

# Left Radial Approach versus Right Radial Approach of Coronary Angiography in the Diagnosis of Coronary Heart Disease

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## Abstract

**Background:** Transradial coronary angiography has established itself as safe alternative to transfemoral approach. Today, the artery of approach lies completely on the operator's choice. The Right Radial Approach (RRA) has been a favorite for most of the interventional cardiologists due to the convenience in operating from the right side. The Left Radial Approach (LRA) has always been a neglected route. LRA does have many advantages over the right, the vascular anatomy being one of them. The aim of our study was to compare the right radial approach of diagnostic coronary angiography with left radial approach. **Method:** A total of 70 cases of Coronary Angiography (CAG) with normal Allen test and satisfying the inclusion criteria were prospectively observed and studied after randomly assigning them into two equal groups, LRA (Left Radial Approach) n = 35 and RRA (Right Radial Approach) n = 35. Multipurpose TIG (Tiger) catheter was used in both the approaches to catheterize the right as well as left coronary artery. **Results:** The access time, catheter manipulation time, procedure time, amount of contrast used, hospital stay, intensity of pain experienced, cost of the procedure and quality of coronary angiogram observed were statistically insignificant while the fluoroscopy time was slightly statistically significant which was independent to catheter manipulation time. **Conclusions:** The neglected Left Radial Approach to coronary angiography is as efficacious, safe and cost effective with reduction in arterial spasm complications when compared to the Right Radial Approach performed by multipurpose Tiger catheter.

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## Keywords

**Left Radial Approach, Right Radial Approach, Coronary Angiography, Coronary Heart Disease, Tiger Catheter**

## 1. Introduction

The Coronary Angiography (CAG) is one of the minimally invasive diagnostic and therapeutic techniques used in patient with Coronary Heart Disease (CHD). It involves the injection of a special contrast agent into the coronary arteries which is promptly detected by X-rays that further gives a series of image called the angiogram. The angiogram thus obtained provides an inside view of different coronary arteries and their abnormalities which further aids to treatment strategy accordingly. CAG was performed only via the femoral artery in the beginning of its invention but with the development and advancement in the field of Interventional Cardiology, this classic approach has been shifted to radial due to their advantages over the former. Moreover, the advancement in the technology today has made it possible for the miniaturization of the diagnostic catheters and percutaneous transluminal coronary angioplasty equipment too. The radial approach, as an alternative to femoral approach, is becoming popular throughout the world due to this miniaturization [1]-[11]. A lower incidence of access site complications, earlier patient ambulation, improved patient satisfaction and lower cost are the main advantages of this approach [1]-[3] [6] [10]-[12].

Therefore, transradial coronary angiography has established itself as safe alternative to transfemoral approach. Today, the artery of approach lies completely on the operator's choice. The right radial approach has been a favorite for most of the interventional cardiologist due to the convenience in operating from the right side. Moreover, the left radial approach has always been a neglected route. The left radial approach do have many advantages over the right, the vascular anatomy being one of them, which completes the procedure with more ease and quick thereby resembling the procedure same as the femoral approach [13]. Previous studies have shown that transradial cardiac catheterization has decreased not only bleeding complications related to the access site, as well as procedural discomfort, but also morbidity and hospitalization rates as compared to the transfemoral approach [14]-[21]. There has always been a debate as to which approach should be opted for radial angiography. Therefore, we chose this topic and subsequently studied to compare left radial approach with the right using a multipurpose Tiger (TIG) catheter and to study the factors which lead to the difference, if any.

## 2. Methods

This was a single centered prospective observational study conducted in Interventional Cardiology Department of Jingzhou Central Hospital, Jingzhou, Hubei, China. A total of 75 patients undergoing diagnostic coronary angiography with normal Allen test and satisfying the inclusion criteria were randomly assigned to two approach groups LRA ( $n = 35$ ) and RRA ( $n = 35$ ) from 1st April 2015 to 31st December 2015. Variables such as age, sex, risk factors were taken into account and analyzed. Different parameters including access time (radial artery puncture time), catheter manipulation time, procedure time, fluoroscopy time, total contrast agent used, hospital stay, pain experienced by the patients, complications and radial artery abnormalities were recorded and analyzed separately.

