Published in final edited form as:

Am J Cardiol. 2017 June 15; 119(12): 1937–1941. doi:10.1016/j.amjcard.2017.03.020.

Patient versus Physician Variation in Use of Transradial Percutaneous Coronary Intervention

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Abstract

The prevalence of radial access for transradial catheterization remains low in the US, occurring in only 28% of cases in the National Cardiovascular Data Registry (NCDR[®]) CathPCI[®]. It is unknown whether the low adoption rate has been influenced by patient characteristics, or is more operator dependent. In a 10-center study, we compared clinical and demographic characteristics among 323 radial and 1506 femoral access PCIs performed by 65 interventionists capable of radial percutaneous intervention (PCI). We created a hierarchical logistic regression model to identify operator and patient characteristics associated with radial PCI and the median rate ratio to quantify the variation across operators. A subset was interviewed to assess health literacy and preferences in shared medical decision-making. Radial access was used in 17.7% of patients. Patient factors associated with lower rate of radial PCI were prior PCI (33.4% vs 41.4% $P=0.008$), history of Coronary Artery Bypass Graft (8.4% vs 23.0% $P<0.001$) and Chronic Total Occlusion PCI (10.2% vs 17.9% $P<0.001$). Operator characteristics associated with lower rate of radial PCI are being older, being longer in practice, lower number of publications and Southern practice location. The range of radial use across operators was 1–99% and the median rate ratio was 1.97. Patients with radial access had lower health literacy, as assessed by the REALM score (6.6 ± 2.6 vs 7.1 ± 2.0 , $p=0.03$) but did not differ in their preferences for shared decision-making. In conclusion our study demonstrates a high degree of variability of radial access for PCI among different operators, with few differences in patient characteristics, suggesting that improvement efforts should focus on operators.

Keywords

radial access; PCI access variability; shared decision making; operator dependent variability

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Disclosures: The authors have no financial disclosures.

Introduction

The prevalence of transradial approach (TRA) for percutaneous coronary intervention (PCI) varies across regions of the world, with some using it as much as 58-82% of cases.¹⁻⁵ The adoption rate for TRA in the United States (US) has been much slower, with only 28% of PCIs being performed transradially in recent reports from the NCDR[®]-CathPCI[®] registry.⁶ This relatively slower rate of adoption occurs despite growing evidence demonstrating improved outcomes with TRA, particularly in patients presenting with an acute coronary syndrome. The reason for poor US adoption of TRA have been insufficiently evaluated. It is possible that US physicians may favor the transfemoral approach (TFA) because of greater operator familiarity with the procedure, ability to use larger sheath sizes and lower radiation exposure.⁷ It is also possible that there are patient characteristic associated with preferential use of TFA, such as clinical status, comorbidities, prior revascularizations, socio-economic factors or patient preferences. In this study, we sought to examine whether the choice of TRA is more correlated with patient or physician characteristics. Understanding what driving factors account for the use of TRA vs TFA may inform future quality improvement efforts to improve TRA use in the US.

Methods

To better evaluate the variability of TRA use as a function of patient and physician characteristics, we used data obtained from Outcomes of PCI Study/Personalized Risk Information Services Manager (OPS/PRISM) study. A total of 3299 patients were enrolled in 2009 and 2010 at 10 participating hospitals. Patients with brachial access PCI were excluded, reducing the patient population to 3294. There were a total of 158 operators in the dataset, of which 93 operators did not perform any TRA procedures. The operators who used TFA exclusively were presumed to have insufficient TRA training and were excluded to minimize selection bias. Consequently, 1465 patients treated by the femoral-only operators were excluded, resulting in a final study cohort of 1829 patients eligible for TRA (Figure 1).

A subgroup of 393 PCI patients were interviewed and administered the Rapid Estimate of Adult Literacy in Medicine revised, shorter version (REALM-R) score, to assess their health literacy. In brief, the REALM-R score assesses patients' ability to read common medical words and takes <2 minutes to administer. Scores range from 0-8 for correct identification of 8 medical words.⁸ In addition, their preferences for shared decision-making were assessed using the questions developed by Deber and colleagues.⁹ To provide deeper insight into potential patient-centered reasons for TRA use, we compared characteristics of patients who underwent TFA versus those had TRA approach. Questionnaire and clinical report forms of the PRISM Registry are presented in Appendix 1. Institutional Review Board approval was obtained from all participating sites, and all patients participating in the interviews provided written informed consent.

