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ORIGINAL ARTICLE

Coronary angiography safety between radial and femoral access

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Abstract One of the major criticisms of the radial approach is that it takes longer overall procedure and fluoroscopy time, which means not only more staff will be exposed during the procedures, but they will also stand close to the patient where rates of radiation scattered by the patient are higher. The aim of this study was to evaluate the safety of the radial versus femoral artery approach in our institution's routine coronary angiography practice.
Methods: All cases of diagnostic coronary angiography (CA) over a 23 month period at a tertiary care hospital were reviewed for this analysis. Procedure duration was calculated as a total in laboratory catheter time. Contrast volume and fluoroscopy time were recorded, as it is correlated to catheter manipulation.
Results: Eight hundred patients who underwent a diagnostic CA were included in this study. The radial approach was used in 586 patients (73.25%) and the femoral approach in 214 patients (26.75%). Comparing the radial and femoral approaches, fluoroscopy and procedure times were not significantly different (3.43 ± 1.19 vs 3.86 ± 1.49 min, $P = 0.215$ and 31.87 ± 9.61 vs 33.24 ± 10.33 min, $P = 0.170$, respectively). While contrast utilization during the procedure was significantly lower in the radial than the femoral approach (67.63 ± 25.49 vs 81.53 ± 24.80 mL respectively, $P = 0.03$).
Conclusion: Transradial coronary angiography can be safely performed for the patient and the professional staff members as the transfemoral approach.

1. Introduction

The hand receives a dual arterial supply from the radial and ulnar arteries, which come together to form deep and superficial palmar arches. The radial artery – unlike the femoral or brachial artery – is therefore not an end artery, and in the presence of a satisfactory ulnar collateral supply, its occlusion does not compromise the vascular supply to the hand. Furthermore, the superficial course of the distal radial artery provides for

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easy compression of the artery, so that patients can mobilize as soon as the arterial sheath is removed on completion of the procedure.[1] Recent technological advances have enabled the miniaturization of diagnostic catheters as well as the equipment for percutaneous transluminal coronary angioplasty. Owing to this miniaturization, the percutaneous arm approach via the radial artery is becoming more popular throughout the world as an alternative to the femoral artery technique.[2–12] Advantages of this approach include a lower incidence of access site complications, earlier patient ambulation, improved patient satisfaction, and lower cost.[2–4,7,11–13] Transradial procedures may be performed by cannulation of either the right or the left radial artery. At present, the choice for the right radial or the left radial approach largely depends on the operator's preference. Most of the studies of the transradial approach have been performed through right radial artery probably because of the familiarity in performing the study from the patient's right side as commonly used in the femoral approach.[2] One of the major criticisms of the radial approach is that it takes longer overall procedure and fluoroscopy time, which means not only more staff (interventionists, radiographers, nurses, and anesthetists if needed clinically) will be exposed during the procedures, but they will also stand close to the patient where rates of radiation scattered by the patient are higher.[14] The American Heart Association/American College of Cardiology clearly state that "the responsibility of all physicians is to reduce the radiation injury hazard to their patients, to their professional staff and to themselves".[15] So, the aim of this study was to evaluate the safety of the radial versus femoral artery approach in our institution's routine coronary angiography practice.

2. Methods

All cases of diagnostic coronary angiography (CA) over a 23 month period (starting from March 2007 till the end of January 2009) at a tertiary care hospital (Cardiothoracic department, Spedali Civili, Brescia University, Italy) were retrospectively reviewed for this analysis. All the data were entered into a database after the end of each procedure, detailing arterial access route, crossover from one access to other approach, contrast amount, overall procedure time and fluoroscopy time.

The choice between femoral or radial artery access was left to the discretion of the operator. The right radial approach is the default strategy at the Brescia catheterization laboratory-Spedali Civili. In accordance with institutional policy, the femoral approach was favored for patients with negative findings on the Allen test,[16,17] and for patients with coronary artery bypass grafts (CABG). Radial arterial access was achieved in a standard fashion using commercial micropuncture kits. After sheath insertion, 5000 U of unfractionated heparin was injected directly into the radial artery through the sheath; also intra arterial nitroglycerine (200 mcg) was used as the primary antispasmodic. CA was performed using 6 Fr diagnostic catheters. At procedure completion, the sheath was removed immediately and a compression by hemostatic band was installed for 3 h, patients were allowed to walk around immediately after the end of the procedure. Femoral procedures were done using vascular sheaths, which placed using Seldinger's technique. CA was performed using 6 Fr diagnostic catheters. After the end of the procedure, the sheath was removed in the catheter laboratory and manual compression was performed for a minimum of 15 min or until satisfactory hemostasis had been achieved. This was followed by placement of a compressive bandage for 6 h. Closure devices were not used.

