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Original Scientific Paper

RADIATION EXPOSURE USING THE TRANSRADIAL VERSUS TRANSFEMORAL APPROACH IN ACUTE CORONARY SYNDROME

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SUMMARY – Cardiovascular disease (CVD) is the leading cause of global mortality, with a significant portion attributed to ischemic heart disease. Acute coronary syndrome (ACS), encompassing both non-ST-elevation (NSTE)-ACS and ST-elevation myocardial infarction (STEMI), often heralds the onset of CVD. While STEMI demands urgent reperfusion therapy, ideally via percutaneous coronary intervention (PCI), the timing of invasive coronary angiography in NSTE-ACS depends on risk stratification. The transradial approach (TRA) has gained preference in ACS due to its lower incidence of vascular complications and increased patient benefits compared to the transfemoral approach (TFA). However, there are concerns about increased procedure duration and fluoroscopy dose. This study aimed to assess radiation exposure between TRA and TFA in patients undergoing cardiac catheterization for ACS. Through a single-center retrospective review spanning the period from June 2011 to December 2017, data from 1,608 procedures were analyzed. We revealed no significant difference between radiation exposure in TRA and TFA. These findings support TRA's use in ACS, echoing recent trends that indicate decreasing radiation differences over time. Nonetheless, the study's single-center, retrospective nature necessitates further research validation in varied clinical settings.

Keywords: *Acute coronary syndrome; Percutaneous coronary intervention; Transradial approach; Transfemoral approach; Radiation exposure*

Introduction

Cardiovascular disease (CVD) is the most common cause of mortality worldwide, with nearly half of the related deaths being due to ischemic heart disease. Acute coronary syndrome (ACS) is often the first clinical manifestation of CVD and encompasses both non-ST-elevation (NSTE)-ACS and ST-elevation myocardial infarction (STEMI). Patients diagnosed with STEMI should be triaged for immediate reperfusion therapy, ideally by percutaneous coronary intervention (PCI) when available, while the timing of

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invasive coronary angiography in NSTE-ACS is determined by clinical risk stratification[1,2]. The transradial approach (TRA) has become the preferred approach in ACS patients undergoing invasive assessment with or without PCI due to decreased associated vascular complications, convenience for the patients, earlier ambulation, shorter hospital stay and even lower rate of all-cause mortality compared to the transfemoral approach (TFA)[2-8]. It is also a highly successful technique with a success rate of over 90%. However, it is associated with increased procedure duration and fluoroscopy dose[3,4,9-12], although a recent randomized trial and meta-analysis found that the difference in radiation exposure between TRA and TFA decreased overtime and is becoming clinically insignificant[13,14].

The aim of this study was to evaluate radiation exposure when using TRA and TFA in a population of patients undergoing cardiac catheterization in the setting of ACS.

Methods

Patients

This is a single-center retrospective review. All patients with acute coronary syndrome referred for cardiac catheterization between June 2011 and December 2017 were reviewed. Data were extracted from hospital databases and medical records, and included patient demographics and procedure details. The procedures were performed according to valid international guidelines and by high-volume interventional cardiologists with extensive experience with both approaches. The choice of vascular approach was made at the operator's discretion, as well as the type of catheter, type of view used and the number of radiographies. Radiation exposure was measured as a dose-area product and was measured in centigrays per centimeters square (cGY/cm^2).

Statistical analysis

Standard descriptive statistics were used to describe the data. Continuous data were expressed as a median with a corresponding interquartile range (IQR), while categorical variables were presented as absolute values and percentages. Group differences regarding radiation dose were compared using the Mann-Whitney test. The level of statistical significance was set at a *P*-value of < 0.05.