Continuous variables were compared using Student's T-test and categorical variables were compared using chi-square or Fisher's exact test. A hierarchical regression model was then constructed to identify patient and physician characteristics independently associated with TRA use. Modified Poisson model was used because the rate of TRA is greater than 10%.¹⁰

From this model, we also calculated the median rate ratio (MRR) across operators. The MRR estimates the average difference in the likelihood of undergoing TRA for 2 statistically identical patients treated by 2 random operators within the study. For example, an MRR of 2.0 suggests that a patient treated by one random physician vs. another in the study would be twice as likely, on average, to be treated with TFA.

For each analysis, the null hypothesis was evaluated at a 2-sided significance level of 0.05 with 95% confidence intervals (CIs) calculated. All analyses were performed with SAS 9.2 (SAS institute, Cary, NC) and R version 2.7.0 (Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 1829 patients were included in the study (Appendix 2). Of this cohort, 323 (17.7%) underwent TRA while 1506 (82.3%) patients underwent TFA. There was no significant age difference between the study groups. Most patients in both study groups were male. The majority of enrolled patients were white, with no difference in race between TRA and TFA. A small proportion of patients did not have insurance while most patients had at least a high school education.

There was no difference in smoking status, history of hypertension, dyslipidemia or diabetes between TRA and TFA patients. Rates of chronic kidney disease, heart failure, prior cerebrovascular accident, chronic obstructive pulmonary disease and pre PCI creatinine also were not different between the groups. Demographic and clinical characteristics of the patients who underwent TRA are presented in Table 1. Patients characteristics associated with lower rates of TRA were prior PCI, prior coronary artery bypass graft (CABG) and chronic total occlusion (CTO)-PCI. Higher body mass index (BMI) was associated with more TRA.

We compared operators who performed TFA exclusively to operators who performed both TRA and TFA (Table 2). Operators who performed both access approaches have been in practice for a shorter time and have almost three times more publications. TFA only operators are more likely to be present in southern states and the Midwest region had the most TRA operators. Operator-specific rates of TRA varied from 1-99% (Figure 2). Upon analysis, patients who had lower BMI, CABG history, having ongoing ischemia and CTO were less likely to have TRA. The MRR for TRA in our study cohort was 1.97. This means that for two randomly selected operators, who perform both TRA and TFA, treating patients with identical characteristics the probability of TFA is 97% more than TRA.

There was no difference in the answers to questions pertaining to shared decision making when TRA patients were compared with TFA. However, a significant difference was noted in REALM-R scores. Patients with TRA had lower health literacy (Table 3).

The rate of having at least one covariate missing was 8.8%. Insurance had the highest missing rate of 6.2%, race was missing in 1.7% cases and the rest of the variables were missing in 1% cases. Missing data was minimum and assumed to be missing at random.

Sensitivity analysis was conducted on data imputed by single imputation. The result stayed almost identical. (Appendix 3)

Discussion

The adoption of TRA is known to have occurred more slowly in the US despite reported benefits in high bleeding risk and acute coronary syndromes patients¹¹. This study provided a detailed analysis of patient characteristics, including health literacy and shared decision-making and demonstrated that they were less likely associated with the use of TRA than with the physician factors. In fact, a few operators used TRA in as low as 1% of cases compared to others who used it almost 99% of time. This, compared quantitatively between two randomly selected operators, shows the probability of proceeding with TFA 97% higher than TRA. These data extend the literature by highlighting the importance of the physician initiative in patient-centered decisions, underscoring the importance of quality improvement initiatives in Cath labs across the country. The Executive summary by the Transradial Committee of the Society for Cardiac Angiography and Interventions (SCAI) emphasizes the critical importance of training in TRA for competency of Interventional Cardiology fellows.¹² To further advance adoption of TRA in the US, further action by professional societies, including review of pay for performance and quality, is required. Incentivizing same day discharge, establishment of radial lounges, etc. will also have a major role to play in reducing heterogeneity of care.

