

Comparison of Fluoroscopy Time During Coronary Angiography by Radial and Femoral Routes

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ABSTRACT

Background: The use of radial access in cardiac interventions is associated with reduced vascular complications, however it demands a longer learning curve and may increase fluoroscopy time. This study aimed to evaluate the fluoroscopy time as a surrogate marker of radiation exposure, during diagnostic cardiac catheterization by radial and femoral routes. **Methods:** Retrospective observational study including patients who underwent cardiac catheterization from July 2013 to October 2014. Radial and femoral groups were compared for total procedural time, fluoroscopy time, fluoroscopy to procedural time ratio and vascular complications. **Results:** The study included 1,915 procedures, 11.2% of which performed by radial approach and 88.8%, by femoral approach. A male prevalence was found in the radial group (80% vs. 54.1%, $p < 0.01$), but age (61.6 ± 9.7 years vs. 62.4 ± 11.6 years, $p = 0.13$), total procedural time (8.7 ± 3.8 vs. 8.1 ± 4.1 minutes, $p = 0.91$), fluoroscopy time (4.8 ± 2.7 vs. 4.1 ± 2.6 minutes, $p = 0.89$), fluoroscopy/procedure time ratio (0.56 ± 0.24 vs. 0.49 ± 0.32 , $p = 0.89$), and major complications (0.0% vs. 0.3%, $p = 0.55$) were similar between groups. **Conclusions:** The use of the transradial approach for diagnostic procedures by experienced operating physicians may be used with an acceptable total procedural time without increasing the radiation exposure of the patient and staff, and with a low incidence of complications.

DESCRIPTORS: Cardiac catheterization. Radial artery. Radiation.

The transradial technique in interventional procedures in cardiology is a method commonly used in catheterization laboratories in Brazil and worldwide. Currently, technical improvements allow

RESUMO

Comparação do Tempo de Fluoroscopia Durante Cateterismo Cardíaco pelas Vias Radial e Femoral

Introdução: O uso da via radial em intervenções cardíacas associa-se à redução das complicações vasculares, porém requer maior curva de aprendizado e pode aumentar a exposição do paciente e da equipe à radiação. Este estudo teve como objetivo avaliar o tempo de fluoroscopia, como variável substituta para a exposição à radiação, durante cateterismo cardíaco diagnóstico pelas vias radial e femoral. **Métodos:** Estudo retrospectivo observacional que incluiu pacientes submetidos ao cateterismo cardíaco entre julho de 2013 e outubro de 2014. Foram comparados os grupos radial e femoral quanto ao tempo total do procedimento, tempo de fluoroscopia, relação tempo de fluoroscopia/procedimento e complicações vasculares. **Resultados:** Foram incluídos 1.915 procedimentos, sendo 11,2% realizados por via radial e 88,8% realizados por via femoral. Observou-se predomínio do sexo masculino no grupo radial (80% vs. 54,1%; $p < 0,01$), mas a média de idades ($61,6 \pm 9,7$ vs. $62,4 \pm 11,6$; $p = 0,13$), o tempo do procedimento ($8,7 \pm 3,8$ vs. $8,1 \pm 4,1$ minutos; $p = 0,91$), o tempo de fluoroscopia ($4,8 \pm 2,7$ vs. $4,1 \pm 2,6$ minutos; $p = 0,89$), a relação tempo de fluoroscopia/procedimento ($0,56 \pm 0,24$ vs. $0,49 \pm 0,32$; $p = 0,89$) e as complicações maiores (0,0% vs. 0,3%; $p = 0,55$) foram semelhantes entre os grupos. **Conclusões:** A utilização da via radial para procedimentos diagnósticos por operadores experientes pode ser feita com um tempo de procedimento aceitável, sem aumentar a exposição radiológica do paciente e da equipe, e com baixo número de complicações.