### 2.1. Inclusion Criteria

The patients included in the study satisfied following criteria:

- 1) Normal Allen test
- 2) Indication for CAG
- 3) Informed consent

### 2.2. Exclusion Criteria

- 1) Abnormal Allen test
- 2) Previous CAG by radial approach

- 3) Right heart catheterization
- 4) Simultaneous renal or aortic angiography
- 5) Presence of indication for ventricular angiogram
- 6) Any contraindication for coronary angiography

### 2.3. Procedure

All patients in the RRA had their wrists hyperextended and the operator standing on right side of the patient while in the LRA the patients had their left forearm laid on their left side. After local subcutaneous anaesthesia with 1% lignocaine, the anterior wall of the radial artery was punctured using an 18 gauge needle. A 0.032" guide wire was introduced through the needle followed by the insertion of 6 Fr. radial sheath. A bolus dose of 2000 IU of heparin was administered intraarterially. For coronary angiography, appropriate size Tiger catheter was used for left radial route and appropriate size Tiger catheter was used for right radial route. The left coronary angiograms were obtained at least four projection views and the right coronary angiograms at least two views.

### 2.4. Study Limitations

- 1) Because of language problem it was difficult to collect data.
- 2) Because of limited number of literature and research studies on left versus right approach we could not consider more explanations and clinical aspects from various research sources.
- 3) Because of the operators convenience usually operating from right approach we could not get sufficient number of case to compare the study in a large aspect.
- 4) Because of our single centered prospective evaluation of 9 month of study, our findings may be clinically significant and reliable for only our hospital setup, which may or may not be true for another hospital setup.

### 2.5. Data Collection

The data for this study was collected for a period of 9 months, by the principal researcher during the procedure and was recorded into a structure questionnaire.

### 2.6. Ethical Consideration

Permission to do the study was sought from Jingzhou Central Hospital, Department of Cardiology. Confidentiality and personal privacy was respected in all levels of the study. Collected data will not be used for any other purpose.

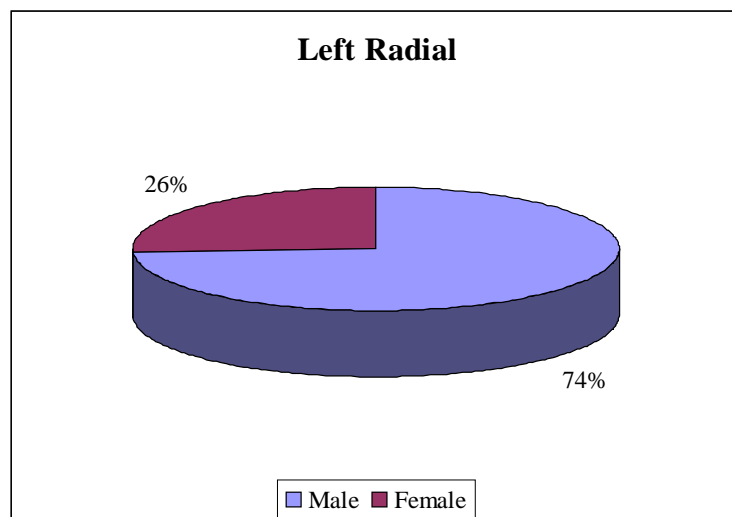
### 2.7. Statistical Analysis

The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 16.0 for Windows). All quantitative variables were estimated using measures of central location (mean, median) and measures of dispersion (standard deviation). Normality of data was checked by measures of Kolmogorov Smirnov tests of normality. For normally distributed data means were compared using student's t-test for two groups. For skewed data Mann-Whitney test was applied. Qualitative or categorical variables were described as frequencies and proportions. Proportions were compared using Chi square or Fisher's exact test whichever was applicable. All statistical tests were two-sided and performed at a significance level of  $\alpha = 0.05$ .

