Content available at: https://www.ipinnovative.com/open-access-journals

Panacea Journal of Medical Sciences

Journal homepage: http://www.pjms.in/

Original Research Article

Relationship of body mass index on the radiation exposure of patient in diagnostic coronary angiogram through radial route by dose area product

S Kumaran[1]*, A Srinivasan[1], G Anandh[1], P Jai Shankar[1], S Anbarasan[1], K Muthuselvan[1], Suresh Kumar P[2]

[1]*Dept. of Cardiology, Thanjavur Medical College, Thanjavur, Tamil Nadu, India*
[2]*Dept. of Cardiology, Chengalpattu Medical College, Vallam, Tamil Nadu, India*

A R T I C L E I N F O

Article history:
Received 19-11-2022
Accepted 20-03-2023
Available online 13-08-2024

Keywords:
Ionising radiation
Dose area product
Body mass index

A B S T R A C T

Background: Ionising radiation which is responsible for many side effects is very common among medical professionals like interventional cardiologists. Obesity is on the rise and one of the important risk factor for coronary artery disease. Incidentally it also leads to increased patient radiation and also the attending interventional cardiologist, catheterisation lab personnel according to some studies. Dose area product as a measure of radiation used to study the relationship of radiation to obesity in our single centre observational study.

Materials and Methods: Study was conducted in single centre retrospective observational study. Body mass index calculated in Kg/ m^2. Dose area product was measured in Gy-cm^2. Patients who underwent diagnostic coronary angiogram for coronary artery disease through radial route was taken for study and were divided into four groups. Then analysed with SSPS software.

Results : Patient with body mass Index was divided into four groups and their distribution BMI, a. < 21.00 9.1 %, b. 21.01- 25.00 35.1%, c. 25.01-29.00 – 48.10 %, d. 29.0+ - 7.8 %. Compared with BMI < 25, a patient BMI≥ 40 was associated with 2.1 fold increase in patient radiation dose and 7 fold increase in physician radiation dose. Compared with BMI < 25, a patient BMI≥ 40 was associated with 2.1 fold increase in patient radiation dose and 7 fold increase in physician radiation dose. Our study group has predominantly between BMI of 21and 29. After confounding factors like catheter engagement difficult cases, radial spasm, anxious patients, BMI was not correlating with fluoroscopy time in our study group.

Conclusion: According to our study patient radiation exposure as measured by Dose Area Product is incremental but statistically not significant enough to conclude positive correlation.

1. Introduction

Ionising radiation during diagnostic and therapeutic cardiology and radiological procedures are very common in present day medical practice and are one of the largest medical sources of radiation to humans.[1] Increasing prevalence of obesity in the general population, obesity has become more prevalent among patients undergoing cardiac catheterisation.[2] Increasing body mass Index results in higher patient radiation doses during coronary angiography.[2] The greatest source of physician radiation exposure during cardiac catheterisation comes from the patient, which itself is proportional to patient radiation dose.[2] The raise in obesity has impacted radiation usage in the catheterisation laboratory because obese patients undergoing fluoroscopic procedures receive greater radiation doses than non obese patients.[3–5] Increase in radiation is attributable to the increased energy required to overcome tissue attenuation and facilitate a sufficient number of photons reaching the image intensifier to

* *Corresponding author*.
E-mail address: srinikumaran72@gmail.com (S. Kumaran).

https://doi.org/10.18231/j.pjms.2024.100
2249-8176/© 2024 Author(s), Published by Innovative Publication.

generate adequate images.[6] The greatest source of physician radiation exposure during cardiac catheterisation comes from scatter radiation. Chronic repeated exposure to low doses of ionizing radiation that is thought to account for increased incidence of premature cataract formation.[7,8] The dose area product (DAP), related to the effective dose, is a measure of stochastic risk and a potential quality indicator.[9] Very simple radiation reduction techniques enabled us to reduce median dose area product for below the values for coronary angiography and percutaneous coronary intervention.[9,10] Procedures that utilize ionizing radiation should be performed in accordance with the As Low As Achievable (ALARA) principle. Fluoroscopy time is a non-dosimetric quantity. It is readily available.