Study population was stratified according to arterial access used to perform the procedure into two groups; radial group and femoral group. Access crossover was recorded and stratified based on the first route of access attempted. Crossover to femoral was defined as the need to shift to the transfemoral approach and was left to the operator's discretion. Crossover to the femoral approach was classified into the following three groups: puncture failure (lack of radial cannulation), radial and brachial failure (severe spasm, tortuosity, loops, remnant, or other anomalies), and epiaortic failure (severe subclavian or aortic tortuosity).[18]

Procedure duration was calculated as the time between the patient entering and leaving the catheter laboratory. Fluoroscopy time is recorded, as it is correlated to catheter manipulation, whereas the fluorography time is not included in our study, as it is independent from catheter manipulation and is associated with the cineangiography recording. Contrast injection was performed using an automatic power injection device that allows for online control of contrast injection rate and volume.[19] In our institution, coronary angiography and subsequent coronary intervention – when necessary – are performed in a single session in order to optimize patient health and comfort. All diagnostic coronary angiography which were followed by percutaneous coronary intervention (PCI) were excluded, as we were not measuring and recording into the data base the contrast amount, fluoroscopy and procedure times of the diagnostic coronary angiography independently from PCI procedures of the same case.

2.1. Statistical analysis

The data were coded and computed on a statistical package for social sciences SPSS version 17 for windows for statistical analysis. Continuous data were analyzed using student's t test and presented as mean ± SD. Categorical data are presented as a percentage, and were analyzed using a chi squared analysis. Times measured were analyzed and reported in minutes. Significance was defined as $P < 0.05$.

3. Results

A retrospectively collected catheterization laboratory database of consecutive patients who underwent a diagnostic coronary angiography over a 23 month period (starting from March 2007 till the end of January 2009) at a tertiary care hospital (Cardiothoracic department, Spedali Civili, Brescia University, Italy) was reviewed for this analysis. Eight hundred patients who underwent a diagnostic CA, which was done by the authors were included in this study. The radial approach was used in 586 patients (73.25%) and the femoral approach in 214 patients (26.75%).

The baseline characteristics of the patients are summarized in Table 1, which were similar in both groups except for age which is significantly higher in the femoral than radial group, representing older population in this group (72.36 ± 18.20 vs 66.47 ± 10.22 years respectively, $P = 0.00$). Also according

Table 1 Patient demographics.

	Radial CA (N = 586)	Femoral CA (N = 214)	P value
Age (*y.*)			
Range	34–88	36–90	0.000
Mean ± SD	66.47 ± 10.22	72.36 ± 18.20	
Sex, n (%)			
Male	402 (68.60%)	138 (64.49%)	0.271
Female	184 (31.40%)	76 (35.51%)	
BMI (kg/m^2)			
Range	15.34–35.89	16.64–34.21	0.540
Mean ± SD	27.20 ± 12.78	26.83 ± 11.23	
Diabetes mellitus, n (%)	387 (66.04%)	153 (71.49%)	0.117
Hypertension, n (%)	416 (70.99%)	158 (73.83%)	0.321
Dyslipidemia, n (%)	343 (58.53%)	131 (61.21%)	0.340
Previous CABG, n (%)	11 (1.88%)	63 (29.44%)	0.000
Renal impairment, n (%)	77 (13.14%)	39 (18.22%)	0.071

CA = coronary angiography, BMI = body mass index, CABG = coronary artery bypass grafting, Renal impairment = serum creatinine > 1.2 mg/dL.

to our institutional policy, the incidence of post CABG patients was higher in the femoral group (63 patients "29.44%"), while only 11 CABG patients (1.88%) were done through the left radial artery (P = 000).

Crossover from right radial artery access to the femoral approach occurred in 24 cases (4.1%), while there was no crossover in the femoral group (P = 0.003). Crossover due to puncture failure occurred in 11 patients (1.9%), eight cases (1.4%) due to radial and brachial failure, and in five patients (0.8%) because of epiaortic failure (Figs. 1–4).

