

Radiation Exposure during Varicocele Embolization: Does Access Site and Treated Side Matter?

Abstract

Purpose: The purpose of the study was to evaluate radiation exposure during varicocele embolization and correlate it with access site, embolized side, and complexity of varicoceles. **Materials and Methods:** This retrospective study included 39 adults who underwent varicocele embolization with a combination of coils and sclerosing agents between January 2015 and December 2018. Left-sided embolization was done in 26 patients and bilateral embolization in 13 patients. Jugular access was used in ten patients, whereas upper limb access was done in 29 patients. Dose area product (DAP) and total fluoroscopy time were collected and correlated to the treated side, access site, and complexity of varicoceles. **Results:** The mean fluoroscopy time for left varicocele embolization was 26.76 min, which was not statistically different ($P = 0.16$) compared to bilateral embolization (33.2 min). There was no statistical difference ($P = 0.37$) between the mean DAP for left embolization of 106,239 mGy.cm² compared to bilateral DAP of 107,153 mGy.cm². There was no difference in the mean DAP or fluoroscopy time between jugular vein access (DAP = 87,569 mGy.cm², time = 34 min) and upper limb venous access (DAP = 113,086.8534 mGy.cm², time = 28 min) with $P = 0.64$ and $P = 0.14$, respectively. There was no statistically significant correlation between the left varicocele Bühren classification and the fluoroscopy time ($P = 0.52$) or DAP ($P = 0.76$). **Conclusion:** This study finds no significant difference in DAP or fluoroscopy time between jugular and upper limb venous access or between left and bilateral embolization.

Keywords: Dose area product, fluoroscopy time, radiation dose, varicocele

Introduction

Embolization or transvenous sclerotherapy of gonadal veins is an accepted nonsurgical alternative for the management of varicoceles. While minimally invasive, it entails the use of radiation with the potential risk of cancer or gonadal radiation exposure. It is the prime responsibility of the operator to reduce the radiation exposure and time as low as reasonably possible using proper radiation protection precautions. This can be challenged by the vascular anatomy, body habitus, and complexity of the varicoceles that may result in significant variations in the procedural time. The use of different embolic agents may also influence the radiation exposure and fluoroscopy time. This study aims to evaluate radiation exposure and fluoroscopy time during varicocele embolization and correlate it with access site and embolized side and the complexity of varicoceles.

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Materials and Methods

This retrospective study was approved by the institutional review board, and informed consent from patients was waived. This observational study aims to examine the radiation doses during varicocele embolization and attempt to assess the risk factors associated with increased radiation exposure. The study included 39 patients who underwent varicocele embolization between January 2015 and December 2018. Data were retrieved from the radiology information system and the hospital electronic medical records. Radiation doses and fluoroscopy times were retrieved from the radiation report associated with each study. The mean age of the patients was 39 ± 12 years with a range of 22–68 years. Embolization was done in all cases using a combination of coils/plugs and sclerosing agents in the form of sandwich technique. Procedures were done by several operators with variable degrees of expertise from supervised trainees to consultant level as a solo operator. The exact participation

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of each operator could not be determined from these retrospective data. All procedures were performed on Philips angiography machine (Allura Xper, Philips Medical Systems, Amsterdam, The Netherlands). Bilateral embolization was done in 13 patients, whereas only the left side was embolized in 26 patients. Jugular vein access was used in ten patients, whereas upper limb venous access was used in 29 patients. The choice of access was at the discretion of the primary operator. Angiographic Bühren classification of left varicoceles^[1] was retrospectively assessed in 29 patients and was correlated with radiation exposure parameters. Dose area product (DAP) and total fluoroscopy time were collected and correlated to the treated side and venous access site. Statistical analysis was done (StatPlus: Mac, AnalystSoft Inc., Version v6) using Wilcoxon and Kruskal–Wallis tests, two-sample *t*-test, and one-way analysis of variance (ANOVA).

Results

The mean fluoroscopy time for left varicocele embolization was 26.76 min (8.23–49.6 min), which was not statistically different ($P = 0.16$) compared to bilateral embolization mean fluoroscopy time of 33.2 min (10.3–58.83 min) [Figure 1]. There was no statistically significant difference ($P = 0.37$) between the mean DAP for left varicocele embolization of 106,239 mGy.cm² (12,672–590,429) compared to bilateral DAP of 107,153 mGy.cm² (29,593–257,259) [Figure 2]. There was no difference in DAP or fluoroscopy time between jugular vein access and upper limb venous access ($P = 0.64$ and $P = 0.14$, respectively) [Figures 3, 4 and Table 1]. Using one-way ANOVA, there was no significant correlation between the left varicocele Bühren classification and the fluoroscopy time ($P = 0.52$) or DAP ($P = 0.76$) [Table 2].

