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Transradial Access in Coronary Angiography: A Study of its Safety and Efficacy in Comparison to Transfemoral Access

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Abstract:

***Introduction**: Coronary angiography is traditionally performed through transfemoral access. Transradial access is increasingly being used for this purpose for its various advantages. However, its use in Bangladesh is less well studied. The aim of this study was to find out the safety and efficacy of transradial access as compared to transfemoral access.*

***Methods**: This was a single-center, cross-sectional study. 100 randomly selected elective coronary angiography from August 2017 to September 2018 by the same operator using either transradial access or transfemoral access were analyzed.*

***Results**: Among 100 coronary angiography, transradial access were 50 and transfemoral access were 50. Fluoroscopy time was 3.08[1-9] vs 1.47 [1-17] minutes (p=.014), dose area product was 4807 [1947-11489] vs 3202 [1130-12826] ìGy.m2 (P<0.001), total dose was 788 [276-2055] vs 520 [158-2424] mGy (p<0.001). Transradial failure occurred in 4 (8%) cases. Transfemoral failure occurred in 1 (2%) case. There was no significant difference in failure rate between the groups (p= 0.169). Ecchymosis was the commonest (10% in transradial access vs 22% in transfemoral access, p= 0.102) among post procedure complications. Other complications like thrombophlebitis (6% vs 18%, p=0.004); hematoma (0% vs 12%, p= 0.005); puncture site bleed (2% vs 4%, p= 0. 039) were seen in TRA and transfemoral access, respectively.*

***Conclusion**: Access site complications are more in transfemoral access. Transradial access is an effective alternative to transfemoral access, and it can be performed safely by experienced operators.*

Keywords: ***Coronary angiography, transradial, transfemoral***

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Introduction:

Worldwide, coronary artery disease (CAD) is the most common form of cardiovascular disease (CVD), for which coronary angiography (CAG) is the standard diagnostic strategy.[1]

Classically, CAG is performed via transfemoral access (TFA). Recently, transradial access (TRA) is becoming popular and increasingly being used. Compeau first introduced it in 1989.[2] There are some advantages and disadvantages of TRA over TFA. Especially, vascular bleeding complications at the femoral puncture site can result in increased morbidity.[3] Therefore, the rationale for TRA is to reduce access site bleeding complications, earlier ambulation and improved patient comfort.[4-6] However, TRA is still less commonly used because it requires a steep learning curve.[7-9]

One of the significant disadvantages of CAG is that it exposes both the patient and the operator to x-ray, and it represents an important issue.[10] It is associated with both deterministic effects, such as radiation-induced injuries to patients' skin,[11] and stochastic effects, such as radiation-induced cancer.[12] Whether TRA is associated with increased radiation exposure is still a matter of debate since conflicting data have been reported.[13]

The aim of this study was to find out the safety and efficacy of transradial access as compared to transfemoral access.

Methods:

We conducted a cross-sectional study at Combined Military Hospital, Dhaka, a tertiary care hospital in the Bangladesh armed forces. 100 patients (91 males, 9 females) scheduled for CAG between August 2017 and September 2018 were included in the study. Eligible patients were randomly selected for either TRA or TFA.

Patients with abnormal Allen's test, local vascular problems make difficulty gaining access, local skin infection, coronary

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artery bypass surgery, cardiogenic shock, acute or chronic kidney disease, and patients requiring percutaneous coronary interventions (PCI) or implantation of temporary pacemaker were excluded from the study.

Informed written consent was obtained from each patient before the procedure. Procedure time, access and radiation times, complications were recorded. All the procedures were performed by the same cardiologist.

Vascular access:
For TRA, 5-F catheters were used. 0.2 mg isosorbide trinitrate and 2.5 mg verapamil to prevent radial artery spasm and weight-adjusted dose of unfractionated heparin (UFH) to prevent thrombosis were injected directly into the radial artery through the sheath. 6-F sheaths were used for TFA.

