

## TRANS-RADIAL CORONARY ANGIOGRAPHY- A STUDY OF CAUSES OF PROCEDURAL FAILURE IN A TERTIARY CARE HOSPITAL IN SOUTH BENGAL

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### ABSTRACT

#### BACKGROUND

The trans-radial approach for performing coronary angiography was practiced for long time. This procedure has some advantages over femoral approach. Due to technical complexity this route is rarely selected for coronary angiography worldwide. The objectives of this study were 1. to assess the feasibility of trans-radial angiography for selective catheterization of the coronary arteries, and 2. to determine the causes of procedural failure.

#### MATERIALS AND METHODS

100 patients of acute coronary syndrome or significant symptomatic angina or abnormal stress test or myocardial perfusion scan were selected for coronary angiography by trans-radial route at R. G. Kar Medical College between 1<sup>st</sup> March 2013 - 28<sup>th</sup> February 2014. The number of failure cases is evaluated to find out the causes along with the complications that occurred during procedure in all cases. Results were then analyzed.

#### RESULTS

Radial artery spasm is the main cause trans-radial failure along with anatomical abnormality of radial and subclavian artery. It is more common in female patients. This approach is cost effective because of reduced hospital stay and was found to be very safe with high degree of success with very low rate of complications.

#### CONCLUSION

Trans-radial approach for coronary angiography is safe and cost-effective procedure in experienced hands.

#### KEY WORDS

Trans-Radial Coronary Angiography, Procedural Failure.

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#### BACKGROUND

The trans-radial approach for performing coronary angiography was initially proposed by Campeau<sup>1</sup> in 1989. Several studies have shown that the trans-radial approach allows treatment of the same type of patients and lesions as the classic femoral approach, with some advantages. Because it involves a minimal vascular complication rate, eliminates the necessity for prolonged compression or closure devices and allows for earlier ambulation for the patient. Trans-radial approach more comfortable for the patient because it decreases hospital costs and length of stay in hospital. But, the greater technical complexity of the procedure, its use is limited in our country.

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The primary objectives are to assess the feasibility of trans-radial angiography for selective catheterization of the coronary arteries, and to determine the causes of procedural failure.

#### Objectives of the Study

1. To determine the causes of procedural failure.
2. To determine complication rate.

#### MATERIALS & METHODS

Patient came with the Complain of angina and angina equivalent at Cardiology OPD or Emergency of R. G. Kar Medical College were screened. Routine history, clinical examination along with relevant biochemical, Echocardiographic and Radionuclide scan were performed. The selected cases were planned for TRCAG after written consent. Then assessment of dual arterial supply to both hands was assessed by performing Allen's test<sup>1</sup> (Modified Allen's<sup>1</sup> test was performed only when Allen's test was be abnormal).

**Study Type and Design-** Prospective Observational Study.

**Study Area-** R. G. KAR Medical College and Hospital, Kolkata.

**Study Period-** 1<sup>st</sup> March 2013 - 28<sup>th</sup> February 2014.

**Sample Type and Size**

Simple random sample, 100 patients (Sample).

**Inclusion Criteria**

1. Acute coronary syndrome.<sup>2</sup>
2. Significant symptomatic angina.
3. Abnormal stress test or myocardial perfusion scans.

**Exclusion Criteria**

1. Negative Allen's test.
2. Chronic renal failure requiring regular hemodialysis.
3. Cases where simultaneous right heart catheterization to be attempted.

**RESULTS**

Chi-square test ( $\chi^2$ , Pearson's)- A method of testing the significance of difference between two categorical variables. A p value of <0.05 was considered significant.

Trans-radial coronary angiography (TRCAG) was done in R. G. Kar Medical College in total of hundred (100) patients. Coronary angiography was successfully done in 83 cases (83%) and 17 patients could not be performed through this (Radial) route. They had to convert through femoral route and brachial route. These cases were categorized as a Procedural failure cases.

