

Radial versus femoral access percutaneous coronary intervention in patients with acute myocardial infarction: Experience from a Southeast Asian country PCI registry

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Abstract

Introduction

Bleeding complications adversely affect patient's outcomes following percutaneous coronary intervention (PCI). Radial approach PCI was advocated to overcome this complication. The information regarding the safety and feasibility of radial approach PCI in acute myocardial infarction (AMI) in the Southeast Asian population was limited. Hence, we sought to examine the outcome of radial versus femoral approach in this particular cohort.

Materials and Methods

This is an observational retrospective analysis of the Malaysian National Cardiovascular Disease Database-Percutaneous Coronary Intervention (NCVD – PCI) registry, recruiting patients with AMI from 2007 – 2014. Patients were stratified into radial and femoral groups depending on the PCI access route. The patient's baseline characteristics, lesion, and procedural data, complications, and outcomes are assessed accordingly.

Results

A total of 11,555 (4895 radial and 6660 femoral) cases were included in the analysis. In the radial group, there were predominantly more males (89.2%) with the younger patient (mean age 55.2 ± 10.5 years) as compared to the femoral group. They also had a higher body mass index (BMI) and taller. However, femoral group patients had significantly more premorbid conditions, namely diabetes mellitus, hypertension, previous stroke, heart failure, and chronic kidney disease. Complex lesions were similar in both groups with no difference in fluoroscopy time, although higher contrast load recorded in the femoral group. The adjusted odds ratio of developing in-hospital complications after femoral approach PCI compared to radial approach for death, MACE and vascular complications were OR: 8.21 95% CI 5.38 – 12.54, OR: 3.39 95% CI 2.51 – 4.58, OR: 1.79 95% CI 1.01 – 3.16 respectively.

Conclusion

PCI via the trans-radial approach has resulted in a significantly lower risk of vascular complications, MACE and death compared to the trans-femoral approach. Our study confirmed the superiority of the trans-radial approach in the setting of primary PCI in the Southeast Asian population and underscores the importance of trans-radial interventions to reduce bleeding complication rates.

Introduction

Bleeding complications independently affect adverse outcomes and mortality following percutaneous coronary intervention (PCI) procedures (1,2). Patients with access site hematoma requiring blood transfusion have up to nine-fold increased risk of in-hospital death following PCI (3). It is well accepted

now that modification to pharmacological and procedural strategies adopted in the management of acute coronary syndrome (ACS) might reduce the bleeding risk (4–6).

RIVAL (Radial Versus Femoral Access for Coronary Intervention) trial, RIFLE-STEACS (Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome) study and MATRIX (Radial versus femoral access and bivalirudin versus unfractionated heparin in invasively managed patients with acute coronary syndrome : final 1-year results of a multicentre, randomised controlled trial) trial are perhaps the driving evidence for the adoption of trans-radial approach for PCI, particularly in AMI. The results from these studies highlighted that the reduction of bleeding complications is an important prognostic factor when the trans-radial approach for PCI is performed in experienced centres (7–9). An all-comer registry of Mortality benefit Of Reduced Transfusion after percutaneous coronary intervention via the Arm or Leg (MORTAL) study further compounded the paradigm shift from femoral to radial approach with reduced transfusion rate and mortality following PCI (10).

However, trans-radial PCI also bound to approximately 5% of the failure rate. Among reasons for failed trans-radial PCI are puncture failure, radial artery spasm or dissection, tortuous subclavian artery, the height of patients and operator's experience (11).

This study aimed to analyze the safety and feasibility of trans-radial access in PCI for AMI from one of the largest PCI registries in the Southeast Asian population.

Materials And Methods

Study population

The National Cardiovascular Disease Database – Percutaneous Coronary Intervention (NCVD – PCI) registry is a continuous ‘real-world’ practice data collection exercise involving major PCI capable or PCI accessible hospital in Malaysia. It is one of the successful collaborative efforts between the Ministry of Health Malaysia and the National Heart Association of Malaysia. For this study, the data of patients who underwent PCI from 2007 to 2014 in 15 participating hospitals across the country were retrospectively analyzed. The description of methods can also be found in previously published articles generated from this registry (12,13) and in the Annual Report of the NCVD-PCI registry year 2013-2014 (14).