DESCRIPTORES: Cateterismo cardíaco. Artéria radial. Radiação.

for high success rates in acute or elective situations, for diagnostic cardiac catheterization and percutaneous coronary intervention (PCI) with stent.¹⁻⁵

Although the learning curve for its technical mastery by interventional cardiologists is steeper, these professionals should be familiar with the transradial technique, so that cases in which the preferred access route is not available can be treated.^{6,7}

Given the absence of Brazilian data, this study aimed to evaluate fluoroscopy time as a surrogate variable for exposure to radiation during diagnostic cardiac catheterization by radial and femoral routes.

METHODS

Design and study population

This was a single-center, retrospective, comparative, descriptive observational study based on data collected from medical records and information obtained and recorded at the Interventional Cardiology Department of Hospital Evangélico de Vila Velha, in the city of Vila Velha, ES, Brazil.

The sample consisted of consecutive patients admitted for diagnostic cardiac catheterization in a regional referral center, coming from their residence, from hospitalization sectors of the same hospital, or from other hospitals between July 2013 and October 2014. Patients over 18 years undergoing elective cardiac catheterization for coronary artery disease investigation were included in the present study, including those who underwent coronary angiography with or without left ventriculography through radial or femoral route. The possible diagnoses included silent myocardial ischemia, stable angina, acute coronary syndromes (ACS) without ST-segment elevation, acute myocardial infarction with ST-segment elevation (AMIWST) outside the therapeutic opportunity window, and heart valve diseases. Patients who underwent emergency cardiac catheterization (AMIWST undergoing primary PCI), right heart chamber catheterization, pre-heart transplant protocol, simultaneous procedures (such as provisional pacemaker implant or extra-cardiac territory arteriography), *ad hoc* PCI, brachial access route, and failure of an access route needing crossover to another route were excluded.

The variables evaluated were: access route used, age, gender, fluoroscopy time, total procedure time, and fluoroscopy time/total procedure time ratio. The times described were evaluated separately for each of the operating physicians, comparing the radial and femoral routes for each interventionist involved. Serious complications and total complications related to the puncture sites were also analyzed.

Procedures

All patients undergoing diagnostic cardiac catheterization followed the pre- and post-catheterization routine at the Service, and signed the informed consent

form before the procedure. The choice of the access route was done at the discretion of the operating physician, as well as the catheters used, sheath and catheter calibers, the use of sedation, and whether or not a left ventriculography would be performed. The use of unfractionated heparin was also at the discretion of the interventional cardiologist; the drug (2,500-5,000 units) would be administered through the introducer sheath. Before each procedure performed via radial route, the Allen test was performed. In all patients, an AngiX device (X-PRO/General Electric Healthcare – Contagem, MG, Brazil) was used.

Asepsis, patient positioning on the procedural table, preparation of sterile fields, and removal of the introducer sheath with hemostatic techniques were followed for each patient. After the procedures patients were encouraged to personally return to the Service to report possible complications related to the puncture site to allow for a specialized medical evaluation, in cases of intercurrentence.

The procedure execution time was recorded from the time the physician prepared to administer local anesthesia for the arterial puncture until the end of the last image acquisition. Fluoroscopy time was obtained from the information available in the hemodynamics device, soon after each procedure.

In the sample, only patients undergoing cardiac catheterization conducted by interventional cardiologists who performed over 10% of the procedures via the radial route and/or with over 15 procedures through this route during the study period were included, in order to achieve homogenization for a comparative analysis between the two access routes.

Definitions and outcomes

For comparative analysis, the patients included in the study were divided into two groups, according to the vascular access route used for cardiac catheterization: radial or femoral.

The study primary endpoints were total procedure time and fluoroscopy time in diagnostic cardiac catheterization. The relationship between fluoroscopy time and total procedure time was also analyzed; this analysis determines the fraction of time spent in the examination for the fluoroscopy, by comparing the access routes in the total sample and for each interventionist separately. Major complications (moderate or severe bleeding according to the GUSTO criteria,⁸ pseudoaneurysm, symptomatic arterial occlusion, arteriovenous fistula, puncture site infection, retroperitoneal hematoma, and major hematoma causing compartment syndrome) and total complications (including those serious and non-serious, such as hematoma without hemodynamic consequences or need for transfusion, or local pain without hematoma and without loss of pulse) were computed.