	Number	Percentage (%)
TRCAG Successfully Done	83	83 %
Procedural Failure	17	17%
<b>Total</b>	<b>100</b>	<b>100%</b>

**Table 1. Procedural Failure in Study Period**

**TRCAG- Trans-Radial Coronary Angiography**

Out of 100 patients 78 were male and 22 were female. Trans-radial coronary angiography (TRCAG) was successfully done

in 69 (88.46%) male and 14 (63.63%) female patients. TRCAG failed in 9 (11.53%) male and 8 (36.36%) female. Out of total 17 patients of Procedural failure through trans-radial route 9 (52.94%) patient were male and 8 (47.05%) patients were female. Data is not statistically significant with P value = 0.11

Out of total 100 patents 67 (67%) patients were Smokers and 33 (33%) were non-smoker. Trans-radial coronary angiography (TRCAG) was successfully done in 59 (88.05%) smoker and 24 (72.72%) non-smoker patients. TRCAG failed in 8 (11.94%) smokers and 9 (27.27%) non-smoker. Out of total 17 patients of Procedural failure through radial route 9 (52.94%) patient were non-smokers and 8 cases (47.05%) were smokers. Data is statistically significant with P value =0.048.

Out of total 100 patents 75 (75%) patients had normal blood pressure (Normotensive) and 25 (25%) had high blood pressure (Hypertensive). Trans-radial coronary angiography (TRCAG) was successfully done in 64 (85.33%) normotensive and 19 (76%) of hypertensive patients. TRCAG failed in 11 (14.66%) normotensive and 6 (24%) hypertensive patient. Out of total 17 patients of Procedural failure through radial route 11 (64.70%) patient were normotensive and 6 cases (35.29%) were hypertensive. This data is statistically insignificant with P value = 0.217

Out of total 100 patents 68 (68%) patients had normal blood glucose level (No-diabetic) and 32 (32%) had high blood glucose (Diabetic). Out of total 17 patients of Procedural failure through radial route 7 (41.17%) patient were non-diabetic and 10 cases (58.82%) were Diabetic. Data is statistically significant with P value = 0.012. Out of total 32 diabetic patients 10 (31.25%) cases had procedural failure.

Variables		Total		TRCAG Successfully Done		Procedural Failure		
		N	(%)	N	(%)	Number & % in Total Cases		% in 17 Cases
Gender	Male	78	78%	69	88.46 %	9	11.53%	52.94%
	Female	22	22%	14	63.63%	8	36.36%	47.05%
H/O Smoking	Non-Smokers	33	33%	24	72.72%	9	27.27%	52.94%
	Smokers	67	67%	59	88.05%	8	11.94%	47.05%
H/O HTN	Non-Hypertensive	75	75%	64	85.33%	11	14.66%	64.70%
	Hypertensive	25	25%	19	76%	6	24%	35.29%
H/O Diabetes	Non-Diabetic	68	68%	61	89.70%	7	10.29%	41.17%
	Diabetic	32	32%	22	68.75%	10	31.25%	58.82%
H/O PVD	No PVD	94	94%	78	82.97%	16	17.02%	94.11%
	PVD	06	06%	5	83.33%	1	16.66%	5.88%
Height in cm	<=150	15	15%	10	66.66%	05	33.33%	29.41%
	151-160	31	31%	26	83.87%	05	16.12%	29.41%
	161-170	46	46%	40	86.95%	06	13.04%	35.29%
	>=171	08	08%	07	87.5%	01	12.5%	5.88%
R Radial Artery Spasm	No Radial Artery Spasm	66	66%	64	96.96%	2	3.03%	11.76%
	Radial Artery Spasm	34	34%	19	55.88%	15	44.11%	88.23%
Peripheral Artery Dissection	No Peripheral Artery Dissection	99	99%	83	83.83%	16	16.16%	94.11%
	Peripheral Artery Dissection (Brachial Artery)	01	01%	0	00%	01	100%	5.88%
Coronary Artery Spasm	No Coronary Artery Spasm	93	93%	77	82.79%	16	17.20%	94.11%
	Coronary Artery Spasm	07	07%	6	85.71%	01	14.28%	5.88%
Loop/ Tortuosity	No Loop/ Tortuosity	89	89%	77	86.51%	12	13.48%	70.58%

