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Radiation Exposure in TransradialvsTransfemoral Coronary Angiography: A Single Centre Experience.

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Abstract

Background: Several studies found that there is an increased risk of radiation exposure during transradial coronary angiography (CAG) when compared with transfemoral CAG. We compared radiation exposure to patients during CAG through these routes. **Aim of the study:**This study aims to assess the difference of radiation exposure between transradial and transfemoral coronary angiography.**Methods:** This study was a prospective study conducted on randomly selected 100 patients who underwent coronary angiography by the same operator at a tertiary centre from August 2017 to September 2018. The study outcomes were fluoroscopy time (FT), dose area product (DAP), and total dose (TD).**Results:**FT (3.08 [1-9] vs 1.47 [1-17] minutes; P=.014), DAP (4807 [1947-11489] vs 3202 [1130-12826] μGy.m2;P<0.001), and TD (788 [276-2055] vs 520 [158-2424] mGy; p<0.001) were found significantly higher in TRA than TFA. A strong correlation between FT and DAP (Spearman's rho 0.730; P<.01) and a statistically significant correlation between body mass index (BMI) and DAP (Spearman's rho 0.446; P<.01) was observed.**Conclusion:**TRA is associated with higher radiation exposure when compared with TFA in patients undergoing coronary angiography.

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Keywords: Radiation Exposure, Transradial Coronary Angiography, Transfemoral Coronary Angiography, Fluoroscopy Time.

INTRODUCTION

Coronary artery disease is a disease of high morbidity and mortality. Percutaneous coronary angiography is a standard diagnostic strategy for this disease.[1] Percutaneous coronary angiography can be performed by the following three routes: femoral, brachial or radial arteries. Traditionally coronary angiography is performed via the transfemoral approach. However, transradial approach is becoming popular and increasingly being used for this procedures. It was first introduced by Compeau in 1989 for diagnostic coronary angiography.[3] There are some advantages and disadvantages of transradial access for coronary artery catheterization over transfemoral access. Especially vascular bleeding complications at the femoral puncture site can result in increased morbidity and duration of hospitalization.[2] Therefore, the rationale for the transradial approach is the intention to reduce access site bleeding complications, earlier ambulation, and improved patient comfort.[3-5] However, TRA is still less commonly used in routine practice despite these obvious advantages. This is because TRA requires steep learning curve,[6-8] and there is a higher rate of transradial failure (TRF) due to some unique problems related to this approach. One of the major disadvantages of coronary angiography is that it exposes both the patient and the operator to x-ray. Medical exposure to x-ray in the field of interventional cardiology represents an important issue.[9] Exposure to x-ray is associated with both deterministic effects, such as radiation-induced injuries in patients' skin,[10] and to stochastic effects, such as radiation-induced cancer.[11] Whether TRA is associated with increased radiation exposure is still a matter of debate, since conflicting data have been reported.[12] The aim of this study is to investigate radiation exposure during coronary angiography in a resource limited country.

METHODOLOGY AND MATERIALS

Study Design: This was a prospective study conducted in the Combined Military Hospital, Dhaka, Bangladesh which is a tertiary care hospital in the Bangladesh armed forces. 100 patients (91 males, 9 females) who were scheduled for coronary angiography between August 2017 and September 2018 were included in the study. Eligible patients were randomly selected for either transfemoral or transradial catheterization. Informed written consent was obtained from each patient before the procedure. Procedure time, access and radiation times, contrast volume, complications, and length of hospital stay were recorded. All the procedures were performed by the same cardiologist. The primary outcome was dose area product (DAP), which reflects both the dose of radiation administered and the area on the patient it is administered to. This was measured in micrograу meter squared (µGym2). Secondary outcome was fluoroscopy time (FT) measured in minutes,

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which reflects the length of time the patient and operator are exposed to radiation; and total dose (TD), measured in milligray (mGy), administered from the angiography system. These parameters of radiation exposure and the number of exposures (number of scenes recorded for review) were obtained from built-in software in the angiography system.

Exclusion Criteria:

- Patients with:
  - coronary artery bypass surgery
  - cardiogenic shock
  - abnormal Allen's test
  - local vascular problems making difficulty in gaining access
  - local skin infection
  - acute or chronic kidney disease
- patients requiring implantation of temporary pacemaker

Vascular access:
For transradial approach, 5-F catheters were used for diagnostic CAG. 0.2 mg isosorbidetrinitrate 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 transfemoral diagnostic CAG.