Catheterization procedures:
Selective angiography of the right and left coronary arteries was carried out using Tiger catheter (Terumo) sized 5-F in case of TRA and with JL and JR 6-F in TFA.

Vascular hemostasis:
In TRA, arterial sheaths were removed immediately following CAG. Hemostasis was obtained using a pressure bandage over the puncture site. No manual compression was done before the application of the pressure bandage. Patients were instructed not to use the punctured arm for the following 4 h after the procedure, and the bandage was removed after at least 6 h.

On the other hand, the sheath was removed in the catheterization laboratory, and hemostasis was obtained by manual compression in TFA CAG. A bandage was applied, and the patient was instructed for bed rest for 6 h.

Measurement of radiation exposure:
Dose area product (DAP) which reflects both the dose of radiation administered and the area on the patient it is distributed to, was measured after each procedure. It was expressed as a microgray meter squared (ìGym2). Fluoroscopic time (FT), which reflects the length of time the patient and operator are exposed to radiation were measured in minutes. After each procedure, the total dose (TD) was measured in milligray (mGy), administered from the angiography system.

Statistical analysis:
IBM SPSS Statistics version 23 and JASP version 0.14 were used to analyze the results. Clinical and procedural characteristics were compared between patients managed by TRA and TFA. Categorical variables were expressed as percentages and were compared by the Chi-square test. Continuous variables were tested for normal distribution using histograms. The variables were expressed as mean ± standard deviation or median and were compared by Student's t-test. Correlations between continuous variables were done by the Pearson correlation coefficient or the Spearman correlation coefficient when variables were not normally distributed. Statistical significance was defined as a p-value of less than 0.05.

Results:
CAG was successfully done in 46 (92%) of 50 patients in TRA and 49 (98%) of 50 patients in the TFA group (p= 0.169). Baseline clinical characteristics are shown in Table 1. TRA patients were younger (p=0.375) and had a lower mean body mass index (BMI) (p=0.555), but those findings were not statistically significant. There was no statistically significant difference in gender in either group (p=0.014).

Most of the patients were male in either group. Among females, more were in TFA. There were no statistically significant differences in age, BMI, hypertension, diabetes mellitus, and smoking.

Procedural characteristics (FT, DAP, and TD) are shown in Table 2.

Table-I

Baseline clinical characteristics

Variables		TRA (n=50)	%	TFA (n=50)	%	p value
Gender	Male	49	98%	42	84%	0.014
	Female	1	2%	8	16%	
Age (years) (mean±SD)		51.46±12		53.2±8.8		0.375
BMI (mean±SD)		24.8±3.6	24.3±3.4	0.555		
Hypertension		23	46%	25	50%	0.689
Diabetes		11	22%	20	40%	0.052
Smoker		42	84%	35	70%	0.096

Abbreviations: n- number, BMI- body mass index; SD- standard deviation; TRA- transradial access; TRF- transfemoral access

Table-II

Procedural characteristics of the studied subjects

	TRA (Median) (n=50)	TFA (Median) (n=50)	p value
FT (minute)	3.08 [1-9]	1.47 [1-17]	0.014
DAP (μGy.m^2)	4807 [1947-11489]	3202 [1130-12826]	<0.001
TD (mGy)	788 [276-2055]	520 [158-2424]	<0.001

Abbreviations: n- number; FT- fluoroscopic time; DAP- dose area product; TD- total dose

The FT was more in TRA compared to TFA. DAP and TD were also significantly found more in TRA compared to TFA.

Median FT was significantly longer (p=0.014) in TRA (3.08 [1-9] minutes) compared with TFA (1.47 [1-17] minutes). DAP was significantly higher in TRA compared with TFA (4807 [1947-11489] vs 3202 [1130-12826] μGy.m^2; $p < 0.001$) **(**Figure 1**)**. TD was also significantly high in TRA compared with TFA (788 [276-2055] vs (520 [158-2424] mGy; $p < 0.001$). A strong correlation between FT and DAP (Spearman's rho 0.730; *P*<.01) was observed **(**Figure 2**)**.