Trained personnel from the source data provider (participating hospitals) will enter the patient's information via a secured web application using an electronic case report form. Patients are assigned a unique identification number to maintain anonymity and cross-checked with the national identification number to avoid duplication. The information included among others are patient's baseline characteristics, risk factor profile, the extent of coronary artery disease, procedural details, and complications. Phone call follows up at 1-year post-discharge is the most commonly used method as well as clinic visit review. To ensure the quality of the data, periodic edit check runs, and data cleaning exercise is carried out by the data manager. A detailed description of data management of this registry is reported in the annual report publication (14).

Definitions

Since this analysis included patients from 2007, ST-elevation myocardial infarction (STEMI) was defined as persistent ST-segment elevation ≥ 1 mm in two contiguous electrocardiographic leads, or the presence of a new left bundle branch block in the setting of positive cardiac biomarkers, namely CK-MB and troponins. Non-ST elevation myocardial infarction (NSTEMI) were patients without ST-segment elevation on an electrocardiogram (ECG) but recorded positive cardiac biomarkers.

Baseline characteristics and co-morbidities were recorded during hospitalization for ACS or admission for PCI. To give a perspective for the local reader, data regarding major ethnicity breakdowns; namely Malay, Chinese and Indian were also presented. Approximately 5% of the study population was categorized into others; which include other native people, non-native Malaysian, foreigner and unknown status. A lesion causing $> 50\%$ stenosis in only 1 major epicardial vessel was labeled as single-vessel disease whereas lesions causing $> 50\%$ stenosis in 2 or more epicardial vessels were labeled as a multi-vessels disease. As widely recommended, lesion type was divided according to the American Heart Association / American College of Cardiology (AHA/ACC) classification (15).

Outcomes

The procedural complications were defined as per the NCVD data definition form document (14). Vascular complications were defined as the composite of bleeding, access site occlusion, loss of distal pulse, dissection and pseudoaneurysm during or after the index procedure. Bleeding complications were defined using thrombolysis in myocardial infarction (TIMI) criteria. To be adjudicated, the bleeding endpoint required blood transfusion and/or prolonged hospital stay and/or caused a drop in hemoglobin ≥ 3.0 g/dl (16). Major adverse cardiovascular events (MACE) were the sum of one or more of periprocedural MI, emergency PCI, bail-out CABG, cardiogenic shock, arrhythmia, TIA/stroke, cardiac tamponade, and heart failure. Death was considered separately and included all-cause of death. Other important endpoints evaluated in the present study were fluoroscopy time (s) and contrast volume (ml).

Statistical analysis

All statistical analyses were performed using SPSS version 23. The cohort of patients with AMI (NSTEMI and STEMI) were divided into radial and femoral access routes. Results were expressed as mean \pm standard deviation (SD) for normally distributed data and compared using the independent samples *t*-test. Median (interquartile range) was used for skewed data and compared using the Mann-Whitney *U* test. Chi-square or Kruskal-Wallis test was performed to compare categorical variables. To evaluate the association between different access routes for PCI and in-hospital complications, the multivariable-adjusted logistic regression model was used to calculate their respective odds ratios (OR) and reported together with the 95% confidence interval (CI) values. Separate univariate analysis was performed and variables with a p-value of < 0.05 were included in the final model. Multicollinearity between the included variables was examined using standard error of b coefficient. Finally, a p-value of less than 0.05 was considered statistically significant.

Ethics Statement

The NCVD-PCI registry is registered in the National Medical Research Register of Malaysia (ID: NMRR-07-20-250) and received ethical approval from the Ministry of Health Medical Research and Ethics committee. Since the data collected from patients were unidentifiable, consent from individual patients was waived by the ethics committee.

Results

We analyzed a total of 11,555 cases of cardiac catheterization with the indication of AMI (NSTEMI and STEMI) performed during the study period, comprised of 4,895 (42.4%) performed via radial approach and 6,660 (57.6%) via the femoral approach. Unlike other 'real-world' registry, we included significantly large numbers of radial cases for comparison. Three thousand eight hundred (32.9%) cases were performed for NSTEMI while 7,755 (67.1%) cases for STEMI.