Vascular haemostasis:
After transradial procedures, arterial sheaths were removed immediately following coronary angiography. Haemostasis was obtained using a pressure bandage over the puncture site. No manual compression was done before application of pressure bandage. Patients were instructed not to use of 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 haemostasis was obtained by manual compression in case of transfemoral diagnostic catheterization. A bandage was applied, and the patient was instructed for bed rest for 24 h.

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

Radiation exposure:
The procedures were performed in two angiographic rooms equipped with Innova 2000 cardiac angio- graphic system (General Electric) and Simens AXIOM-Artis angiographic system. The number of frames was routinely set at 15 s frame rate both for fluoroscopy and cine acquisition. The operator and the cath lab staffs used lead aprons and thyroid collars, as well as a ceiling-mounted glass shield and a lead skirt along the table to shield scattered radiations. A medical radiation technician operated the x-ray system and was responsible for patient and staff radioprotection.FT, DAP and TD were measured after each procedure.

Statistical analysis:
IBM SPPS Statistics version 23 was used to analyse the results. Clinical and procedural characteristics were compared between patients treated by TRA and TFA. Categorical variables were expressed as percentages and were compared by chi-square test or Fisher's exact test. Continuous variable was tested for normal distribution using histograms and

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Shapiro-Wilk's test. The variables were expressed as mean ± standard deviation or median, and were compared by Student's t-test or Mann-Whitney U-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

Baseline clinical characteristics are recorded as shown in Table I. There were 42 males (84%) and 8 females (16%) in the transfemoral group and 49 males (98%) and 1 female (2%) in the trans-radial group. The mean age was 53.3±8.8 years and 51.46±12years in transfemoral and transradial groups respectively. The mean BMI was 24.3±3.4 in the transfemoral group and 24.8±3.6 in the transradial group. Most of the studied subjects were smokers. Radial group patients were younger and had a higher mean body mass index (BMI) but those findings were statistically not significant. Femoral grouppatientswereolder,morefrequentlyfemale butagainthosefindingswerestatisticallynotsignificant. Procedural characteristics (FT, DAP and TD) are shown in Table II. The FT was more in transradial group compared to transfemoral group of patients (3.08 [1-9] vs.1.47 [1- 17] minutes; p=0.014). DAP (4807 [1947-11489] vs. 3202 [1130-12826] µGy.m2; p<0.001) and TD (788[276-2055] vs. 520 [158-2424] mGy; p<0.001) were also significantly found more in transradial compared to transfemoral group of patients.Median FT was significant longer (p=0.014) in the transradial group (3.08 [1-9] minutes) compared with the transfemoral group (1.47 [1-17] minutes). DAP was significantly increased in the transradial group compared with the transfemoral access group(4807[1947-11489]vs.3202[1130-12826]µGy.m^2;p<0.001)(FigureI).TDwasalsosignificantly increased in the transradial group compared with the transfemoral access group (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) (Figure II) and a statistically significant correlation between BMI and DAP (Spearman's rho 0.446; *P*<.01) (Figure III) were observed.

Table I: Demographic characteristics of the studied subjects

Variable		Femoral (N=50)		Radial N=50)		P value
			%		%	
Age (Years)	mean± SD	53.2±8.8		51.46±12		0.375 (NS)
Gender	Male	42	84	49	98	0.014
	Female	8	16	1	2	
BMI (mean±SD)		24.3± 3.4		24.8±3. 6		0.555 (NS)
Smoking history		35	70	42	84	0.096 (NS)

Table II: Procedural characteristics of the studied subjects.

	Femoral (Median) (N=50)	Radial (Median) (N=50)	p value

Fluoroscopy time (min)	1.47 [1-17]	3.08 [1-9]	0.014
DAP (µGy.m2)	3202 [1130-12826]	4807 [1947-11489]	<0.001
TD (mGy)	520 [158-2424]	788 [276-2055]	<0.001

Figure I: Boxplot graph showing dose-area product values (DAP, µGy.m2) for procedures performed through transradial and transfemoral access.

