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Radiation Dose in Coronary Angiogram: A Comparison of Radial and Femoral Approach

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Background: Many clinical trials have demonstrated the benefit of trans-radial access (TRA) over trans-femoral access (TFA) in reducing mortality and bleeding events, but there is some concern about radiation exposure with radial access.

Objective: To assess the difference in radiation exposure between radial and femoral approach as measured by dose-area product (DAP) and fluoroscopy time.

Methods: This cross-sectional study was performed in patients aged 15 years and above who underwent invasive percutaneous coronary angiography at Ramathibodi Hospital between December 2019 and December 2020. Exclusion criteria included previous coronary artery bypass graft, unstable hemodynamic status during procedure, and changing the access site or using access sites other than femoral or radial arteries. Demographic data of patients was collected through medical records. DAP and fluoroscopy time of patients with radial and femoral approach were evaluated.

Results: Of 427 patients (49.4% male wtih mean age of 65.7 years), 245 (57.4%) patients underwent TFA. There was no significant difference in the mean DAP between the radial and femoral approach (radial 1838 mGy.cm^2 vs femoral 1690.7 mGy.cm^2, P = .31). However, the fluoroscopy time was significantly higher in radial approach group (radial 4.6 min vs femoral 3.3 min, P < .001).

Conclusions: The radiation exposure was not significantly different between trans-radial and trans-femoral coronary angiography.

Keywords: Radiation, Coronary angiogram, Radial, Femoral

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Introduction

In the past decade, many clinical trials have demonstrated the benefit of trans-radial access (TRA) over trans-femoral access (TFA) in percutaneous coronary intervention (PCI) in patients with acute coronary syndromes (ACS). TRA associated with lower bleeding and vascular complications, enhanced patients comfort and decreased morbidity and cardiac mortality.[1, 2]

The current guideline also recommends TRA over the TFA for percutaneous coronary intervention.[3, 4] However, when performed via radial approach, there is some concern whether the diagnostic coronary angiography (CA) or percutaneous coronary interventions (PCI) may increase the risk of radiation exposure.

This study aimed to assess the difference of radiation exposure between radial and femoral approach as measured by dose-area product (DAP) (which demonstrates the stochastic risk), and fluoroscopy time.

Methods

Participants

Transradial and Transfemoral Procedures

The coronary angiograms were performed by different cardiologists, regardless of the access routes. The access site was made on the doctor's discretion, including types of catheter, types of view used and number of the radiographies.

Radiological Exposure Parameters

The radiological exposure of patients was measured by DAP and fluoroscopy time. DAP is a product of the absorbed dose to air and the cross-sectional area of the irradiated field. This parameter is measured using a special designed ionization chamber, mounted on the collimator of the x-ray tube and calculated by the software presenting in each angiographic system.

DAP provides practical valuation of the total radiation energy transferred to patient during the procedure and helps aid in determining the long-term stochastic risk of cancer.[5, 6]

Ethics

This study was approved by the Human Research Ethics Committee of Faculty of Medicine Ramathibodi Hospital, Mahidol University (No. MURA 2021/453 on June 9, 2021).

Study Design

This cross-sectional study was performed in patients (aged ≥ 15 years) who underwent invasive percutaneous coronary angiography at Ramathibodi Hospital from December 2019 to December 2020. Indications for angiography were acute coronary syndrome or chronic coronary syndrome or preoperative screening for coronary artery disease. Patients with post coronary bypass, unstable hemodynamic status during procedure, changing the access site or using access sites other than femoral or radial arteries, access site complication and patient underwent PCI were excluded from the study. The demographic information of all enrolled patients was collected through medical records. The primary outcome was the comparison of radiation exposure of patients with radial and femoral approach. The secondary outcomes was fluoroscopy time.

Statistical Analysis

The continuous data were expressed as mean and standard deviation (SD), while count and percentage were used for discrete variable. Radiation exposure, DAP and fluoroscopy time were evaluated by mean and SD. Statistical analyses were performed using SPSS software, version 23 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp; 2015).

Results

Baseline Characteristics

Of the patients who met the inclusion criteria, those with at least one of exclusion criteria were excluded. Thus, 427 eligible patients were evaluated in this study. The mean (SD) age of patients was 65.7 (12.5) years, 49.4% were male and 57.4% underwent TFA. The complete demographic and clinical data were determined (Table 1).