Statistical analysis

The data obtained were stored in a Microsoft Office Excel spreadsheet for further descriptive and comparative analysis.

In the descriptive analysis, categorical variables were expressed as absolute numbers and percentages and compared using the chi-squared test or Fisher's exact test, as appropriate. Continuous variables were described as means and standard deviations, and compared using Student's *t*-test. For these analyzes, SPSS) version 20.0 for Windows was used, and P-values < 0.05 were considered as statistically significant.

RESULTS

During the study period, 4,954 procedures were performed in the catheterization service, with 3,045 diagnostic cardiac catheterizations, of which 1,915 (62.9%) met the inclusion criteria and were performed by interventionists with > 10% of transradial procedures and/or more than 15 transradial procedures during the study period. This last group composed the sample evaluated. The mean age of patients was 62.2 ± 11.3 years, ranging from 26-94 years, and 1,098 (57.3%) were male.

The mean procedure execution time was 8.4 ± 3.9 minutes for the total population, and the mean fluoroscopy time was 4.2 ± 2.8 minutes (fluoroscopy time/total procedure time = 0.50 ± 0.34). Table 1 lists the features and results of the radial and femoral groups.

Four operating physicians met the criteria for percentage and/or absolute number of cardiac catheterizations via radial route and had their procedures included in the analysis. The number of procedures performed (in ascending order) was: operating physician 1 = 123; operating physician 2 = 320; operating physician 3 = 672; and operating physician 4 = 800. The use of the femoral route prevailed for all operating physicians included. The results, discriminated per operating physician and the chosen access route are described in Table 2.

Regarding complications related to vascular access sites, no major complications occurred in the radial group. Only two patients (0.9%) returned after cardiac

catheterization via the radial route, reporting a local discrete hematoma and local pain in the absence of any hematoma or a decreasing pulse, respectively, both without therapeutic intervention. In the femoral group, vascular complications of any kind occurred in 44 (2.6%) patients: 39 (2.3%) local hematomata without hemodynamic repercussions, 2 (0.1%) local hematomata with moderate GUSTO grading (requiring blood transfusion), and 3 (0.2%) pseudoaneurysms (without need for surgery). There were no cases of infection at the puncture site, thrombosis or arterial thromboembolism, arteriovenous fistula nor retroperitoneal hematoma in the femoral group. Total and severe vascular complications are shown in Table 3.

DISCUSSION

In the present study, total procedure time, fluoroscopy time, and the fluoroscopy time/procedure time ratio were similar for the radial and femoral groups. The incidence of vascular complications was low, being similar between groups, with a tendency in favor of a lower rate of total complications in the radial group.

The first report of a series of cardiac catheterizations performed via the radial route dates from 1989 in Canada; at that time, a low success rate using radial artery puncture was observed.⁹ Since then, technical and equipment developments and scientific evidence have inserted the radial approach into day-to-day interventional cardiology, with increased success rates and reduced risk of vascular complications.^{1,5}

By providing shorter hospital stays, less risk of bleeding events in the access route, and an earlier ambulation, the transradial approach has been spreading around the world, becoming a common procedure in many centers, both for diagnostic and therapeutic cardiac catheterization, in elective situations and also in cases of ACS.^{1,10,11}

Due to the wider use of antiplatelet and antithrombotic drugs in PCI, this scenario became the main subject of studies and comparisons between the radial and femoral routes. Special attention is given to ACS, a situation in which drug therapy is even more intense. It is in this scenario that we find the main benefit of

TABLE 1
Characteristics and procedure and fluoroscopy times in the radial and femoral groups