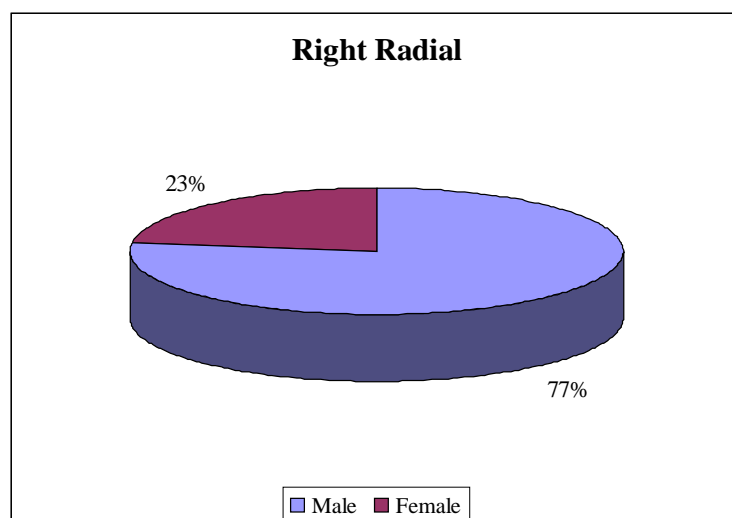
## 3. Results

The mean age of the patients in left radial approach group (LRA) was 48.28 with an age group of 29 - 75 years whereas in the right radial approach group (RRA) were in the age group 32 - 78 years with a mean of 48.25 years ( $P = 0.991$ ).

Amongst 35 patients in LRA group, 26 (74%) were males and 9 (26%) were females with Male: Female ratio of 2.88:1, **Figure 1**. On the other hand in the RRA group, 27 (77%) were males and 8 (23%) were females with Male: Female ratio of 3.37:1, **Figure 2**. The sex distribution also did not differ significantly between the RRA and LRA groups ( $P = 0.780$ ).



**Figure 1.** Sex distribution in left radial approach group.



**Figure 2.** Sex distribution in right radial approach group.

Diabetes Mellitus (DM) was the predominant risk factor occurring in 22 patients in RRA group and 18 patients in LRA group. Hypertension (HTN), Obesity and Smoking were the other risk factors respectively (**Figure 3**) and none of the risk factors were found to be statistically significant in either group (DM- $P = 0.527$ , HTN- $P = 0.637$ , Obesity- $P = 0.738$ , Smoking- $P = 0.563$ ).

The time required for securing access (access time-AT) to the radial artery ranged from 15 - 60 seconds in the LRA while it ranged from 20 - 70 seconds in RRA, ( $P = 0.542$ ), **Table 1**.

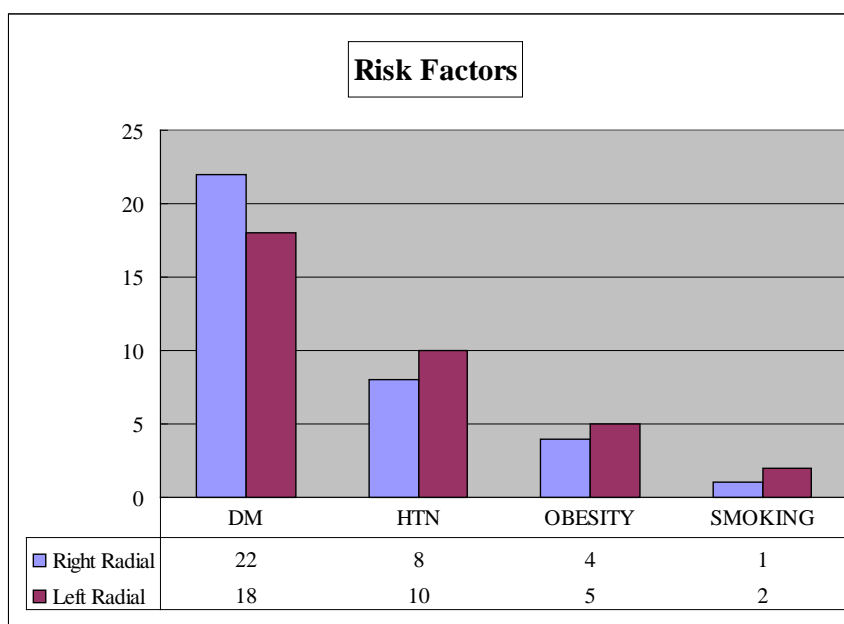
The mean catheter manipulation time (CMT) in LRA was 64.00 seconds while it was 63.09 seconds in the RRA, ( $P = 0.686$ ).