Nevertheless it does not incorporate information about dose rate and skin entrance ports.[11,12] Radial approach when compared to femoral approach, former one carried more radiation dose.[13,14] Novel noise fluoroscopy system, such as those utilize real time image noise reduction technology, have been demonstrated to reduce radiation doses by ≈ 50% or more.[15–18] Evidence of a detectable acute DNA damage response in operators performing fluoroscopic procedures has been demonstrated.[19] Long term radiation exposure among interventional cardiologists has been linked to multiple adverse effects.[20,21]

2. Aim

The aim of the study is to find out the effect of body mass index on the radiation exposure of patient in radial coronary angiogram.

2.1. Objective

As quoted by previous studies, body mass index has very high influencing factor on the radiation exposure of patient. Our aim is to find out BMI effect on patient radiation exposure exclusively on patients who undergo radial coronary angiogram. Recently as we are getting more obese patients with coronary artery disease as the whole world is going through pandemic of obesity. As such obesity is responsible for procedure related complications from vascular access to final outcome of the procedure. Since radiation exposure has many short term to long term effects, like skin rash to cancer. This study intended to the effect of BMI on radiation exposure. We have chosen patients who undergone coronary angiogram exclusively through radial access as it is the preferred one when compared to femoral access. Illustrative (Figure 1 A and B) is shown as examples from our study.'At the same time radial access coronary angiogram cause more radiation when compared to femoral access.

2.2. Study design

Retrospective, single centre observational analytical study.

3. Materials and Methods

Study was conducted in Thanjavur Medical College in the Dept. of Cardiology. From the coronary angiogram and case history of 77 coronary heart disease admitted in the cardiology department between month of July and August of 2021. Angiogram was done in Single plane catheterisation lab Phillips Allura XD 10. Body mass index was measured using patients height in metres and weight in Kilograms. BMI = Kg/ m^2. z Patient radiation exposure was measured by the catheterisation lab system and the radiation metrics like fluoroscopy time, Air kerma and Dose area product are taken from radiation log of Individual procedure for that particular patient. Physician radiation dose as measured by Thermiluminescent dosimeter (TLD) Badge was not taken as it is beyond the scope of this study. Study group was divided into four groups with BMI. a < = 21 b.21.01 to 25.0. c. 25.01 to 29.00. d. > 29.01. Measurement of patients' radiation exposure was assessed by Dose Area Product which was measured in Gy-cm^2. Fluoroscopy time of procedure also measured. Baseline characteristics like age, gender, co-morbidities blood pressure, ejection fraction family history and personal habits like smoking and alcohol were also studied. Coronary angiogram was done with multiple angulated views in Phillips Allura XD Single plane catheterisation lab.

3.1. Inclusion criteria

All patients with coronary artery disease who have undergone coronary angiogram in the prescribed time period, of all age groups and both sexes were included in the study.

3.2. Exclusion criteria

Procedures involving stand alone ventriclogram, aortogram, pacemaker implantation were excluded. Those who have undergone femoral access coronary angiogram. Those who have not given consent, Those who have undergone diagnostic angiogram and angioplasty simultaneously.

4. Results

Descriptive variables in baseline characteristics were measured as mean. Categorical valuables were measured as frequency. Our study population has 23 female patients and 54 male patients (Graph 1). That constitutes 29.9 % for female and 70.1 % for male patients. Personal habits of study population like alcoholics 19.5 %, smoking 26.0% smoking and alcoholic 19.5 and no bad habits 35.1 % (Graph 2). Co- morbid conditions Diabetes alone 22.1 %, Diabetes and systemic hypertension put together constitutes 22.1%, Systemic hypertension alone constitutes 27.3 %. Nil constitutes about 28.6%.(Graph 3) Altogether 77.9 % of patient has no family history of coronary artery disease.