Discussion

Reduction of radiation exposure during interventional procedures, particularly varicocele embolization, is paramount to minimize the radiation risks in this fertile age group. Several factors may contribute to increased radiation exposure during the varicocele embolization procedure. These can be operator or patient related. It is the prime responsibility of operators to properly adhere to standard radiation protection precautions such as tight beam collimation, lower fluoroscopy pulse rate, source–detector distance, last image hold, and most importantly reducing the fluoroscopy time. Patient-related factors include laterality of procedure, access choice, challenging anatomy, complexity of varicoceles, and the choice of embolic agent. Previous reports indicate that kerma area product rates could vary between 5.6 and 50.8 Gy.cm².^[2-4] Proper utilization of meticulous radiation protection techniques such as virtual collimation and patient-positioning techniques may significantly mitigate the radiation doses to as low as 0.54 Gy.cm².^[5] Chalmers *et al.* reported 0.1% estimated

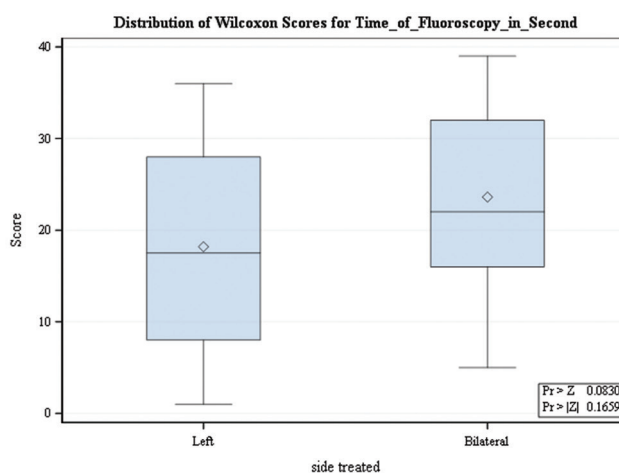


Figure 1: Correlation between the treated side and the fluoroscopy time

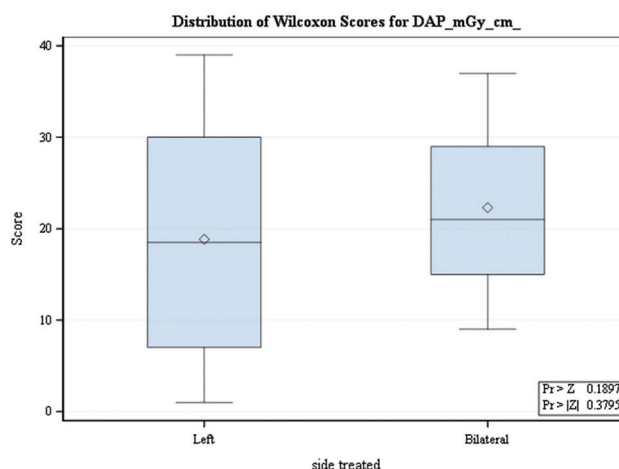


Figure 2: Correlation between the treated side and the dose area product

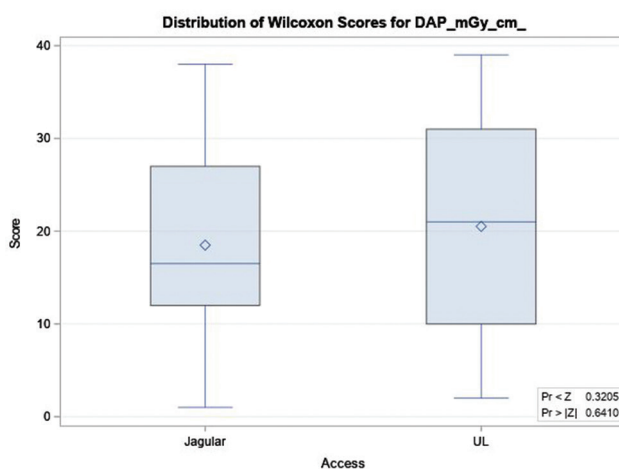


Figure 3: Correlation between the access site and the dose area product

lifetime fatal cancer risk from a retrospective study of 41 patients and showed a possible seven-fold reduction in radiation dose during varicocele embolization when using

Table 1: Correlation between the treated side and access site with the fluoroscopy time and dose area product