It was observed that the mean fluoroscopy time was more in LRA when compared to RRA approach and was slightly statistically significant (LRA-5.72 minutes vs RRA-4.25 minutes,  $P = 0.041$ ).

However, when the procedure time (PT) was taken into account, it was seen that it did not differ significantly between the two groups (LRA-14.26 minutes vs RRA-13.58 minutes,  $P = 0.194$ ).

The amount of contrast used (CU) during the angiography procedure was also similar while comparing both the groups (LRA-40.71 mL vs RRA-38.39 mL,  $P = 0.217$ ).

Tiger catheter was used to catheterize the coronary arteries in both the approach groups. The number of catheters used for angiography also did not differ significantly between the two groups in our study.



**Figure 3.** Risk factors for coronary heart disease.

**Table 1.** Clinical procedural finding of LRA and RRA.

	Left Radial Approach					Right Radial Approach					Total					P-value
	n	Min	Max	Mn	Md	n	Min	Max	Mn	Md	n	Min	Max	Mn	Md	
AT	35	15.00	60.00	32.51	31.00	35	20.00	70.00	34.28	31.00	70	15.00	70.00	33.40	31.00	0.542
CMT	35	53.00	76.00	64.00	63.00	33	45.00	80.00	63.09	66.00	68	45.00	80.00	63.55	64.50	0.686
FT	35	1.55	14.56	5.72	4.62	33	1.27	11.21	4.25	3.80	68	1.27	14.56	5.01	4.30	0.041
PT	35	12.12	24.39	14.26	14.17	33	11.13	21.21	13.58	13.16	68	11.13	24.39	13.93	13.41	0.194
CU	35	30.00	50.00	40.71	40.00	33	20.00	50.00	38.39	38.00	68	20.00	50.00	39.58	40.00	0.217
BCT	35	2.00	3.00	2.41	2.00	33	2.00	3.00	2.38	2.00	68	2.00	3.00	2.40	2.00	0.801
DT	35	6.00	12.00	7.71	6.00	33	6.00	12.00	7.09	6.00	68	6.00	12.00	7.41	6.00	0.156
PE	35	1.00	4.00	2.00	2.00	33	0.00	5.00	2.27	2.00	68	0.00	5.00	2.13	2.00	0.336

\*AT-Access Time (in seconds), CMT-Catheter Manipulation time (in seconds), FT-Fluoroscopy Time (in minutes), PT-Procedure Time (in minutes), CU-Contrast Used (in mL), BCT-Bed Confinement Time (in hours), DT-Discharge Time (in hours), PE-Pain Endured (in scale of 0 - 10). \*n = no. of patients, Min-Minimum, Max-Maximum, Mn-Mean, Md-Median.