Patient's baseline characteristics

Consistent with previously published reports from NCVD-PCI registry, our cohort of patients are generally much younger than reports from other parts of the world by approximately 10 years. (12,14) There were significantly more old and female patients subjected to the femoral approach during cardiac catheterization likely because they tend to have difficult and complex vasculatures. In patients with higher BMI and taller, it was more commonly performed via a radial approach. However, patients with co-morbidities namely diabetes mellitus, hypertension, previous stroke, heart failure, and chronic kidney disease were more likely to received cardiac catheterization via femoral access. More details of the patient's baseline characteristics are summarized in Table 1.

Table 1: Baseline characteristics

Characteristics	Radial, n (%)	Femoral, n (%)	p-value
Age (year, mean \pm SD)	55.2 \pm 10.5	56.7 \pm 11.1	<0.001 ^a
Gender			
Male	4368 (89.2)	5507 (82.7)	<0.001
Female	527 (10.8)	1153 (17.3)	
Ethnicity			
Malay	2452 (50.1)	3485 (52.4)	<0.001
Chinese	1068 (21.8)	1372 (20.6)	
Indian	816 (16.7)	1466 (22.0)	
Others	555 (11.3)	334 (5.0)	
BMI (kg/m ² , median)	26.0	25.7	0.027
Height (cm, mean \pm SD)	164.1 \pm 8.0	163.0 \pm 8.6	<0.001
Smoking status			
Never/Former smoker	2547 (58.4)	3667 (63.3)	<0.001
Current smoker	1817 (41.6)	2123 (36.7)	
Medical history			
Diabetes mellitus	1848 (40.1)	2896 (47.0)	<0.001
Hypertension	3013 (65.0)	4218 (68.2)	0.001
Dyslipidemia	2912 (65.5)	3868 (65.8)	0.759
Cerebrovascular disease	50 (1.1)	144 (2.3)	<0.001
Heart failure	139 (2.9)	303 (4.8)	<0.001
Chronic kidney disease	99 (2.1)	446 (7.1)	<0.001
Peripheral vascular disease	28 (0.6)	42 (0.7)	0.623

Lesion characteristics and procedural data

Multi-vessels PCI was more likely to be performed via the femoral approach as compared to the radial approach. However, in contrast to the usual belief, the lesions performed via the femoral approach were not more complex than the one treated via the radial approach. The rate of type B2 and C lesions, as well as chronic total occlusion treated via either approach, were similar (Table 2).

Table 2: Lesion characteristics and procedural data

Variable	Radial, n (%)	Femoral, n (%)	p-value
Single vessels	1663 (55.7)	2180 (49.4)	<0.001
Multi Vessels	1323 (44.3)	2234 (50.6)	
AHA/ACC lesion type			0.096
A/B1	1896 (40.6)	2483 (39.0)	
B2/C	2775 (59.4)	3878 (61.0)	
Chronic total occlusion	267 (5.6)	381 (5.9)	0.538
Type of devices			<0.001
BMS	1171 (26.7)	2267 (38.8)	
DES	2750 (62.7)	3040 (52.0)	
Others	465 (10.6)	538 (9.2)	
POBA only	174 (3.6)	308 (4.7)	0.004
Fluoroscopy time, (median(s))	14.5	14.5	0.859
Contrast volume, (mean ± SD)	161.9 ± 65.10	173.0 ± 70.54	<0.001

Clinical presentation

There were numerically more cases of PCI performed for STEMI as compared to NSTEMI in both groups. Among the STEMI cases, a proportionally higher percentage of patients presented with Killip class 3 and 4 underwent femoral approached PCI. In the event of failed thrombolysis, the radial approach was favored possibly due to presumably lower bleeding risk. Other details were listed in Table 3.

Table 3: Clinical presentation of PCI procedures

Variable	Radial, n (%)	Femoral, n (%)	p-value
Clinical presentation			
STEMI	3279 (67.0)	4476 (67.2)	0.803
NSTEMI	1616 (33.0)	2184 (32.8)	
Killip classification			
Class 1 & 2	2485 (94.5)	3064 (80.7)	<0.001
Class 3 & 4	144 (5.5)	733 (19.3)	
PCI status			
Rescue	984 (76.1)	1735 (68.5)	<0.001
Primary	77 (6.0)	597 (23.6)	
Facilitated	9 (0.7)	18 (0.7)	
Delayed	223 (17.2)	183 (7.2)	
Kidney function*			
CKD	99 (2.1)	446 (7.1)	<0.001
Non-CKD	4656 (97.9)	5869 (92.9)	