Comparing the radial and femoral approaches, fluoroscopy and procedure times were not significantly different (3.43 ± 1.19 vs 3.86 ± 1.49 min, P = 0.215 and 31.87 ± 9.61 vs 33.24 ± 10.33 min, P = 0.170, respectively). While contrast utilization during the procedure was significantly lower in the radial than the femoral approach (67.63 ± 25.49 vs 81.53 ± 24.80 mL respectively, P = 0.03) (Table 2).

4. Discussion

The transradial approach for cardiac catheterization is a common alternative to transfemoral access both for diagnostic coronary angiography and percutaneous coronary interventions.[1] The radial approach is an appealing technical strategy to reduce bleeding complications in patients with coronary artery disease undergoing percutaneous invasive management.[20,21] A major effort in increasing the rate of invasive procedures performed through the transradial approach is expected worldwide in the next years.[22]

Radial artery access has been associated with a greater access crossover rate, which reported to be 4% to 7% in previous studies.23–25 The crossover from the radial to femoral approach occurred in 24 patients (4.1%) in our study for the radial group, while there was no crossover in the femoral group (P = 0.003). Louvard et al.[26] reported the crossover from the radial to the femoral approach was 8.9% and from femoral to radial occurred in 8.1% of their patients' study (P = NS). Roberts et al.[27] reported the incidence of the crossover from radial to femoral access to be 1% in their study, which is a low crossover rate. They attributed this level of success to the accurate selection of suitable radial cases and the use of specific techniques, careful guide catheter choice, methods for dealing with tortuous subclavian anatomy, and specific guide catheter manipulation techniques have also developed alongside increasing use of radial access, and reflect the practice of high volume experienced radial operators.

Fluoroscopy time in our study for both radial and femoral approaches was not significantly different (3.43 ± 1.19 vs 3.86 ± 1.49 min respectively, P = 0.215). Louvard et al.[28] reported fluoroscopy time was significantly shorter in the femoral group (3.1 ± 1.7 min) than in both radial groups (right: 3.8 ± 2.2 min; left: 4.2 ± 1.7 min), P < 0.01. Again Louvard et al.[26] conducted another study to compare transradial and transfemoral approaches for coronary angiography and angioplasty in octogenarians and they reported that fluoroscopy time was shorter in the femoral group versus the radial group (4.5 ± 3.7 vs 6.0 ± 4.4 min; P < 0.05) for the coronary angiography. They commented that the radial approach is more demanding and takes longer in elderly patients because of the frequent presence of specific vascular abnormalities, such as calcification or arterial loops. Kawashima et al.[29] reported the fluoroscopy time in coronary angiography was shorter in

Tip of the diagnostic catheter in the radial artery

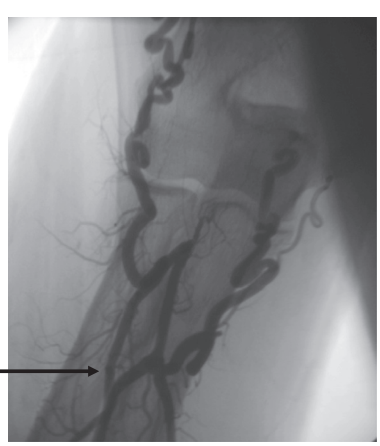

Figure 1 Patient with brachial artery anomaly.

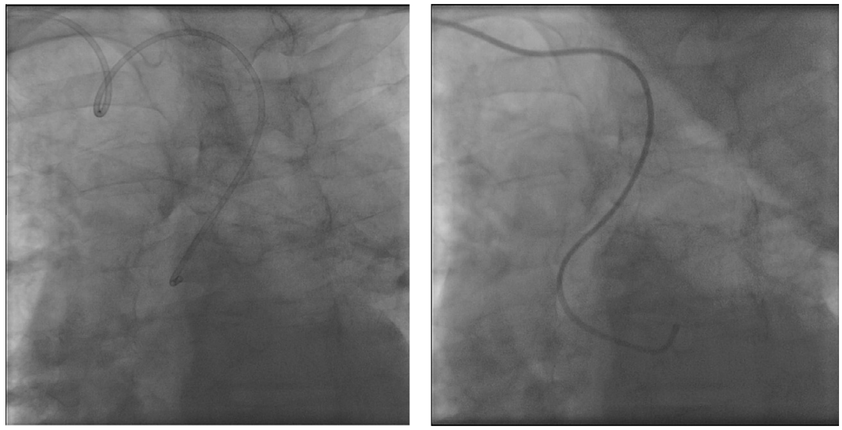

Figure 2 Patient with epiaortic tortuosity before and after cannulation of left main coronary artery.