Rest of 22.1% patients has family history of coronary artery disease. Overall disease spectrum in our study Antero septal myocardial infarction 3.9 %

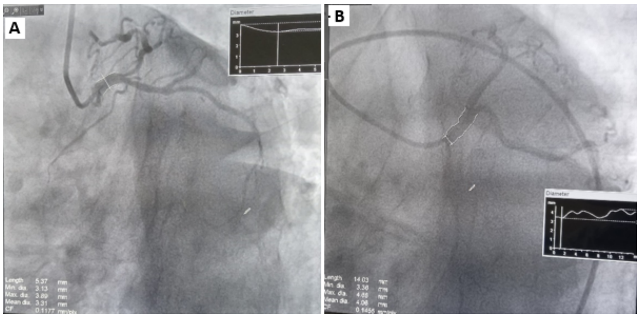
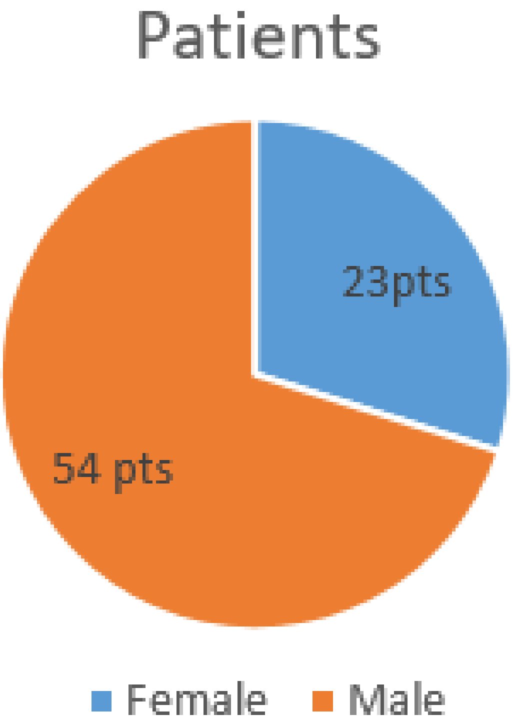
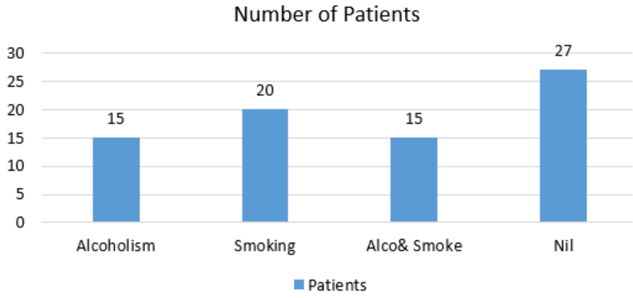


Figure 1: A: LAO Caudal view (Radial approach)**; B:** LAO caudal view (Femoral approach)

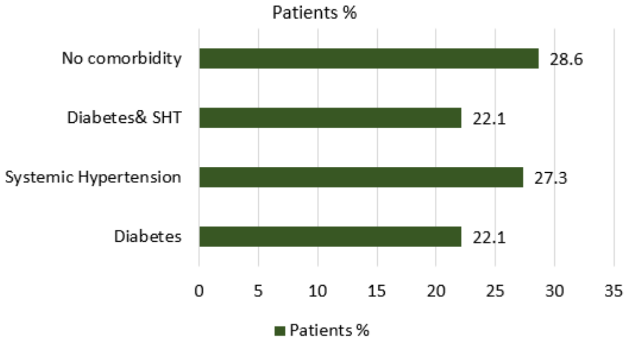


Graph 1: Gender pie chart in numbers

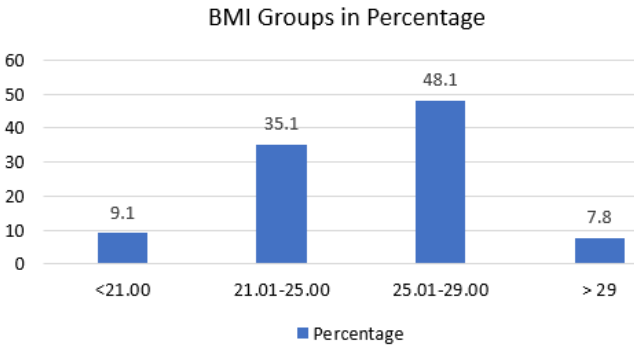
Anterior wall myocardial infarction 48.1%, Inferior wall myocardial infarction 33.8%, Non ST elevation myocardial infarction 6.5% and Unstable angina 7.8 %. Patient with body mass Index was divided into four groups and their distribution BMI a. < 21.00 -9.1 %, b. 21.01- 25.00- 35.1% c. 25.01-29.00 – 48.10 % d. 29.0+ - 7.8 % (Graph 4) Only less number of patients were in our study population beyond BMI 29 and less than 21 . Minimum age 34 years and maximum 73yrs mean age 42.08 years with Standard deviation being 10.872.