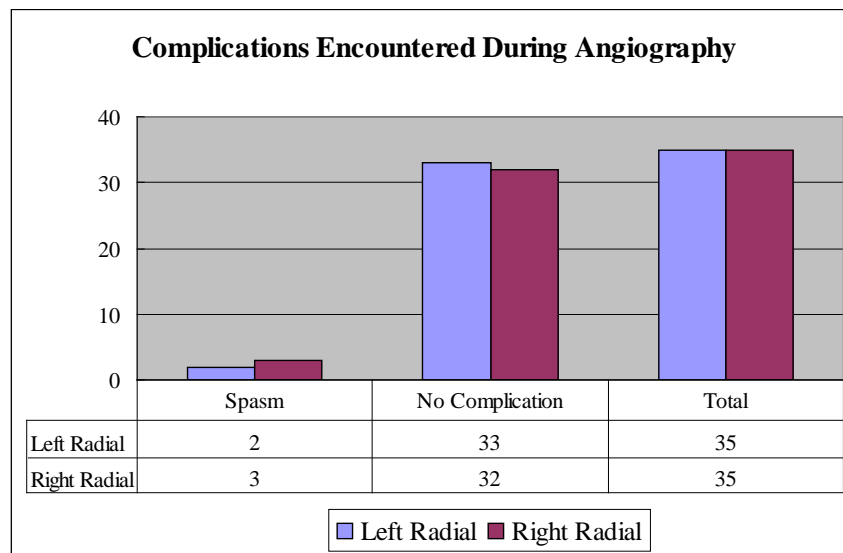
The quality of angiograms (QA) was measured on a scale of 1 to 3 for the left coronary artery as well as right coronary artery which did not differ significantly between the two groups (LRA-3 vs RRA-3).

The average bed confinement time (BCT) was 2.41 hours in LRA while it was 2.38 hours in RRA. Patients in LRA were discharged after a mean of 7.71 hours while those in RRA were discharged after a mean of 7.09 hours. The bed confinement time and discharge time also did not differ significantly between the two groups ( $P = 0.801$ ,  $P = 0.156$  respectively).

All the patients in both the approach groups were asked to grade their pain endured (PE) on a scale of 0 - 10. The grades were not statistically significant between the 2 groups (LRA-2.00 vs RRA-2.27,  $P = 0.336$ ).

The mean cost (C) of the angiography was 1300 RMB in each approach groups which did not differ statistically.

The common complication encountered was radial artery spasm (2 in LRA vs 3 in RRA;  $P = 0.642$ ), **Figure 4**, **Table 2**.

**Figure 4.** Complications encountered during angiography.**Table 2.** Complications, radial artery anomalies, stenosis & angiography findings.

	Left Radial Approach	Right Radial Approach	P-value
Complications			
Radial Artery Spasm	2	3	0.642
Crossover	0	2	0.357
Radial Artery Anomalies			
Tortuosity	2	4	0.414
H-bRO	1	0	0.317
Hypoplasia	1	0	0.317
RA & BA Stenosis			
RA > 50% stenosis	9	7	0.617
BA > 50% stenosis	2	4	0.414
RA < 50% stenosis	3	2	0.654
BA < 50% stenosis	1	1	1
RA > 50% stenosis	1	3	0.317
BA > 50% stenosis			
RA > 50% stenosis	0	1	0.317
BA < 50% stenosis			
RA < 50% stenosis	0	0	0
BA > 50% stenosis			
RA < 50% stenosis	0	0	0
BA < 50% stenosis			
Catheterization Findings			
0 vessel Involved	8	13	
1 vessel Involved	12	7	
2 vessel Involved	6	9	0.294
3 vessel Involved	9	6	

\*H-bRO-High-bifurcating Radial Origin, RA-Radial Artery, BA-Brachial Artery.

There were total numbers of 2 crossovers in our study both due to radial artery spasm which were only in the RRA, one to ipsilateral ulnar and other to the femoral. The difference between the crossover in our study was not statistically significant, ( $P = 0.357$ ).