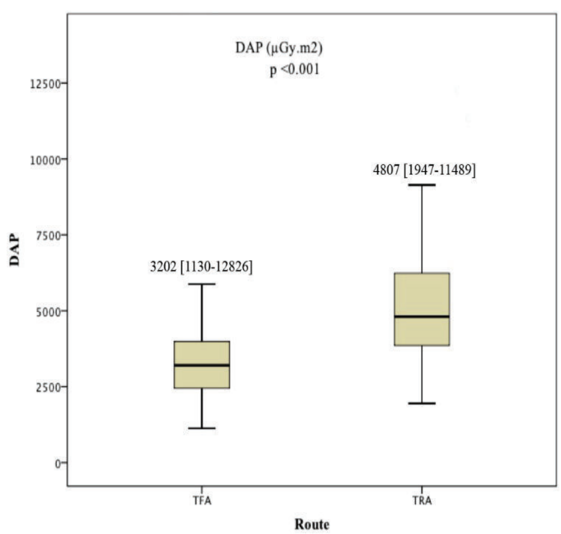

Fig.-1: *Boxplot graph showing DAP (μGy.m^2) for procedures performed through TRA and TFA. DAP was significantly higher in TRA compared with TFA.*

Abbreviations: TRA- transradial access; TFA- transfemoral access; FT- fluoroscopic time; DAP- dose area product; TD- total dose

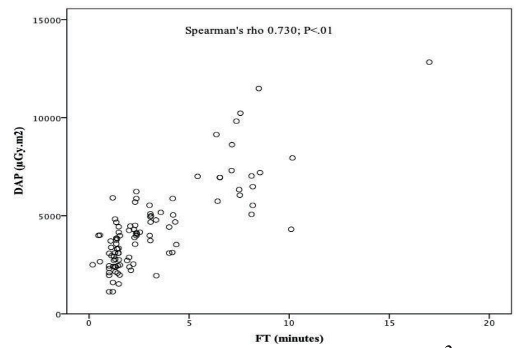

Fig.-2: *Correlation between DAP (μGy.m^2) and FT (minutes). A strong correlation between FT and DAP was observed.*

Abbreviations: FT- fluoroscopic time; DAP- dose area product

Complications are shown in Table 3. Transradial failure (TRF) occurred in 4 (8%) cases; all of those were switched over to TFA successfully. Among the causes of TRF were puncture failure 1(2%), radial arterial loop at the level of the brachial artery in 1(2%), and radial artery spasm in 2 (4%). Transfemoral failure (TFF) occurred in 1 (2%) cases because of occlusion at the level of the common iliac artery bilaterally; the procedure was done successfully via TRA. There were no statistically significant differences in failure rate between groups (p= 0.169).

TRF was more than TFF. Reasons for TRF were puncture failure, radial loop, and radial spasm. TFF was due to pre-existing stenosis of the common iliac artery bilaterally. Post-procedure complications were ecchymosis (most typical), hematoma, puncture site bleeding, and thrombophlebitis.

Ecchymosis was 10% in TRA vs. 22% in TFA, p=0.102) among post-procedure complications. Other

Table-III

Complications

Complications	TRAn (%)	TFAn (%)	p value
Overall procedural failure	4 (8%)	1 (2%)	0.169
TRF due to puncture failure	1 (2%)	N/A	
TRF due to radial Loop	1 (2%)	N/A	
TRF due to radial artery spasm	2 (4%)	N/A	
Vascular occlusion/stenosis (preexisting)	0	1 (2%)	
Vascular complications			
a. Ecchymosis	5 (10%)	11 (22%)	0.102
b. Hematoma	0	6 (12%)	0.012
c. Puncture site bleeding	1 (2%)	2 (4%)	0.558
d. Thrombophlebitis	3 (6%)	9 (18%)	0.065
e. Arterial dissection	0	0	
f. Arterial rupture	0	0	

Abbreviations: n- number; TRA- transradial access; TFA- transfemoral access; TRF- transradial failure; TFF- transfemoral failure; N/A- not applicable

complications, like thrombophlebitis (6% vs 18%, p= 0.065); hematoma (0% vs 12%, p= 0.012); puncture site bleed (2% vs 4%, p= 0.558) were in TFA and TRA, respectively. There was no arterial dissection or arterial rupture in either group. There was no incidence of post-procedure myocardial infarction, stroke, acute renal failure and infections.