Graph 2: Habbits in percentage



Graph 3: Co- morbidity prevalence in percentage



Graph 4: BMI division percentage

Minimum height of patients 145 cm and maximum being 175 cm. Mean value 158.4 cm and the standard deviation is 63.81. Weight of the study population minimum value 46 kg, maximum value 80 Kg. Mean value is 63.81 Kg and the standard deviation is 7.907.

Cumulative air kerma and cumulative dose area product, and fluoroscopy time are divided into below median and above median and then associated with Body mass Index.(Table 1)

On assessing cumulative dose area product for convenience of analysis in view of less study subjects in group d and a. Study population BMI is divided into two major groups i:e Below 25 and above 25. Cumulative

Table 1: Radiation exposure

Statistics		CUM AK	CUM DAP	FLOUR TIM
N	Valid	77	77	77
	Missing	0	0	0
Mean		718.58247	43.55844	5.33468
Median		553.20000	30.70000	3.20000
Mode		304.500[a]	17.800[a]	1.400[a]
Std. Deviation		539.010607	36.350535	5.744874
Range		4041.500	223.000	39.010
Minimum		3.000	5.000	0.490
Maximum		4044.500	228.000	39.500
a. Multiple modes exist. The smallest value is shown				

CUM AK- Cumulative air kerma, CUM DAP- Cumulatice Dose Area product
FLOUR TIM- Flouro time.

Table 2: Cumulativedose area product and bod mass index crosstab

		BMI		Total
		<= 25.00	**25.01+**	
CUM DAP	<= 30.000	17	21	38
	30.001+	17	22	39
Total		34	43	77

Chi square = 0.010, P=0.919, Not significant. BMI- Bod Mass Index,
CUM DAP – Cumulative Dose Area Product

Table 3: Fluoroscopy time and body mass index. Crosstab Count

		BMI		Total
		<= 25.00	**25.01+**	
Flouro time	<= 3.200	19	20	39
	3.201+	15	23	38
Total		34	43	77

Chi square = 0.667, P=0.414, Not significant.

dose area product into less than 30 Gy-cm ^{2}more than 30 Gy-cm^{2}We got the value of chi square = 0.01. and P= 0.919 which is not significant. (Table 1) Based on this analysis radiation exposure of patient is not associated with Body mass index within the BMI range of our study population.

Compared with BMI < 25, a patient BMI≥ 40 was associated with 2.1 fold increase in patient radiation dose and 7 fold increase in physician radiation dose.[6] Increase in radiation dose is attributable to the increase energy required to overcome tissue attenuation and facilitates sufficient number of photons reaching the image intensifier to generate adequate images.

As per study by Ran D Madder. MD, Stacie Van Oosterhout. Med, Abbey Mulder, BSN. RN. Jan 2019. Circulation. Cardiovascular Interventions, DAP Vs BMI Group with BMI < 25 has DAP 44.5 Gy-cm^2, 25 -29.9 DAP is 56 Gy- cm^2,30- 34.9 DAP is 69.1 Gy- cm^2, 35-39.9 DAP is 77.8 Gy- cm^2, ≥ 40 DAP is 91.8 Gy- cm^2 P value derived was < 0.001. In our study centre population none of the individual had BMI more than 35. Based on this, the subset of patients coming to our centre from nearby semi urban and rural areas yet to have considerable number of morbid obesity or class II obese patients, since most of them are leading physically active life style, epidemic of pandemic yet have its impact in this geographical area.