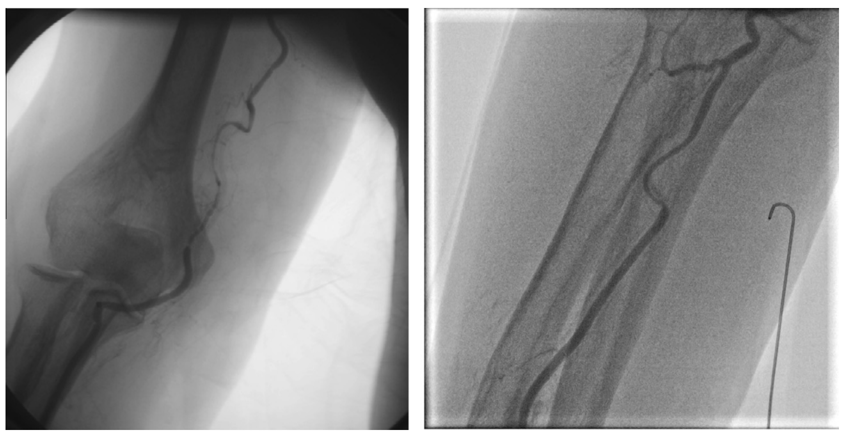

Figure 3 Two patients with brachial and radial artery spasm.

the left radial than in the right radial approach group (3.7 ± 2.5 vs. 5.0 ± 3.3 min; $P < 0.001$). Behan et al.[30] reported the median fluoroscopy time was 4.4 vs 3.9 min ($P = 0.16$), for the right radial approach with the standard X-ray protection group versus standard protection plus the transradial radiation protection board group, respectively.

Louvard et al.[28] reported the procedural duration (from first puncture attempt to removal of last catheter) was significantly longer with the left radial (14.2 ± 3.3 min) approach than the femoral approach (11.2 ± 3.3 min); $P < 0.001$. While procedure duration was 12.4 ± 5.8 min in right radial access without any significant differences between the femoral and right radial approach. Again Louvard et al.[26] reported in another study for octogenarians population that procedure duration was 15.9 ± 9.5 in the femoral group vs 18.5 ± 10.5 min in the radial group (right and left radial in a common pool); $P < 0.05$. Kawashima et al.[29] reported the procedural duration in coronary angiography (time from the initiation of local anesthesia to completion of the procedure) was shorter in the left radial than in the right radial approach group (11.4 ± 4.8 vs. 13.7 ± 6.4 min; $P < 0.001$). Sciahbasi et al.[18] reported procedural time (the time from local anesthesia to the end of the procedure) was not significantly different between the 2 arms (left radial approach 13 min vs right radial approach 13 min; $P = 0.56$). Behan et al.[30] reported Median total procedure duration (total in-laboratory time) was 35 vs 35 min; $P = 0.14$, for the right radial approach with the standard X-ray protection group versus standard protection plus the transradial radiation protection board group, respectively. The overall procedure time between the patient entering and leaving the catheter laboratory in our study – total in laboratory time rather than knife to skin time – was not significantly different (31.87 ± 9.61 vs 33.24 ± 10.33 min respectively, $P = 0.170$) for both radial and femoral approaches.

Contrast utilization during the coronary angiography procedure was significantly lower in the radial than the femoral approach in our study (67.63 ± 25.49 vs 81.53 ± 24.80 mL respectively, $P = 0.03$). Louvard et al.[26] reported the volume of contrast was similar in radial and femoral approaches for coronary angiography. Kawashima et al.[29] reported the amount of contrast material in coronary angiography did not differ between the left radial and right radial approach group (79 ± 27 vs. 83 ± 25 mL; $P > 0.05$). Sciahbasi et al.[18] reported a trend toward a lower dose of contrast media used during diagnostic coronary procedures in the left radial approach compared with the right radial approach (65 ± 32 and 68 ± 35 mL respectively, $P = .098$). Behan et al.[30] reported the median total contrast load was 100 vs 100 mL; $P = 0.9$, for the radial approach with the standard X-ray protection group versus standard protection plus the transradial radiation protection board group, respectively.