*CKD GFR < 60 ml/min/1.73m², non-CKD GFR ≥ 60 ml/min/1.73m²

Procedural complications and outcomes

In terms of vascular complications, more bleeding was encountered during the femoral approach PCI as compared to radial (Table 4). On the other hand, more cases of general complications occurred in the femoral group possibly due to higher risk patient's characteristics. Composite in-hospital complications (vascular complications, MACE, and death) were significantly more frequent in the femoral group than in the radial group (Table 5). Patients with MI undergoing PCI via the femoral approach showed nearly 8 times higher risk of death, 3 times higher risk of developing MACE and doubled the risk of getting vascular complications as compared to their radial counterpart (Table 6).

Table 4: Procedural complications

Complications	Radial, n (%)	Femoral, n (%)	p-value
Vascular complications			
Bleeding	15 (0.3)	53 (0.8)	0.001
Access site occlusion	2 (0.0)	5 (0.1)	0.706
Dissection	4 (0.1)	8 (0.1)	0.523
Pseudoaneurysm	0 (0.0)	3 (0.1)	0.267
General complications			
Periprocedural MI	42 (0.9)	70 (1.1)	0.285
Emergency PCI	16 (0.3)	78 (1.2)	<0.001
Bail-out CABG	3 (0.1)	4 (0.1)	1.000
Cardiogenic shock	9 (0.2)	130 (2.0)	<0.001
Arrhythmia (VT/VF/Brady)	16 (0.3)	139 (2.1)	<0.001
Heart Failure	4 (0.1)	20 (0.3)	0.011
Renal Impairment	5 (0.1)	64 (1.0)	<0.001
TIA/Stroke	3 (0.1)	7 (0.1)	0.533
Tamponade	0 (0.0)	9 (0.1)	0.013

Table 5: In-hospital complications

Complications	Radial, n (%)	Femoral, n (%)	p-value
Vascular complications*	25 (0.4)	80 (1.1)	<0.001
MACE**	74 (1.3)	352 (4.7)	<0.001
Death	41 (0.7)	482 (6.4)	<0.001

*vascular complications included bleeding, access site occlusion, loss of distal pulse, dissection, pseudoaneurysm

**MACE (major adverse cardiovascular events) included periprocedural MI, bail-out CABG, cardiogenic shock, arrhythmia, TIA/stroke, cardiac tamponade, and heart failure.

Table 6: Adjusted odds ratios of developing in-hospital complications after trans-femoral PCI compared to the trans-radial approach.

Events	Adjusted OR*	95% confidence interval	P-value
Death	8.21	5.38-12.54	<0.001
MACE	3.39	2.51-4.58	<0.001
Vascular complications	1.79	1.01-3.16	0.047

*Adjusted for gender, race, age, smoking status, diabetes, hypertension, dyslipidemia, CVA, Types of ACS, renal failure, heart failure

Discussion

This study confirmed that trans-radial access in PCI for AMI is feasible and safe in the Southeast Asian population. AMI is a medical emergency and adequate percutaneous access promptly are important aspect for the success of emergency PCI. Historically, trans-radial PCI deemed to take longer duration and delayed the crucial door to balloon time in comparison to trans-femoral PCI (17). Hence, for the past few decades, femoral artery puncture was the preferred access for primary PCI, however as time advances the radial access has become more popular. In our study, femoral access was the main route for PCI among the operators. Changes over time in PCI practice is beyond the scope of the current analysis.

Another factor that influences the choice of access was the complexity of the vascular anatomy. The elderly tend to have significant tortuosity of the subclavian artery and aortic arch. Furthermore, aortic root dilatation, calcification of great vessel and coronary may make it difficult for catheter manipulation and device delivery. Thus, femoral access might be a better option in these circumstances. Obese or overweight patients are also not uncommonly encountered in daily PCI practice. As the BMI increase, the cannulation of femoral artery may become increasingly difficult as well as post-procedure access site management. This is likely to explain the favor of trans-radial access to high BMI index patients. Yee et. al concluded that trans-radial access is progressively preferred as BMI increases and in younger patients, while in STEMI or emergent cases and elderly patient trans-femoral access is preferred (18).