Body mass index was divided above and below 25 for convenience of calculation. Chi square value is 0.667 and the P= Value is 0.414. (Table 3) After confounding factors like catheter engagement difficult cases, radial spasm, anxious patients BMI was not correlating with fluoroscopy time in our study group. Our study group has predominantly between BMI of 21 and 29. A group and d group in the extreme of sample has less number. In study conducted by Ran D Madder as per reference 1, Fluoroscopy time in minutes with BMI value < 25.0 is 5.9 min, 25-30 is 5.6 min , 30-35 is 5.9 min, 35- 39.9 is 6.1 min, ≥ 40 is 7.0 with P Value of 0.26 [1] which is not significant and correlates with our study.

5. Discussion

Long term radiation exposure among interventional cardiologists has been linked to multiple adverse effects[7,8] and the prevalence of obesity in cardiac catheterisation laboratory has been increased over time.[2] Obesity is associated with increased health problems in patients.[10] Patient radiation exposure increases with body mass index especially with more than BMI 35.Body mass index is increasing the risk of physician radiation exposure as mentioned above and low sustained radiation exposure has inherent radiation hazards not only for the patients but also to the treating interventional cardiologist like cataract, carcinoma etc. Apart from radiation exposure BMI also has procedure related issues right from vascular access to outcome of procedure. Fluoroscopy time also increases, though statistically not significant proportionate to body mass index.

6. Conclusion

From our study patient radiation exposure as measured by Dose Area Product is incremental but statistically not significant enough to conclude positive correlation. As study is carried out in Tier II city, single centre study involving sample population who carry out physically active life style incidentally found to be predominantly between BMI of 21 to 29. Epidemic of obesity still to conquer this geographical area significant enough to produce coronary artery disease. Fluoroscopy time and cumulative air kerma also not significantly related to body mass index in the given range of our study

7. Limitations

Extremes of BMI group study sample is less to throw light on the effect of patient radiation exposure on body weight. Since it is a single centre study in Tier II city with small sample size, it is difficult to extrapolate the results to general population.

8. Conflict of Interest

None.

9. Source of Funding

None.

10. Acknowledgement

Dr. Suresh kumar. MD, DM. Assistant Professor of Cardiology. Chengalpattu Medical College. Chennai.