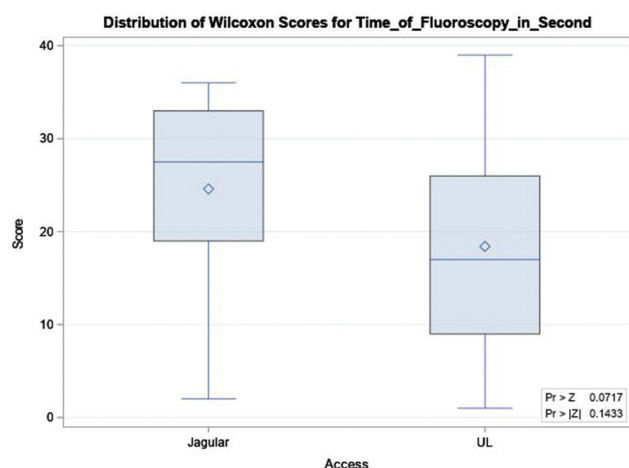
	Patients	DAP (mGy.cm ²)	P	Time of fluoroscopy (min)	P
Treated side			0.37		0.16
Left	26	106,239 (12,672-590,429)		26.76 (8.23-49.6)	
Bilateral	13	107,153 (29,593-257,259)		33.2 (10.3-58.83)	
Access site					
Jugular	10	87,569 (12,672-292,608)		34 (8.3-49.6)	
Upper limb	29	113,086 (12,681-590,429)	0.64	27.6 (8.23-58.83)	0.14

DAP: Dose area product

Table 2: Correlation between the Bähren classification with the fluoroscopy time and dose area product

Bähren classification	Number of patients	Mean DAP (mGy.cm ²)	Mean fluoroscopy time (s)
1	10	142,468 (15,522-590,429)	1896 (1057-2825)
2	2	75,507 (26,133-124,881)	1730 (791-2670)
3	7	84,191 (16,709-235,284)	1682 (619-3530)
4	8	73,106 (12,672-257,258)	1452 (494-3146)
5	2	118,420 (66,223-170,617)	2745 (1970-3521)
Total	29	102,991 (12,672-590,429)	1769 (494-3530)
Variation between groups		P=0.76	P=0.52

DAP: Dose area product

**Figure 4: Correlation between the access site and the fluoroscopy time**

strict radiation techniques. A study of 67 patients showed that the mean effective dose of varicocele embolization is 18 mSv compared to 1.3 mSv for abdominal X-ray or 4.6 mSv for urography.^[6] In a series of 21 patients, the mean gonadal effective dose was very low (2.15 mSv) and much lower than the threshold for the deterministic effect of temporary sterility (150 mSv). The mean hereditary risk was 0.002%, and the mean fatal cancer risk was 0.03%.^[7] Another study of 206 patients who underwent transfemoral varicocele embolization with a combination of coils and sclerosing agents showed that the maximum effective dose and maximum gonadal dose equivalent were 6.9 mSv and 0.69 mSv, respectively.^[8] Right, left, or bilateral embolization appears to be associated with similar fluoroscopy time and DAP in a study of 237 procedures done through transfemoral approach using coils and

sclerosing agents.^[3] This is similar to the observation in our study, which showed no difference in radiation exposure in relation to the treated side. The mean fluoroscopy time in this study is longer than what was previously reported in the literature,^[2-8] which can be related to several factors including the exclusive use of jugular or arm access as compared to femoral access in prior studies. This could be related to the time spent by the operators to cross from the heart into the inferior vena cava, which could have been avoided with femoral access. Furthermore, operator expertise and the level of training may have influenced the radiation exposure. In this study, there was no significant difference in DAP or fluoroscopy time between jugular and brachial/basilic veins combined. The use of coils and sclerosing agents to achieve embolization could be an additional factor leading to higher doses in the present study. The choice of embolic agent was shown to impact the radiation exposure. In a retrospective study of 182 patients, fluoroscopy time and kerma were significantly lower with glue embolization compared to mechanical embolization with coils/plugs or sclerosing agents. However, DAP was lower with glue compared to coils/plugs but not when compared to sclerosants.^[9]

This study has several limitations including its retrospective nature and small sample size, which did not include any pediatric patients. The lack of data on body mass index and body habitus limits the ability to properly calculate the effective and gonadal doses. The angiographic classification of varicoceles was not available in all patients due to the lack of saved images. Operator experience and access preference may have significantly influenced the findings of this study. Furthermore, right gonadal vein cannulation may have been attempted but not documented by images or in the reports. This may have spuriously increased

the radiation exposure and time for the left-sided cases as compared to bilateral. No femoral access was used in the study, therefore, the effect of choosing femoral access versus jugular or upper limb access in reducing the procedure time or amount of radiation cannot be evaluated.

Conclusion

This study finds no significant difference in DAP or fluoroscopy time between jugular and upper limb venous access or between left and bilateral embolization using a combination of coils and sclerosing agents. Despite its limitations, this study prompted the implementation of more cautious radiation protection measures to further minimize radiation exposure during these procedures in our institution.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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