	Radial Tortuosity	02	02%	01	50%	01	50%	5.88%
	Subclavian Artery Tortuosity	09	09%	05	55.55%	04	44.44%	23.52%
Origin of Coronary Artery	Normal Origin of Coronary Artery	89	89%	76	85.39%	13	14.60%	76.47%
	LMCA	04	04%	02	50%	02	50%	11.76%
	RCA	07	07%	05	71.42%	02	28.57%	11.76%

**Table 2. Correlation with Different Factors and Procedural Failure**

PVD- Peripheral Vascular Disease, LMCA- Left Main Coronary Artery, RCA- Right Coronary Artery

Out of total 100 patents 94 (94%) patients had normal blood Vessels (No-PVD) and 06 (06%) had Peripheral vascular disease (PVD). Out of total 17 patients of Procedural failure through radial route 16 (94.11%) patient had no-PVD and 1 case (5.88%) had PVD while one out of 06 cases (16.66 %) with PVD were associated with procedural failure, which not statistically significant with P value = 0.731.

Although, patients with smaller height were associated with more procedural failure, {height <150 cm=33.33% (5/15), height 151-160 cm=16.12% (5/31), height 161-170 cm =13.04% (6/46) and height >170 cm =12.5% (1/8)} data is not statistically significant with P value = 0.386.

Out of total 100 patents 66 (66%) there were no radial artery spasm and 34 (34%) had radial artery spasm. Out of total 17 patients of Procedural failure through radial route 02 (11.76%) patient had no radial artery spasm while 15 out of 17 cases (88.23 %) with radial artery spasm were associated with procedural failure. Data is statistically significant with P value = 0.01.

Out of total 100 patents 99 (99%) there were no Peripheral artery dissection and 01 (01%) had Peripheral artery dissection. Out of total 17 patients of Procedural failure through radial route 16 (94.11%) patient had no Peripheral artery dissection while one out of 17 cases (5.88 %) with Brachial artery dissection associated with procedural failure.

All patient with Peripheral artery dissection (1/1, 100%) was associated with procedural failure. The data is statistically insignificant with P value = 0.17.

Out of total 100 patents 93 (93%) there were no Coronary Artery Spasm and 07 (07%) had Coronary Artery Spasm. Out of total 17 patients of Procedural failure through radial route 16 (94.11%) patient had no Coronary Artery Spasm while one out of 17 cases (5.88 %) with Coronary Artery Spasm associated with procedural failure. One out of 7 (14.28%) patient with coronary artery spasm was associated with procedural failure. which is statistically insignificant with p value = 0.66.

Out of total 100 patents 89 (89%) there were no Loop/ Tortuosity of artery and 11 (11%) had Loop/ Tortuosity of artery. Out of total 17 patients of Procedural failure through radial route 12 (70.58%) patient had No Loop/ Tortuosity while 05 (29.41%) had Loop/ Tortuosity of artery. Total of 05 out of 11 (45.45%) patient with loop/tortuosity were associated with procedural failure. Data is statistically significant with P value = 0.042.

Four patients had procedural failure out of total 17 due to abnormal origin of coronary artery and constitute 23.52% (4/17), whereas 11 patients with abnormal origin of coronary artery, 4 patients had procedural failure 36.36 % (4/11). Which is statistically insignificant with P value = 0.198.