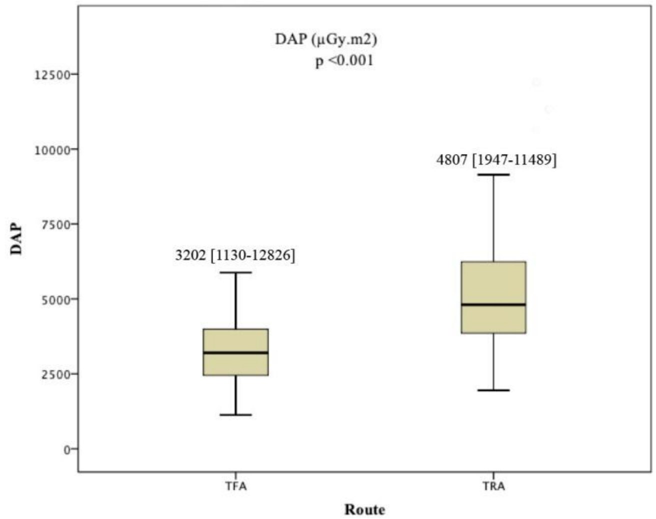

Figure II: Correlation between dose-area product (DAP, µGy.m2) and fluoroscopy time (minutes).

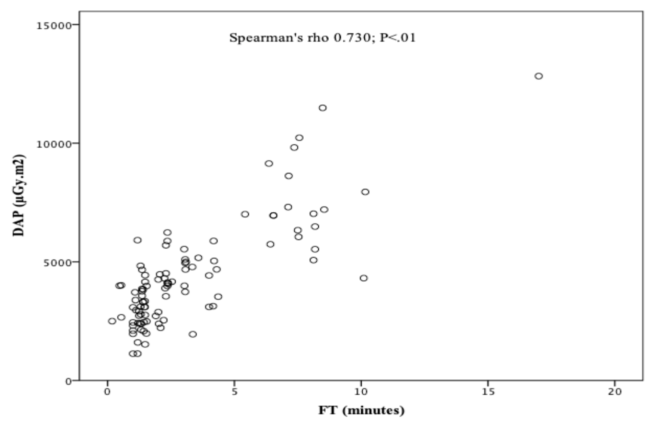

Figure III: Correlation between dose-area product (DAP, µGy.m2) and body mass index (BMI, kg/m2).

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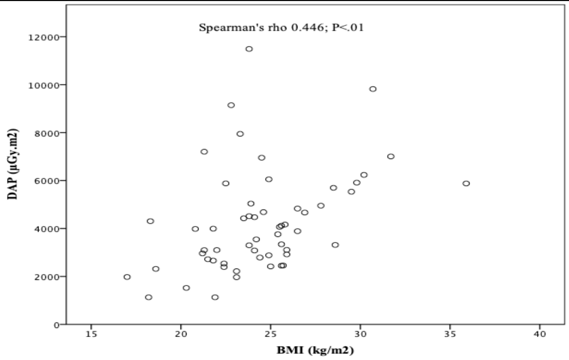

DISCUSSION

Our study demonstrates that radiation exposure during coronary angiography is higher with TRA when compared with TFA. The FT was significantly longer in the TRA compared with the TFA group. This finding was similar to other reports.[13-17] Multiple studies have also demonstrated higher radiation exposure associated with TRA compared with TFA. One observational cohort study evaluated 928 patients who underwent diagnostic coronary angiograms via TFA (n = 734) or TRA (n = 194) and demonstrated FT to be 58% higher in the TRA compared with TFA group.[19] A larger study of 5,954 diagnostic coronary angiograms performed at a tertiary cardiac center demonstrated a significant 23% increase in radiation dose with TRA compared with TFA.[18] The current study also examines DAP as the primary outcome of interest, a better correlate to patient radiation skin dose than FT.[20] It is important to note the risk of radiation from coronary angiography when assessing the risk- benefit ratio of the procedure to a particular patient.[22] 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 patients and operators.[21] 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.

Limitations of the study:

There were several limitations with the present study. Firstly, this was a prospective study conducted in a single centre, and for that, there may be unmeasured confounding variables. Secondly, the sample size was small. Thirdly, the study was not randomized and therefore not free from selection bias. Fourthly, direct radiation exposure to the patient and operator with dosimeter was not done. Lastly, we performed the radial procedures with TIGER catheters. Therefore, it is not known whether these results would be same if other catheters were used.

CONCLUSION

In our study, TRA was associated with higher radiation exposure when compared with TFA among patients undergoing coronary angiography. Although transradial procedures have many advantages, the amount of radiation administered should be kept in mind while selecting this approach. However, with increasing experience and overcoming the common difficulties in TRA, the risk of radiation exposure may be reduced in the future.

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