References

1. Shah A, Das P, Subkovas E, Buch AN, Rees M, Bellamy C, et al. Radiation dose during coronary angiogram: relation to body mass index. *Heart Lung Circ*. 2015;24(1):21–5.
2. Buscher ME, Smith D, Share D, Campbell W, Mattichak S, Sharma M, et al. The burgeoning epidemic of morbid obesity in patients undergoing percutaneous coronary intervention: Insight from the Blue Cross Blushield of Michigen Cardiovascular Consortium. *J Am Coll Cardiol*. 2013;62(8):685–91.
3. Yanch JC, Behrman RH, Hendricks MJ, Mccall JH. Increased radiation dose to over weight and obese patients from radiographic examinations. *Radiology*. 2009;252(1):128–39.
4. Ector J, Dragusin O, Adriaenssens B, Hubrechts W, Willems R, Ector H, et al. Obesity is a major determinant of radiation dose in patients undergoing pulmonary vein isolation for atrial fibrillation. *J Am Coll Cardiol*. 2007;50(3):234–42.
5. Shah A, Das P, Subkovas E, Buch AN, Rees M, Bellamy C, et al. Radiation dose during coronary angiogram: relation to body mass index. *Heart Lung Circ*. 2015;24(1):21–5.
6. Madder R, VanOosterhout S, Mulder A, Brock T, Clarey AT, Parker JL, et al. Is the obesity epidemic impacting the occupational risk of physicians in the catheterisation laboratory. *Circ Cardiovasc Interv*. 2019;12(1):e006823. doi:10.1161/CIRCINTERVENTIONS.118.006823.
7. Ciraj-Bjelac O, Rehani MM, Sim KH, Liew HB, Vano E, Kleiman NJ, et al. Risk for Radiation-Induced Cataract for Staff in Interventional Cardiology: Is There Reason for Concern? *Catheter Cardiovasc Interv*. 2010;76(6):826–34.
8. Vano E, Kleiman NJ, Duran A, Rehani MM, Echeverri D, Caberera M, et al. Radiation cataract risk in interventional cardiology personnel. *Radiat Res*. 2010;174(4):490–5.
9. Georges JL, Livarek B, Gibault-Genty H, Messaoudi JP, Aziza JL, Hautecoeur H, et al. Variations of radiation dosage delivered to patients undergoing interventional cardiological procedures. A monocentric study 2002-05. *Arch Mal Coeur Vaiss*. 2007;100(3):175–81.
10. Lavie CJ, Mcauley PA, Church TS, Milani RV, Blair SN. Obesity and cardiovascular diseases: implications regarding fitness, fatness, and severity in the obesity paradox. *J Am Coll Cardiol*. 2014;63(14):1345–54.
11. Balter S. Methods for measuring fluoroscopic skin dose. *Pediatr Radiol*. 2006;36(Suppl 2):136–40.
12. Einstein AJ, Moser KW, Thomson RC, Cerqueria MD, Henzslova MJ. Radiation dose to patients from cardiac diagnostic imaging. *Circulation*. 2007;116(11):1290–305.
13. Philiipe F, Larrazet F, Meziane T, Dibie A. Comparison of transradial vs. transfemoral approach in the treatment of acute myocardial infarction with primary angioplasty and abciximab. *Catheter Cardiovas Interve*. 2004;61(1):67–73.
14. Sandborg M, Fransson SG, Petterson H. Evaluation of patient-absorbed doses during coronary angiography and intervention by femoral and radial artery access. *Eur Radiol*. 2004;14(4):653–8.
15. Christopoulos G, Christopoulos GE, Rangan BV, Lane R, Grabarkewitz R, Haagan D, et al. Comparison of radiation dose between different fluoroscopy systems in modern catheterisation laboratory. Results from bench test testing using an anthropometric phantom. *Catheter Cardiovasc Interv*. 2015;86(5):927–32.
16. Kastrati M, Brink LL, Piatkowski M, Michaelsen J, Reimann D, Hoffmann R, et al. Reducing radiation dose in coronary angiography and angioplasty using image noise reduction technology. *Am J Cardiol*. 2016;118(3):353–6.
17. Wassef AW, Hiebert B, Ravandi A, Ducas J, Minhas K, Vo M, et al. Radiation dose reduction in the cardiac Catheterisation Laboratory utilizing a novel protocol. *JACC Cardiovasc Interv*. 2014;7(5):550–7.
18. Dekker LR, Van Der Voort P, Simmers TA, Veerbeek XA, Bullens RW, Veer MV, et al. New image processing and noise reduction technology allows reduction of radiation exposure in complex electrophysiologic interventions while maintaining optimal image quality: a randomized clinical trial. *Heart Rhythm*. 2013;10(11):1678–82.
19. El-Sayed T, Patel A, Cho JS, Kelly JA, Ludwinski F, Saha P, et al. Radiation-Induced DNA Damage in Operators Performing Endovascular Aortic Repair. *Circulation*. 2017;136(25):2406–16.
20. Andreassi MG, Piccaluga E, Gargani L, Sabatino L, Borghini A, Faita F, et al. Subclinical carotid atherosclerosis and early vascular aging from long term low- dose ionizing radiation exposure: a genetic, telomere and vascular ultrasound study in cardiac catheterisation laboratory staff. *JACC Cardiovasc Interv*. 2015;8(4):616–27.

21. Andreassi MG, Piccaluga E, Guagliumi G, Greco MD, Gaita F, Picano E, et al. Occupational health risks in cardiac catheterisation laboratory workers. *Circ Cardiovasc Interv*. 2016;9(4):e003273. doi:10.1161/CIRCINTERVENTIONS.115.003273.

Author biography

S Kumaran, Associate Professor

A Srinivasan, Senior Assistant Professor

G Anandh, Senior Assistant Professor

P Jai Shankar, Professor

S Anbarasan, Assistant Professor

K Muthuselvan, Senior Assistant Professor

Suresh Kumar P, Assistant Professor

Cite this article: Kumaran S, Srinivasan A, Anandh G, Shankar PJ, Anbarasan S, Muthuselvan K, Suresh Kumar P. Relationship of body mass index on the radiation exposure of patient in diagnostic coronary angiogram through radial route by dose area product. *Panacea J Med Sci* 2024;14(2):556-561.