	Male		Female		Total	
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
No Radial Artery Spasm	0	00%	2	100%	02	2%
Radial Artery Spasm	9	60%	6	40%	15	15%
<b>Total</b>	<b>09</b>	<b>52.94%</b>	<b>08</b>	<b>47.05%</b>	<b>17</b>	<b>17%</b>

**Table 3. Radial Artery Spasm Gender Wise Distribution**

Female patients contribute 40% (6/15) of the total number of radial spasms, while 6 out of 8 female patients (75%) had had radial spasm.

	Age (Years)								Total	
	41-50		51-60		61-70		>70		Number	(%)
	Number	(%)	Number	(%)	Number	(%)	Number	(%)		
No Radial Artery Spasm	0	00%	0	00%	0	00%	2	100%	2	02%
Radial Artery Spasm	2	13.33%	3	20%	5	33.33%	5	33.33%	15	15%
<b>Total</b>	<b>2</b>	<b>11.76%</b>	<b>3</b>	<b>17.64%</b>	<b>5</b>	<b>29.41%</b>	<b>7</b>	<b>41.17%</b>	<b>17</b>	<b>17%</b>

**Table 4. Procedural Failure Associated with Radial Artery Spasm Age Wise Distribution**

Prevalence of Radial artery spasm was more with higher age group, it contributes 33.33% (5/15) in both 61-70 years group, and >70 years of age group. All patient with age group between 61-70 yrs., had radial spasm (100%, 5/5), while 71.42 % (5/7) in patients with age >70 yrs. This data is statistically significant with P value = 0.037.

Total Procedural Failure was 17		
Causes of TRF	Number	Percentage (%) out of 17
Radial Artery Spasm	15	88.23%
Abnormal Origin of CA	4	23.52%
Loop/Tortuosity	5	29.41%
Peripheral Artery Dissection	1	05.88%
Coronary Artery Spasm	1	05.88%
Puncture Failure	2	11.76%

**Table 5. Causes of Procedural Failure**

**TRF- Trans-radial failure**

Most important cause of procedural failure was radial artery spasm (15/17). Other factors were also associated with radial spasm, but they had not responsible for failure.

	First 50 Patients				Second 50 Patients			
	Yes		No		Yes		No	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Procedure Failure	12	24%	38	76%	5	10%	45	90%
Radial Artery Spasm	15	30%	35	70%	15	30%	35	70%
Coronary Artery Spasm	3	6%	47	94%	2	4%	48	96%
Peripheral Artery Dissection	1	2%	49	98%	0	00%	50	100%
Hematoma	1	2%	49	98%	0	00%	50	100%
Bleeding	1	2%	49	98%	0	00%	50	100%
Pain	14	28%	36	72%	9	18%	41	82%
Infection	1	2%	49	98%	0	00%	50	100%
Granuloma	0	0%	50	100%	0	00%	50	100%
Compartment Syndrome	0	0%	50	100%	0	00%	50	100%
AV Fistula	0	0%	50	100%	0	00%	50	100%
Pseudoaneurysm	0	0%	50	100%	0	00%	50	100%
Neurologic Complaint	0	0%	50	100%	0	00%	50	100%

**Table 6. Causes and Complication of Procedural Failure with Level Experience**

**DISCUSSION**

Radial artery approach for coronary intervention has shown to reduce access site complications; early ambulation and reduced hospital stay.<sup>3</sup> Unfortunately, radial access still accounts for less than 10% of procedures worldwide.<sup>4</sup> Assumption that radial artery approach has excess failure rate and prolonged procedure time could have been the reasons for underutilization of radial artery site.<sup>5</sup> More data is required to convince interventional cardiologist to change their practice.