Compared with the femoral access, the radial access was operated predominantly in younger patients (62.6 years vs 68 years, $P < .001$), more often in male (56% vs 44.5%, $P = .02$) and in patients with higher body weight (63.7 kg vs 67.6 kg, $P = .002$). The femoral access was performed more frequently in the urgency and emergency cases like ACS (Table 2).

Radial Versus Femoral Access

Fluoroscopy time was significantly higher in radial compared with femoral access (radial 4.6 min vs femoral 3.3 min, $P < .001$). The mean DAP had an insignificant increase in radial versus femoral approach (radial 1838 mGy.cm^2 vs femoral 1690.7 mGy.cm^2, $P = .31$) (Table 2).

Table 1. Characteristics of the Patients at Baseline

Characteristic	No. (%)
Demographic	
Age, mean (SD), y	65.7 (12.5)
Male	211 (49.4)
Weight, mean (SD), kg	65.4 (13.9)
Height, mean (SD), cm	161 (9.4)
BSA, mean (SD), m^2	1.68 (0.2)
Access site	
Femoral artery	245 (57.4)
Radial artery	182 (42.6)

Abbreviations: BSA, body surface area; SD, standard deviation.

Table 2. Baseline Characteristic and Radiation Dose With Radial and Femoral Access

Characteristic	No. (%)		*P* Value*
	Femoral Access (n = 245)	Radial Access (n = 182)	
Demographic			
Age, mean (SD), y	68 (12.5)	62.6 (11.9)	< .001*
Male	109 (44.5)	102 (56.0)	.02
Weight, mean (SD), kg	63.7 (12.9)	67.6 (11.9)	.002
Height, mean (SD), cm	159.4 (9.2)	163.2 (9.2)	< .001*
BSA, mean (SD), m^2	1.65 (0.2)	1.73 (0.2)	< .001*
Indication for CAG			
ACS	35 (14.3)	21 (11.5)	< .001*
CCS	155 (63.3)	87 (47.8)	-
Preoperative	46 (18.8)	68 (37.4)	-
Others	9 (3.7)	6 (3.3)	-
Coronary lesion			
Nonobstructive CAD	35 (14.3)	137 (75.3)	.11
Single vessel	155 (63.3)	24 (13.2)	-
Double vessel	46 (18.8)	11 (6.0)	-
Triple vessel	9 (3.7)	10 (5.5)	-
Procedure time, mean (SD), min	30.3 (9.7)	36.3 (10)	< .001*
Fluoroscope time, mean (SD), min	3.3 (3.6)	4.6 (3.3)	< .001*
DAP, mean (SD), mGy.cm^2	1690.7 (1633.7)	1838 (1247.9)	.31

Abbreviations: ACS, acute coronary syndromes; BSA, body surface area; CAD, coronary artery disease; CAG, coronary artery angiography; CCS, chronic coronary syndromes; DAP, dose-area product.

*$P < .05$ indicated statistical significance.

Discussion

Several studies showed advantages of transradial approach over transfemoral approach for coronary angiogram such as periprocedural bleeding, vascular complication, and mortality in case of acute coronary syndrome.[14] However, radiation exposure, which is one of the most important issue in cardiac catheterization labaratory, should be concerned about transradial approach. Thus, this trial aimed to compare fluoroscopic time and DAP between transradial and transfemoral approach.

The main findings of this study can be concluded as follows: 1) patients in transradial group tended to be younger than transfemoral; 2) the proportion of indications between ACS and CCS to proceed coronary angiogram in transfemoral group was more than transradial group; and 3) the primary results showed that fluoroscopic time was significantly different between 2 groups, while DAP was not statistically significant.

Our study found that the proportion of ACS in transfemoral access was slightly higher than in radial acces which was different from the global trend that prefered transradial strategy in case of ACS. There were many trials in ACS that performed significantly decreased in vascular complication, periprocedural bleeding, and also mortality for transradial approach.[14] However, the proportion of indication in this study was dissimilar for the reason that the operators can liberally choose the route to acces depended on the success rate of the procedure and their own convenience.

As a result, fluoroscopy time is a poor surrogate measure of radiation dose for the patient. Small increases in fluoroscopy time during crossing of the subclavian artery with radial access do not appear to lead to significant increases in total radiation dose compared with femoral access. Previous studies showed the meta-analysis and randomized studies examing debatable results of radiation dose between radial and femoral access in coronary angiogram. The meta-analysis and randomized studies examining radiation doses of radial versus femoral access reported an increase in radiation dose in radial access, especially in the low volume of radial centers. However, recent randomized controlled trials did not demonstrate a significant difference in patient radiation exposure.