Results

Between June 2011 and December 2017, a total of 1,608 cardiac catheterization procedures in the setting of ACS were performed. A total of 982 procedures (61.1%) were performed in the setting of STEMI and 626 (38.9%) in the setting of NSTE-ACS. Of these, 1,104 (68.7%) were performed on men and 504 (31.3%) on women. The median age of men was 64.6 years (IQR 56.3–73.6), while the median age of women was 65.2 years (IQR 57.3–76.1), 95% CI -0.27–3.57 (Table 1). There were 196 (12.2%) procedures in the TFA group and 1,412 (87.8%) in the TRA group. There were no statistically significant differences between the TFA and TRA group in terms of age, body mass index and the prevalence of arterial hypertension, dyslipidemia, diabetes mellitus and smoking (Table 2).

Median radiation exposure was 4,347 (2,483–7,285) cGY/cm^2. Median TFA radiation exposure was 4,402 (2,337–7852) cGY/cm^2, while median TRA radiation exposure was 4,344 (2,495–7,197) cGY/cm^2, without significant difference ($P = 0.6998$). The SYNTAX score was 21 (IQR 16–25) in the TFA group and

Table 1. Age, sex and body mass index (BMI) distribution

	Male	**Female**	***P*-value**
Number of procedures (number, percentage)	1104 (68.7%)	504 (31.3%)	
Age (years; median, interquartile range)	64.6 (56.3–73.6)	65.2 (57.3–76.1)	0.0903
Body mass index (kg/m^2, median, interquartile range)	27.8 (25.2–30.7)	27.7 (25.3–30.9)	0.8459

Table 2. Demographic and clinical features

	Transfemoral approach	**Transradial approach**	***P*-value**
Male sex (number, percentage)	116 (60.4%)	988 (69.8%)	
Age (years; median, interquartile range)	65.3 (57.3–76.1)	64.6 (56.3–73.6)	0.0903
Arterial hypertension (number, percentage)	157 (84.9%)	1141 (80.8%)	0.1836
Dyslipidemia (number, percentage)	110 (59.5%)	736 (52.2%)	0.0629
Diabetes mellitus (number, percentage)	57 (30.8%)	357 (25.3%)	0.1105
Smoking (number, percentage)	68 (37.2%)	610 (43.6%)	0.0922
Body mass index (kg/m^2, median, interquartile range)	27.7 (25.3–30.9)	27.8 (25.2–30.7)	0.8459

Table 3. Radiation dose and SYNTAX score according to vascular approach

	Transradial approach	**Transfemoral approach**	***P*-value**
Total procedures (number, percentage)	1416 (88.1%)	192 (11.9%)	
Dose-area product (cGY/cm^2, median, interquartile range)	4344 (2495–7197)	4402 (2337–7852)	0.6998
SYNTAX score (median, interquartile range)	22 (17–26)	21 (16–25)	0.1126

22 (IQR 17–26) in the TRA group, without statistical significance (Table 3).

Discussion

Over the past two decades, TRA has become increasingly used for coronary angiography and percutaneous coronary intervention, and major scientific societies recommend TRA in patients with ACS[2,15]. However, there are still concerns about possible increased exposure to radiation with this approach.

Earlier studies[3,10-12] found that TRA resulted in higher radiological exposure compared to TFA. In our study, we found no statistically significant difference between TRA and TFA in terms of radiation exposure in the setting of ACS.

The main differences in radiation exposure stem from the specific difficulties of TRA, such as maneuvering the catheter and engaging at least two coronary ostia, since catheters are mainly designed for TFA. Also, TRA can be technically more demanding due to issues with puncturing a smaller artery, spasms, radial tortuosity, radial loops, anomalies, calcifications and brachial artery tortuosity. These factors can prolong the duration of the procedure, reduce success rates and lead to additional radiation exposure, since imaging of the arm arteries may be required. Once the guide catheter is properly positioned in the coronary ostium, the remaining use of fluoroscopy during the interventional part of the procedure is likely more influenced by the characteristics of the coronary arteries than by the anatomical differences related to the access site. Thus, the similarity in dose-area product indicates that guide catheter fluoroscopy contributes relatively little to the total radiation exposure in PCI procedures[13,16].

It is also recognized that gaining more experience can help lower radiation exposure, particularly with TRA[17]. The results of the present study can be partly explained by the fact that all our operators were high-volume interventional cardiologists with at least 2 years of TRA experience. The SYNTAX score, an angiographic grading tool to determine the complexity of coronary artery disease, was similar between the groups.