In the radial vs femoral access for coronary intervention trial (RIVAL) the bleeding safety benefit translated to a significantly lower overall mortality (1.3% vs 3.2% $p=0.006$).¹³ Similar results were observed in the radial vs femoral randomized investigation in ST-elevation acute coronary syndrome trial (RIFLE-STEACS), which showed a reduction in net adverse clinical events (13.6% vs 21% $p=0.003$) along with a significantly lower rate of major adverse cardiac events (MACE) (7.2% vs 11.4% $p=0.029$).¹⁴ The results of the ST elevation myocardial infarction treated by radial or femoral approach trial (STEMI-RADIAL) demonstrated 80% less bleeding and access site associated complications at 30 days (1.4% vs 7.2% $p=0.0001$) with no major difference in MACE (3.5% vs 4.2% $p=0.7$) with TRA.¹⁵ In addition to the trial data, an analysis of the NCDR CathPCI Registry[®] from 2007-2011 showed significantly lower in-hospital mortality in patients with ST elevation myocardial infarction undergoing radial PCI (OR: 0.76; 95% CI: 0.57 to 0.99) with significantly lower bleeding (OR: 0.62; 95% CI: 0.53 to 0.72).¹¹

Unlike many other new and clinically superior treatments in cardiovascular medicine, TRA is an economically dominant strategy with lower costs and better outcomes compared to TFA. It has significantly lower cost as compared to TFA (\$11,736 vs \$12,228, $P=0.033$) as well as shorter in-hospital stay (0.47 ± 0.19 days vs 0.78 ± 0.11 days with TFA; difference 0.31 days, 95% CI 0.15–0.48, $P=0.001$).¹⁹ Shorter hospitalization with earlier mobility may contribute to the decrease in overall mortality observed in randomized trials due to decreased risk of hospital acquired complications such as nosocomial infections and deep venous thromboses.²⁰

There are several potential barriers to increased adoption of TRA. Concerns about the possible delay in door to balloon time in STEMI have been raised. A recent meta-analysis showed that the average delay between TRA and TFA was only 1.5 minutes.²¹ Concerns for increased radiation exposure have been voiced as well, however, Jolly et al. concluded that radiation dose was only nominally higher with radial access (median air kerma 1046 vs 930 mGy $P=0.051$), with differences being present only in lower volume centers and operators.¹³ Concerns over these and other technical challenges could discourage learners from adopting TRA. However, a study performed by Hess et al. demonstrated a shallow operator learning curve, with 30-50 cases being enough to overcome its threshold in most cases.²² These obstacles are not insurmountable given the potential benefits of TRA as documented in recent trials.

The fact that patients with TRA had a lower health literacy is intriguing. Health literacy is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions. Patients with lower health literacy, i.e. patients who were less likely to understand personalized consent form or medical discussions, were more likely to get TRA; it is unclear why this happened, however it suggests that it is unlikely to be due to patient-centered decision making based on their understanding of the procedures.

Our study should be interpreted in the context of several potential limitations. It was an observational analysis of prospectively collected registry data at 10 centers, which may limit the external generalizability of our findings. In addition, the possibility of residual confounding may persist. REALM-R and preferences for shared decision-making were performed on subset of the study population thereby limiting the power and sensitivity of the study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Funding

The Outcomes of Percutaneous Coronary Intervention Study (OPS) was supported by an American Heart Association Outcomes Research Center grant (0875149 N), and the Personalized Risk Information Services Manager (PRISM) study was supported by a grant from the National Heart Lung and Blood Institute (R01-HL096624). Although the grants supported different aims, they used the same patient population, study design, and data collection, and they were combined for the purpose of these analyses. The funding agencies had no role in data collection, analysis, interpretation, or the decision to submit the results. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

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Figure 1:
Flow chart of the study design.

Figure 2: Rate of radial access among operators who performed both radial and femoral access. X axis is showing proportions of operators and Y axis is showing number of operators.

Table 1.

Comparing patient characteristics among the patients from operators with some radial cases