Conclusions

This study found that the trans-radial coronary angiography was no significant increase in patients' radiation exposure. Fluoroscope time was an inadequate marker for radiation dose assessment when compared to transfemoral approach.

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การเปรียบเทียบปริมาณรังสีในผู้ป่วยที่รับการตรวจสวนหัวใจผ่านทางหลอดเลือดแดงที่ข้อมือและหลอดเลือดแดงที่ขาหนีบ

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บทนำ: การศึกษาที่ผ่านมาพบว่าการสวนหัวใจผ่านทางหลอดเลือดแดงที่ข้อมือได้ประโยชน์เหนือกว่าการสวนหัวใจผ่านหลอดเลือดแดงที่ขาหนีบด้านการลดอัตราเสียชีวิตและภาวะเลือดออก แต่การศึกษาเหล่านั้นยังขาดการศึกษาเพื่อเปรียบเทียบปริมาณรังสีที่ผู้ป่วยได้รับ

วัตถุประสงค์: เพื่อประเมินความแตกต่างของปริมาณรังสีที่ผู้ป่วยได้รับจากการสวนหัวใจผ่านทางหลอดเลือดแดงที่ข้อมือเปรียบเทียบกับหลอดเลือดแดงที่ขาหนีบ โดยการวัดค่าปริมาณรังสีต่อพื้นผิว (Dose-area product, DAP) และระยะเวลาการฉายรังสี (Fluoroscopy time)

วิธีการศึกษา: การศึกษาย้อนหลังในผู้ป่วยอายุ 15 ปีขึ้นไป ที่เข้ารับการสวนหัวใจในโรงพยาบาลรามาธิบดี ระหว่างเดือนธันวาคม พ.ศ. 2562 ถึงเดือนธันวาคม พ.ศ. 2563 เกณฑ์คัดออกคือ ผู้ป่วยเคยผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจมาก่อน ผู้ป่วยที่มีอัตราการไหลเวียนโลหิตระหว่างทำหัตถการไม่คงที่ และผู้ป่วยที่มีการเปลี่ยนตำแหน่งในการทำหัตถการหรือตำแหน่งอื่น ๆ ข้อมูลทั่วไปของผู้ป่วยเก็บรวบรวมจากเวชระเบียน ปริมาณรังสีต่อพื้นผิวและระยะเวลาการฉายรังสีถูกประเมินในผู้ป่วยที่สวนหัวใจผ่านทางหลอดเลือดแดงที่ข้อมือเปรียบเทียบกับหลอดเลือดแดงที่ขาหนีบ

ผลการศึกษา: กลุ่มตัวอย่างผู้ป่วย จำนวน 427 คน (เพศชายร้อยละ 49.4 อายุเฉลี่ยเท่ากับ 65.7 ปี) ผู้ป่วยได้รับการสวนหัวใจผ่านทางหลอดเลือดแดงที่ขาหนีบจำนวน 245 คน คิดเป็นร้อยละ 57.4 พบว่า ระยะเวลาการฉายรังสีของการสวนหัวใจผ่านหลอดเลือดแดงที่ข้อมือมีความแตกต่างอย่างมีนัยสำคัญ (หลอดเลือดแดงที่ข้อมือ 4.6 นาที และหลอดเลือดแดงที่ขาหนีบ 3.3 นาที, $P < .001$) เมื่อเปรียบเทียบค่าปริมาณรังสีต่อพื้นผิวไม่พบความแตกต่างอย่างมีนัยสำคัญ (หลอดเลือดแดงที่ข้อมือ 1,838 mGy.cm^2 และหลอดเลือดแดงที่ขาหนีบ 1,690.7 mGy.cm^2, $P = .31$)

สรุป: ปริมาณรังสีที่ผู้ป่วยได้รับจากการสวนหัวใจผ่านทางหลอดเลือดแดงที่ข้อมือไม่มีความแตกต่างกันอย่างมีนัยสำคัญ เมื่อเปรียบเทียบกับการสวนหัวใจผ่านทางหลอดเลือดแดงที่ขาหนีบ

คำสำคัญ: ปริมาณรังสี การสวนหัวใจ หลอดเลือดแดงที่ข้อมือ หลอดเลือดแดงที่ขาหนีบ

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