A recent meta-analysis[13] found that radiation exposure in TRA and TFA has been decreasing over time, and started becoming clinically insignificant in 2020. Also, a recent randomized trial[14] found no differences between these two groups. Our results are consistent with this trend; our study analyzed data from the period between 2011 and 2017, and found no significant difference in radiation exposure between the two approaches in the studied period.

At our institution, managing radiation delivery is a collaborative effort between the operator, who handles fluoroscopy time (FT), cinematic image acquisition time and view selection, and the radiographer, who is responsible for collimation, beam angling and general optimization parameters. This teamwork ensures that the obtained images are of high quality, while keeping the radiation doses as low as possible. Higher radiation settings provide better visualization, which increases the overall radiation dose. However, better visualization can also reduce radiation exposure if it improves the speed and quality of the procedure.

This study had several limitations that should be noted. Firstly, it is a single-center, retrospective, observational analysis. The choice of vascular approach for each patient was made at the operator's discretion. Also, data on crossover rates and the presence of trainees during procedures were not available. Additionally, we did not differentiate potential technical difficulties closely associated with radiological exposure. The radiation variable we analyzed reflects the dose delivered by the imaging system, rather than the dose actually received by the patient or the operator; these specific indices were not measured.

Conclusion

Our findings support the use of TRA for cardiac catheterization in ACS, demonstrating comparable radiation exposure to TFA. This aligns with recent trends, which indicate a decrease in radiation differences over time, reinforcing the safety and efficacy of TRA in contemporary practice.

Acknowledgements

The authors have declared that no competing interests exist.

Abbreviations

ACS	acute coronary syndrome
BMI	body mass index
CVD	cardiovascular disease
FT	fluoroscopy time
IQR	interquartile range
NSTE-ACS	non ST-elevation acute coronary syndrome
PCI	percutaneous coronary intervention
STEMI	ST-elevation myocardial infarction
TFA	transfemoral approach
TRA	transradial approach

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Sažetak

Izloženost zračenju pri transradijalnom i transfemoralnom pristupu u akutnom koronarnom sindromu

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Kardiovaskularne bolesti vodeći su uzrok globalne smrtnosti, pri čemu se značajan dio pripisuje ishemijskoj bolesti srca. Akutni koronarni sindrom (AKS), koji obuhvaća i akutni koronarni sindrom bez ST elevacije (NSTE-AKS) i infarkt miokarda s elevacijom ST segmenta (STEMI), često je prva manifestacija kardiovaskularne bolesti. Dok STEMI zahtijeva hitnu reperfuzijsku terapiju, prvenstveno perkutanu koronarnu intervenciju (PCI), odluka o tome kada učiniti koronarografiju kod NSTE-AKS ovisi o stratifikaciji rizika. Transradijalni pristup postao je preferirani pristup u AKS zbog niže učestalosti vaskularnih komplikacija i koristi za pacijente u usporedbi s transfemoralnim pristupom. Međutim, povezuje ga se s dužim trajanjem procedure i većom dozom fluoroskopije. Cilj je ove studije istražiti ima li razlike u izloženosti zračenju između transradijalnog i transfemoralnog pristupa tijekom koronarografije u bolesnika s AKS. Retrospektivno istraživanje provedeno u KBC Sestre milosrdnice obuhvatilo je razdoblje od lipnja 2011. do prosinca 2017. godine, a analizirali smo podatke iz 1608 procedura. Nije bilo značajne razlike u izloženosti zračenju između transradijalnog i transfemoralnog pristupa. Ovi rezultati potiču korištenje transradijalnog pristupa u AKS, što je u skladu s modernim trendovima. Ipak, retrospektivni dizajn ovog istraživanja zahtijeva daljnja istraživanja i potvrdu u različitim kliničkim okruženjima.

Ključne riječi: *Akutni koronarni sindrom; Perkutana koronarna intervencija; Transradijalni pristup; Transfemoralni pristup; Izloženost zračenju*