Our study population comprised of 78 (78%) males and 22 (22%) females with mean age of 56.71 ± 8.94 years. The overall procedural success rate was 83 (83%) for TRCAG. The reasons for failure of trans-radial procedure included failed radial artery puncture (n=2), radial artery loop and tortuous subclavian artery (N=5), failed catheterization of coronary arteries (N=4) and severe radial artery spasm (N=15). All procedures from radial artery approach ended up safely with

standard anticoagulation. There were no major complications encountered in our study, one patient (1%) suffered with minor forearm hematoma and was treated conservatively. None of patients suffered with radial artery occlusion in our study. This observation is similar to International data. That has demonstrated that coronary interventions can be performed more safely than contemporary femoral route. Even the most successful coronary percutaneous intervention can be complicated by vascular access site complications in as much as 2-8% of cases performed from transfemoral route.<sup>6,7</sup> The ACCESS study clearly demonstrated, reduction of major access site complications from radial compared to femoral and brachial approaches (0% vs 2.3% vs 2% respectively).<sup>5</sup> In a recent meta-analysis of 22 randomized controlled trials by Sanjit S Jolly et al,<sup>8</sup> radial access reduced major bleeding by 73% compared to femoral access (0.05% vs 2.3%). Reduction in access site complications is really important in current era when more high-risk interventions are performed in more sick patients with concomitant use of multiple anti-platelet and anti-coagulant medicines. No major access site complications occurred in radial group compared to 7.5% complications at entry site in femoral group among patients receiving abciximab during percutaneous intervention.<sup>6</sup> Transfemoral intervention in acute myocardial infarction carries a risk of access site complications of up to 23%.<sup>9</sup> On the contrary almost no access site complications have been described in patients undergoing transradial percutaneous in acute myocardial infarction who received GpIIb/IIIa inhibitors.<sup>10,11</sup> Our study has also validated that transradial route reduces vascular access site complications considerably, as only one patient (1%) developed minor forearm haematoma which settled successfully with conservative treatment. A study performed at National Institute of Cardiovascular diseases found transradial diagnostic coronary angiogram and percutaneous intervention results to be comparable to femoral approach in terms of success but without any major vascular access site complications.<sup>12</sup>

Out of 100 patient 83 (83%) coronary angiographies were performed from the trans-radial route in our study in the specified study period. The right hand was selected in all cases. The 5F sheath was most commonly used in (100%) and transradial failure in our study was 17% (17/100). This is correlating well with the previous study. The failure to complete the procedure from radial artery approach has been relatively high among the patients with radial artery spasm, radial loops, subclavian artery tortuosity and abnormal origin of coronary artery.<sup>5</sup> The failure to complete the procedure from radial route was 17% (17/100) in our study. The failure or cross over rate of radial access site was 5.9% in the meta-analysis by Jolly et al,<sup>8</sup> compared to 1.4% in the femoral group. Other factors that may contribute to procedural failure in lesser extent are height; patients with smaller height were associated with more procedural failure, Presence of diabetes Mellitus, Coronary artery spasm and presence of smoking history.

Asymptomatic radial artery occlusion occurs in 3-5% of patients in different studies<sup>13</sup> but, in our study we have not

found even a single case of radial artery occlusion. In the first half of our study there was 24% (12/50) procedure failure, while in the second half the study only 10% (5/50) procedure failure noticed, which is statistically significant with p value = 0.05, other complications are either less or equal in second half the study, but data were not statistically significant. So, trans-radial approach for coronary angiography is more successful and less complicated in experienced hand.

### CONCLUSION

1. Radial artery approach is found to be very safe with high degree of success & there are very low vascular access site complications.
2. The main cause of trans-radial failure was radial spasm that was highly prevalent in female sex and older age patients.
3. Tortuous radial and subclavian artery are also related to transradial failure.
4. Trans Radial Failure was more common in female sex, short height, DM and smoker patients.
5. TRCAG should be widely used while performing coronary angiographies because it is appreciated by the patient over femoral access and also convenient for the interventionalist.
6. It may be cost-effective for the institution as well for the patients by reducing hospital stays.

### Limitations

1. Sample size was less (N= 100).
2. It is a single- centered study.
3. The absence of a comparative femoral group.

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