The common radial artery anomalies encountered were high-bifurcating radial origin, tortuosity and hypoplasia ( $P = 0.317$ ,  $P = 0.414$ ,  $P = 0.317$ ). Therefore, no radial artery anomaly was statistically significant between the 2 groups. We did not come across any case of retroesophageal subclavian artery anomaly.

A total of 7 patients in the RRA demonstrated significant stenosis ( $>50\%$  stenosis) of radial artery while the same number in LRA was 9. Similarly, slightly more patients had significant brachial artery stenosis ( $>50\%$  stenosis) in the RRA (4) as compared to LRA (2). However, they were not different statistically. None of the groups attained statistical significance between the RRA and LRA implying that the stenoses of radial artery were evenly distributed across both the groups.

Coronary angiogram done had a range of vessel involvement ranging from no vessel to involvement of all the three coronary arteries by atherosclerosis. In the LRA, the largest number of patients had single vessel involvement by atherosclerosis (34%). In the RRA, more patients had no vessel involvement by atherosclerosis on coronary angiogram (37%). There was no difference between the 2 groups with respect to number of vessels involved ( $P = 0.294$ ).

#### 4. Discussions

This study was undertaken to compare the right radial approach with left radial approach and prove that left radial approach is as efficacious as the right approach in diagnostic coronary angiography with respect to access time, catheter manipulation time, procedure time, contrast, hospital stay, discharge time, pain endured during and after the procedure. The use of TIG catheter to catheterize the arteries lowers the incidence of arterial spasm.

The access time in our study was not found to be significant which was similar to the study of Kawashima O *et al.* [22] and Santas E *et al.* [23].

The catheter manipulation time was found to be similar in both the approaches in our study unlike Kawashima O *et al.* [22] where it was found to be shorter in the left approach.

The fluoroscopy time was slightly significant ( $P = 0.041$ ) and was greater in the LRA which was independent to catheter manipulation time. Santas E *et al.* [23] and Yumiko Kanei *et al.* [24] did not have any difference in their study whereas S L Xia *et al.* [25] and Guo X *et al.* [26] showed fluoroscopy time greater in right radial approach.

Though the fluoroscopy time was found to be dissimilar between both the groups our procedure time was not statistically significant ( $P = 0.194$ ) which is in support of Santas E *et al.* [23] and a recent meta-analysis of prospective studies done by Shah RM *et al.* [27] who also did not find any difference. The use of Tiger catheter in our study for both approaches may be the reason for the similar total procedure time which is also in support of Kim SM *et al.* [28] who in their study proved that the use of Tiger catheter decreases the procedure time.

The amount of contrast and number of catheters used during the procedure was also statistically insignificant in our study when compared to both the groups which was similar to the finding of Kawashima O *et al.* [22], Santas E *et al.* [23], and Binita Shah *et al.* [29]. Amount of contrast was also found to be similar in a recent study done by Dominici M *et al.* [13]. However the amount of contrast used was greater in the left radial approach group in Jun-Won Lee *et al.* [30] whereas Guo X *et al.* [26] had just the opposite finding. The number of catheters used was greater in the left approach group in S L Xia *et al.* [25] findings whereas in Binita Shah *et al.* [29] the use of universal catheter was significantly greater in the right approach group.

Since we used identical type (Tiger) and numbers of catheter for both the LRA and RRA groups, the cost of the procedure did not differ significantly. Moreover, the amount of contrast used was similar which also contributed to the similar cost of the procedure in both the groups. The duration of hospital stay was also found to be similar which is in support of Louvard Y *et al.* [31] findings. Bed confinement time and discharge time were also not statistically different in either group in our findings (BCT  $P = 0.801$  and DT  $P = 0.156$ ) which was similar to Santas E *et al.* [23] study ( $P = 0.07$ ).

There were total numbers of 2 crossovers in our study both due to radial artery spasm which were only in the RRA group, one to ipsilateral ulnar and other to the femoral. The difference between the crossover in our study was not statistically significant ( $P = 0.357$ ) which was similar to Binita Shah *et al.* [29] whereas crossover rate was found to be higher in LRA group than RRA group in Jun-Won Lee *et al.* [30] and puncture failure being the most common cause.