Variables	Radial route (n = 215)	Femoral route (n = 1,700)	p value
Male gender, n (%)	172 (80.0)	920 (54.1)	< 0.01
Age, years	61.6 ± 9.7	62.4 ± 11.6	0.13
Procedure time, minutes	8.7 ± 3.8	8.1 ± 4.1	0.91
Fluoroscopy time, minutes	4.8 ± 2.7	4.1 ± 2.6	0.96
Fluoroscopy time/procedure time ratio	0.56 ± 0.24	0.49 ± 0.32	0.89

TABLE 2
Procedure and fluoroscopy times, stratified by operating physician, comparing the radial and femoral routes

Times	Radial route	Femoral route	p value
Operating physician 1			
n (%)	24 (19.5)	99 (80.5)	
Execution time, minutes	11.9 ± 4.6	12.6 ± 5.2	0.26
Fluoroscopy time, minutes	7.7 ± 3.4	6.1 ± 3.0	0.96
Fluoroscopy time/procedure time ratio	0.62 ± 0.30	0.48 ± 0.24	0.97
Operating physician 2			
n (%)	16 (5.0)	304 (95.0)	
Execution time, minutes	8.0 ± 3.9	8.1 ± 4.1	0.47
Fluoroscopy time, minutes	6.9 ± 2.8	5.0 ± 3.4	0.98
Fluoroscopy time/procedure time ratio	0.86 ± 0.44	0.61 ± 0.39	0.97
Operating Physician 3			
n (%)	42 (6.3)	630 (93.7)	
Execution time, minutes	5.9 ± 3.6	7.0 ± 3.9	0.79
Fluoroscopy time, minutes	3.6 ± 2.4	3.4 ± 2.2	0.69
Fluoroscopy time/procedure time ratio	0.61 ± 0.25	0.49 ± 0.21	0.95
Operating physician 4			
n (%)	133 (16.6)	667 (83.4)	
Execution time, minutes	9.0 ± 4.7	8.7 ± 4.0	0.75
Fluoroscopy time, minutes	4.4 ± 2.5	4.0 ± 2.2	0.95
Fluoroscopy time/procedure time ratio	0.49 ± 0.28	0.46 ± 0.23	0.87

TABLE 3
Vascular complications in the radial and femoral groups

Vascular complications	Radial route (n = 215)	Femoral route (n = 1,700)	p value
Major complications, n (%)	0 (0.0)	5 (0.3)	0.55
Total complications, n (%)	2 (0.9)	44 (2.6)	0.06

the radial versus femoral approach in reducing bleeding events. Since most bleedings observed are associated with the femoral route, the use of the radial technique is one of the main strategies for reducing the risk of this event. In this context, an interesting observation about the radial route is the possibility of a more liberal use of anticoagulants by the interventional cardiologist, due to the safety provided by this route regarding bleeding events at the puncture site.^{1,12,13}

In fact, both the clinical situation and the experience of the center in the use of the radial route appear to affect the results of PCI. In the multicenter Radial Versus Femoral Access for Coronary Intervention (RIVAL) study, with 7,021 patients, the combined outcome of death, myocardial infarction, stroke, and major bleeding

not related to coronary artery bypass surgery was similar in both radial and femoral groups (3.7% vs. 4%, $p = 0.50$); but there was a significant benefit in favor of the radial route in centers with higher volume of procedures performed via this route (relative risk [RR] = 0.49; 95% confidence interval [95% CI]: 0.28-0.87; $p = 0.015$) and for patients with AMIWST (RR = 0.60; 95% CI: 0.38-0.94; $p = 0.026$). Despite similar rates of major bleeding (0.7% vs. 0.9%; $p = 0.23$), the radial group had a lower incidence of local hematoma (RR = 0.40; 95% CI: 0.28-0.57; $p = 0.0001$) and of pseudoaneurysm needing intervention (RR = 0.30; 95% CI, 0.13-0.71; $p = 0.006$).¹²

