE in TRI cohort.

Several limitations of this study should be acknowledged. First, it is limited by its non-randomized and retrospective nature, although we used the propensity score IPW method to minimize the baseline disparity. Although all observed characteristics were well-balanced between TRI and TFI cohorts after the introduction of IPW method, there might still be some unmeasured confounders. The disparate difference in the sample size between the two cohorts may also have influenced our results. Second, our study only included data from a single center, in which transradial approach has been adopted for years. Since the learning curve of TRI for operators could affect clinical outcomes, the generalizability of these findings to other centers remains to be established. Third, the evaluation of economic consequences was conducted based on the hospital's accounting system. The total cost of TRI patients could have been underestimated, if they had undergone more examinations before their admission, since we did not have access to outpatient costs data prior to hospitalization.

Conflict of Interest Statement

The authors have no conflict of interest to disclose.

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