There is no difference in fluoroscopy time or radiation exposure between the radial and femoral approaches studied in this study. The duration of radiation exposure is important, especially when dealing with more complex coronary lesions. In our cohort, the proportion of complex cases performed via the femoral approach is not significantly different from the radial approach. However, different findings were reported in the previous literature (19–23). Despite the low rate of peripheral complication in radial PCI, there is increased concern of patient's and operator's health as higher radiation exposure associated with radial approach PCI regardless of optimal radiation protective measures taken. These could be due to the technical difficulties and the distance between the interventional cardiologist to the radiation source.

The ultimate aim of performing revascularization procedures other than restoring blood flow to the culprit's vessels is hemorrhagic prevention. Bleeding from the access site is the major contributor to bleeding events in patients undergoing PCI and is associated with significant increases in mortality rates

(24)[23]. Trans-radial PCI is one of the best strategies to avoid bleeding complications (25,26)[24, 25]. This is also evident from our study, where the trans-radial PCI appeared to be associated with low bleeding risk. Thus, our results confirm the previous studies which show significant reductions in MACE and bleeding complications (27). In cases of rescue PCI and pharmaco-invasive PCI strategy, the trans-radial approach is also preferred to reduce the bleeding risk (28,29).

Strength And Limitation

Our study presents some limitations that need to be disclosed. Firstly, it is an observational retrospective analysis of an on-going nationwide registry of PCI procedures. Although the data manager has tried to ensure data completeness by vigilant monitoring and communication with the source data provider, we still have a large number of missing information. Continuous measures were taken by the data steering committee to ensure the quality of data, which includes regular training and briefing for personnel involved in data collection. Secondly, we acknowledge significant numbers of the patient who lost to follow up after discharge resulting in difficulty of assessment of long-term outcomes. Thirdly, exclusion of incomplete data from analysis might result in selection bias and the possibility of missing residual confounding factors. Please add some information on did we overcome the missing data issue. We have opted for list-wise deletion technique rather than the much-preferred multiple imputation technique. Fourth, the practice and experience of PCI operators as well as advancement in coronary devices in the country will have been significantly different over the years, a factor which was not taken into account during analysis.

Despite all the limitations, this study includes a significantly large number of cases of radial approach PCI for comparison with the femoral approach PCI in a single registry. Analysis from this kind of practice registry would be a true reflection of real-world data as well as complementing results from randomized controlled trials.

Conclusion

In this observational retrospective analysis of one of the largest PCI registries in the Southeast Asian population, PCI via radial approach in patients with AMI was safe and feasible as compared to the femoral approach. PCI via the femoral approach in this cohort resulted in a significantly higher risk of vascular complications, MACE, and death. Bleeding complications identified as the most important avoidable complications during PCI procedures.

Abbreviations

ACS	Acute coronary syndrome
AHA/ACC	American Heart Association / American College of Cardiology
BMI	Body mass index

CABG	Coronary artery bypass graft
CKD	Chronic Kidney disease
CK-MB	Creatinine-Kinase – Muscle/Brain
ECG	Electrocardiogram
MACE	major adverse cardiovascular events
MORTAL via the Arm or Leg	Mortality benefit Of Reduced Transfusion after percutaneous coronary intervention
NSTEMI	Non-ST elevation myocardial infarction
NCVD	National Cardiovascular Disease Database
PCI	percutaneous coronary intervention
RIVAL	Radial Versus Femoral Access for Coronary Intervention trial
RIFLE-STEACS Syndrome	Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary
STEMI	ST-elevation myocardial infarction
TIMI	Thrombolysis in myocardial infarction

Declarations

Data availability

The raw datasets analyzed can be requested in writing to the steering committee of the NCVD-PCI registry and the National Heart Association of Malaysia.

Conflicts of interest

The authors declare that they have no competing interests.

Funding statement

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Author's contributions

MDI, ASMZ, and WAWA are responsible for data acquisition, designing the study and provided significant ideas towards study execution from the data provided by the National Heart Association of Malaysia. MFH and ZA provided substantial statistical help and performed methodology checks. MDI, MFH, MIAH and MABMF critically analyzed the data and drafted the main manuscript. All authors critically reviewed and approved the final manuscript for publication.

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