Discussion:

Our study demonstrates that radiation exposure during CAG is higher in TRA than TFA. The FT was significantly longer in the TRA compared with the TFA group. This finding was similar to other reports.[14-17] Several studies have also demonstrated higher radiation exposure associated with TRA compared with TFA. One observational cohort study evaluated 928 patients who underwent diagnostic CAG via TFA (n = 734) or TRA (n = 194) and demonstrated FT to be 58% higher in the TRA than TFA.[18] A more extensive study of 5,954 diagnostic CAG performed at a tertiary cardiac center showed a significant 23% increase in radiation dose with TRA compared with TFA.[19] The current study also examines DAP as an essential factor of interest, a better correlate to patient radiation skin dose than FT.[20]

It is essential to note the risk of radiation from CAG when assessing the risk-benefit ratio of the procedure to a particular patient.[21] Adverse side effects of prolonged fluoroscopic procedures and increased radiation exposure over time include dermatologic burns for the patient and increased risk of malignancy to both the patients and operators.[22] Measures must be taken to reduce radiation exposure, including keeping the camera as close to the patient as possible and minimizing camera angulation to reduce radiation scatter, use of collimation and less magnification whenever possible, and use of appropriate shielding.

Our study showed that TRF is higher (8%) than TFF (2%), but the data was not statistically significant (p=0.169). In contrast, in a study done by Martin Brueck et al., including 1024 patients undergoing CAG, even a higher rate of TRF (3.5% of 512 patients) than TFF (0.2% of 512 patients) was found. But, this finding was not statistically significant as well (p=1.00)[23]

We found that puncture failure was one of the causes of TRF, occurring in 1 in 50 (2%) procedures. This finding was similar to other studies.[24] Another cause of TRF was the presence of an arterial loop. In our case, it occurred in 1 in 50 (2%) cases and was at the brachial artery level. Anatomic variations that complicate TRA previously reported[25-31] are in agreement with our finding. Although experience with TRA can, on many occasions, resolve anatomical complications through the use of specific techniques,[28,29,32] these anomalies often inevitably lead to TRF.[28] Also, we found radial spasms as an important cause for TRF. In our study, the impassable radial spasm was the leading cause for crossover to TFA. The incidence of radial spasms found in our study was low (4%). Similar incidences were reported in other studies.[33,34] The administration of intra-arterial vasodilators such as nitroglycerin and verapamil increases the radial artery size[35] and decreases radial spasm,[33,34,36] resulting in a beneficial effect on TRF.

In this study, ecchymosis was the commonest among post-procedure complications. Other complications, like thrombophlebitis, hematoma, puncture site bleed, were seen more in TFA than TRA. These findings are consistent with the results of the study by Bhat et al. l.[37] However, according to other studies, the percentage of severe vascular complications using TRA is low and compares very favorably with femoral access.[38,39]

Study limitations:

There are several limitations to this study. The study population was small. It was a single-center study and PCIs were omitted. We did not measure operator radiation exposure. Lastly, the radial spasm was not assessed using more objective measures such as mechanical devices or a more complex spasm score.

Conclusion:

Transradial access for coronary angiography is a relatively new technique. Fluoroscopic time is higher in transradial access than transfemoral access, which is expected to decrease with operators' experience over time. Transradial failure is not statistically significant as compared to the transfemoral loss. Transradial access nearly abolishes entry site complications, compared to higher rates in transfemoral access, thereby offering more comfort to the patients. Transradial access is a safe, feasible, and effective alternative to transfemoral access. However, further studies are recommended with a larger sample size to confirm these findings and find out the cause of higher radiation exposure and how to minimize this in transradial access.

Conflict of interest: Nothing to declare

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