Variable	Femoral n=1506	Radial n=323	P-Value
Operator Age (years)	48.5±8.2	47.2±7.2	0.010
Years in Practice	15.5±8.9	13.6±8.3	<0.001
Operator Sex			0.351
Male	85 (5.6%)	14 (4.3%)	
Female	1421 (94.4%)	308 (95.7%)	
Region			0.046
Northeast	502 (33.3%)	83 (25.7%)	
Midwest	778 (51.7%)	181 (56%)	
South	66 (4.4%)	15 (4.6%)	
West	160 (10.6%)	44 (13.6%)	
Patient Age (years)	64.5±11.3	63.8±11.1	0.311
Patient Sex			0.145
Male	1100 (73.0%)	223 (69.0%)	
Female	406 (27.0%)	100 (31.0%)	
White	1344 (90.8%)	291 (91.8%)	0.578
Completed High School	1363 (91.1%)	298 (92.5%)	0.405
Body Mass Index	30.4±6.0	31.6±7.0	0.001
Current Smoker	230 (15.5%)	57 (17.8%)	0.306
Dyslipidemia	1263 (83.9%)	269 (83.3%)	0.797
Hypertension	1249 (82.9%)	267 (82.7%)	0.906
Peripheral arterial disease	11.4 (7.6%)	34 (10.5%)	0.077
Diabetes Mellitus	503 (33.4%)	103 (31.9%)	0.601
Chronic Kidney Disease	143 (9.5%)	33 (10.2%)	0.690
Prior Myocardial Infarction	443 (29.4%)	87 (26.9%)	0.373
Prior Percutaneous Coronary Intervention	624 (41.4%)	108 (33.4%)	0.008
Congestive Heart Failure	167 (11.1%)	34 (10.5%)	0.769
Prior Stroke	50 (3.3%)	14 (4.3%)	0.368
Chronic Lung Disease	144 (9.6%)	41 (12.7%)	0.090
Creatinine pre-procedure (mg/dl)	1.1±0.8	1.2±1.7	0.206
Coronary Artery Bypass Grafting	346 (23.0%)	27 (8.4%)	<0.001
Indication			<0.001
ST Elevation Myocardial Infarction	41 (2.7%)	1 (0.3%)	
Non ST Elevation Myocardial Infarction	283 (18.8%)	88 (27.2%)	
Unstable Angina Pectoris	515 (34.2%)	107(33.1%)	
Stable Angina Pectoris	514 (34.1%)	111 (34.4%)	
Others	153 (10.2%)	16 (5.0%)	
Intra-Aortic Balloon Pump	7 (0.5%)	1 (0.3%)	1.000
Chronic Total Occlusion	269 (17.9%)	33 (10.2%)	<0.001

Continuous variables compared using Student's T-test.

Categorical variables compared using chi-square or Fisher's exact test.

All data presented as number (%) or mean $\pm$ standard deviation unless otherwise noted.

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Table 2.

Operator characteristics by vascular access choice

Variable	Operators access choice		P-Value
	TFA Only n = 93	TRA+TFA n = 65	
Operator Age (years)	51.8±8.8	49.2±8.3	0.056
Years in Practice	18.8±9.6	15.6±9.4	0.042
Operator Sex			0.272
Male	90 (96.8%)	59 (92.2%)	
Female	3 (3.2%)	5 (7.8%)	
Publications	13.9±36.1	41.7±107.7	0.022
Cardiology Board Certification	89 (95.7%)	62 (96.9%)	1.000
Region			<0.001
Northeast	15 (16.1%)	18 (27.7%)	
Midwest	24 (25.8%)	32 (49.2%)	
South	50 (53.8%)	3 (4.6%)	
West	4 (4.3%)	12 (18.5%)	

TFA: Transfemoral Access; TRA: Transradial Access

Continuous variables compared using Student's T-test.

Categorical variables compared using chi-square or Fisher's exact test.

All data presented as number (%) or mean ± standard deviation unless otherwise noted.

Table 3.

Subset analysis for shared decision making and health literacy

Variable	Arterial access		P-Value
	site		
	Femoral n = 301	Radial n = 92	
Who decides how acceptable risk/benefits are for you?			0.547
Doctor alone	15 (5.0%)	6 (6.5%)	
Mostly the doctor	43 (14.4%)	18 (19.6%)	
Doctor and you equally	204 (68.5%)	55 (59.8%)	
Mostly you	25 (8.4%)	10 (10.9%)	
You alone			
Who decides what treatment options should be selected?			0.964
Doctor alone	20 (6.7%)	5 (5.5%)	
Mostly the doctor	50 (16.7%)	17 (18.7%)	
Doctor and you equally	192 (64.0%)	56 (61.5%)	
Mostly you	22 (7.3%)	7 (7.7%)	
You alone	16 (5.3%)	6 (6.6%)	
REALM-R Score	7.1±2	6.6±2.6	0.032

Continuous variables compared using Student's T-test.

Categorical variables compared using chi-square or Fisher's exact test.

All data presented as number (%) or mean ± standard deviation unless otherwise noted.