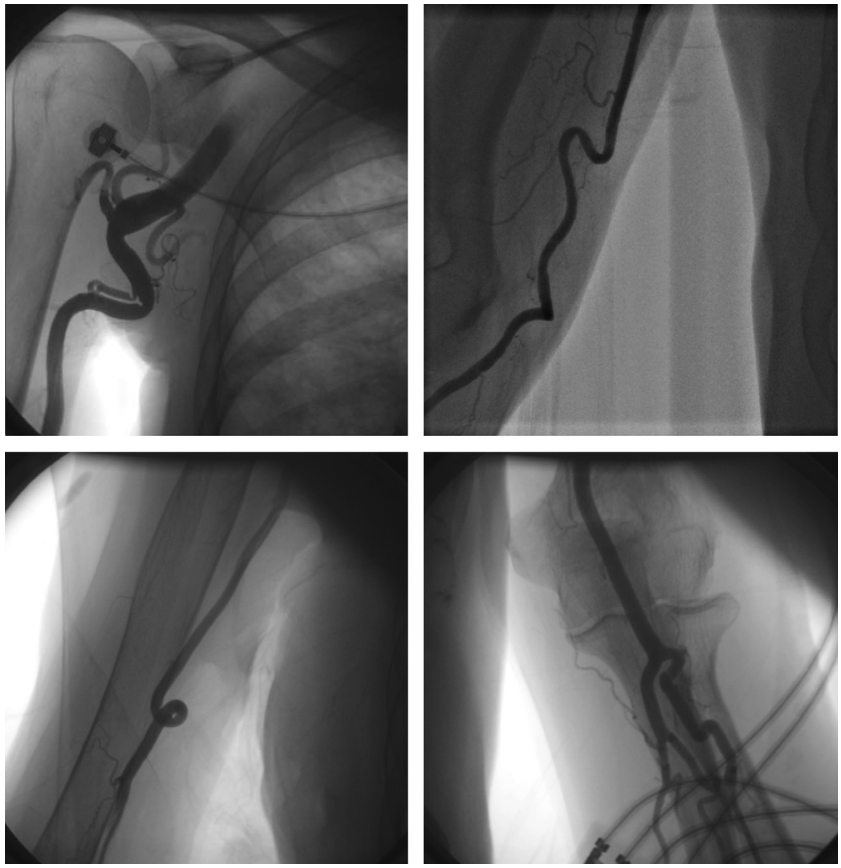

Figure 4 Four patients with brachial and radial arteries tortuosity in right and left sides.

The higher significant contrast dose in the femoral group in our study may partly account for the higher percentage of post CABG patients in the femoral group and the subsequent significant higher utilization of contrast dose during procedure to visualize the graft bypass vessels in addition to native coronary vessels. Also this explanation can be applied to fluoroscopy and procedure times, which were longer in the femoral than the radial group; however it did not reach a significant difference. But we should keep in mind that we performed all transradial procedures with preshaped catheters for the transfemoral approach, and we cannot exclude that the use of preshaped catheters dedicated for the transradial approach[31] could contribute to a further reduction in procedure duration and X-ray exposure time.

From all of the above data, we can conclude that transradial coronary angiography can be performed with the same safety for the patient and the professional staff members as for the transfemoral approach. Moreover, improvements in catheters and X-ray systems can be expected to shorten the procedural duration and fluoroscopy time further and decrease the amount of contrast material.[29] The operator's experience plays a major role in the success rate and procedure duration.[32] Our results are obtained in an experienced center in the transradial approach, and conclusions might look different in catheter laboratory with lower experience in this approach. As for the beginner in the radial approach, it can sometimes take forever to access the radial artery compared with the experienced ones, and the fluoroscopy time can be longer because people struggle for cannulation of the coronary arteries. But, as for the femoral approach, after adequate training, the transradial approach for coronary angiography is no longer merely an alternative strategy when the femoral approach is impossible[33] and can potentially result in an increased number of outpatient procedures. Coronary angiography is furthermore, an excellent opportunity for operators to train for transradial coronary intervention.[28]

Table 2 Procedure data.

	Radial CA	Femoral CA	*P* value
Fluoroscopy time (*min.*)			
Range	1.50 – 6.80	1.30–7.50	0.215
Mean ± SD	3.43 ± 1.19	3.86 ± 1.49	
Procedure duration (*min.*)			
Range	26–39	24–43	0.170
Mean ± SD	31.87 ± 9.61	33.24 ± 10.33	
Contrast dose (*mL*)			
Range	53–93	49–115	0.030
Mean ± SD	67.63 ± 25.49	81.53 ± 24.80	

CA = coronary angiography, min. = minutes.

Conflict of interest

None declared.

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