The quality of angiogram and pain experienced by the patients during the procedure was also similar as well as statistically insignificant in both the groups.

We experienced 4 radial artery anomalies in the RRA group all of which were Tortuosity with the same number in LRA group, 2 Tortuosity, 1 High-bifurcating Radial Origin and 1 Hypoplasia. Vasecchi O *et al.* [32] had an incidence of abnormal origin in 8.3%, tortuosity in 3.8%, hypoplasia in 7.7%, radioulnar loop in 0.8%, stenosis (1.7%) and lusoria subclavian artery in 0.45%. Li L *et al.* [33] conducted a study to find the features and variations of a radial artery approach on southern Chinese population and discovered radial artery tortuosity (3.6%), high origin of radial artery (1.7%), radial artery loop (0.6%), double radial artery (0.1%), brachial artery tortuosity (0.4%), double brachial artery (0.1%), subclavian artery tortuosity (5.4%), small subclavian artery (0.4%), right retro-esophageal subclavian artery (0.6%), brachiocephalic trunk tortuosity (2.8%), small brachiocephalic artery (0.1%), and brachiocephalic artery anomaly (0.4%). We found out that 22.85% of our patients had >50% stenosis of radial artery. The variation in the incidence of anomalies with respect to tortuosity, abnormal origin, hypoplasia can be explained by the fact that our study had only 70 patients while Valsecchi O *et al.* [32] included 2211 cases and Li L *et al.* [33] had 1400 patients in their study. Valsecchi O *et al.* [32] did not clearly define as to how much reduction in luminal diameter constituted stenosis of radial artery. We included all patients who had greater than 50% stenosis of radial artery.

The coronary angiogram findings of our study revealed single vessel disease in 19 patients, double vessel disease in 15 patients, triple vessel disease in 15 patients and 21 patients without significant (>50%) stenosis. The number of vessels involved had no statistical relationship with the left or right radial approach. Saito S *et al.* [8] also found no significant difference between the two approaches with respect to the number of vessels involved.

Radial artery spasm were found to be the only complication in our study which was more in RRA in comparison to LRA but were not statistically significant ( $P = 0.642$ ). Dominici M *et al.* [13] did not encounter any major or minor complications in their study. Santas E *et al.* [23] observed only minor complications: 2 of their patients had hematomas whereas 1 patient had loss of pulse. Kawashima O *et al.* [22] had similar findings to our and observed radial artery spasm as their main complication which occurred only in the right radial approach group. However they used Judkins catheters and the size of their catheters were different (4Fr.) Louvard Y *et al.* [31] noted hematoma and external bleeding as their only complications whereas one of their patients had ventricular fibrillation when RCA was hooked with AL2 catheter which was treated successfully by defibrillation. Our study did not experience hematoma as the complication as all patients had their sheath removed and puncture site closed by radial band immediately after the procedure. Moreover the amount of heparin used during the procedure was only 2000 IU. In Hongyu Hu *et al.* [34] there was also cases of major bleeding and vascular complications requiring surgical intervention. However, one patient experienced a symptomatic stroke and died in the right radial approach group in Hongyu Hu *et al.* [34] study.

Moreover, the unique advantage of the multipurpose Tiger catheter to easily cannulate both right and left coronary artery presents an advantage to the operator and provides patient comfort decreasing the various complications during transradial coronary angiography.

## 5. Conclusion

Coronary angiography performed via left radial approach is as efficacious, efficient and safe as right radial approach when performed by Tiger catheter with respect to the access time, catheter manipulation, procedure time, amount of contrast used, hospital stay, intensity of pain experienced and quality of coronary angiograms observed. Arterial spasm, which is one of the common complications encountered during angiography, is not found to be significant with the use of Tiger catheter in either group.

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