A meta-analysis on the radial access and decrease of adverse events in primary or rescue PCI included five

randomized trials and seven comparative registries, and observed 70% of reduced risk of major bleeding with the radial route when compared with the transfemoral route (0.77 % vs. 2.61%; odds ratio [OR] = 0.30; 95% CI: 0.16-0.55; $p = 0.0001$). Decreases in the combined outcome of death, AMI, and stroke were also significant (3.65% vs. 6.55%; OR = 0.56; 95% CI: 0.39-0.79; $p = 0.01$), as well as in death separately (OR = 0.54; 95% CI: 0.33-0.86; $p = 0.01$).¹⁴

The consolidation of the radial route for diagnostic cardiac catheterization and PCI is supported by the ever increasing adoption of this technique by interventional cardiologists worldwide. The scientific evidence has been demonstrated in numerous scenarios, such as the elderly,¹⁵⁻¹⁹ women,²⁰ bifurcation injuries,¹¹ chronic coronary occlusions,^{21,22} and saphenous vein and internal mammary artery grafts.²³ Thus, mastery of this technique expands its use to situations previously considered adverse.

The percutaneous coronary intervention via the radial approach on an outpatient basis, followed by patient's discharge in less than 24 hours after the procedure, was proven to be safe, helping in cost reduction. This strategy does not increase the risk of adverse events in PCI for clinically and angiographically favorable coronary lesions, provided that they are closely monitored.²⁴⁻²⁶

Exposure to ionizing radiation and its potential deleterious effects are constant fears of interventional cardiology professionals. Decreasing fluoroscopy time, whenever possible, is recommended, and this should be accompanied by the use of all radiation protection devices available, in addition to the calibration of cine-fluoroscopy and radiology equipment.^{27,28} Considering that the radial route demands a steeper learning curve for its technical mastery, this may result in an increased fluoroscopy time, both in absolute terms and in proportion to the total procedure time. To reduce this risk, the entire medical staff should strive for proficiency and experience with the technique.

A recently published Brazilian study evaluated the cardiac catheterization via the radial route in 122 patients. In that study, the following means were obtained: procedure time, 14.8 ± 5.2 minutes; puncture time, 129.7 ± 124.1 seconds; and fluoroscopy time, 4 ± 2.3 minutes. In addition, there was no major complication at the puncture site.²⁹ These results are very similar to those found in the present study.

In various situations, the diagnostic cardiac catheterization via the radial route is feasible and can be a routine conduct in most interventional cardiology services, presenting low rates of complications; besides, the time required for its execution is compatible with that for femoral approach, as demonstrated in this study. Furthermore, the early ambulation and the possibility of a shorter observation time of the puncture

site in the service can optimize the physical space of catheterization laboratories, given the increasing volume of procedures. An extra attention should be paid to the use of fluoroscopy by the interventionist, reducing this time to the minimum required, through technical improvement and proper equipment selection.

It is worth noting that the measurement of the time required for the execution of cardiac catheterization in no way reflects the quality of the procedure; a wide variation between operating physicians can exist, without reflecting technical differences or professional inadequacies. The use of the procedure time in the present study aimed only to analyze the correlation with fluoroscopy time and the functional viability of the radial access for the interventional cardiology services.

Limitations

Although relevant, the present study had limitations, such as its retrospective design, which lead to biases due to the selection of patients for cardiac catheterization via either one of the routes – for example, the preference for the femoral approach in women, due to the increased occurrence of spasms of the radial artery in this population.

Some relevant data were not evaluated and could influence and enrich the results, such as the radiation dose received by the interventionist, the patient's body surface and weight, and the time to ambulation.

Despite the guidance given to all patients to return to service and report possible complications at the vascular access site, this investigative method leaves room for complications not computed, which could underestimate the rate of events.

CONCLUSIONS

The radial route for diagnostic procedures by experienced operating physicians can be performed with an acceptable procedure time, without compromising the patient and interventionist staff safety, in accordance with the radiation exposure, and with a low number of complications.

CONFLICT OF INTERESTS

The authors declare no conflicts of interest.

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None.

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