

Right Versus Left Radial Artery Approach for Coronary Angiography. Differences Observed and the Learning Curve

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There are anatomical differences between right and left radial artery approaches for coronary catheterization that could influence application of the technique. We present the results of a randomized study that compared the effectiveness of the two approaches and identified factors associated with failure of the procedure. The study involved 351 consecutive patients: a left radial approach was used in 180, and a right radial approach, in 171. The procedure could not be completed using the initial approach selected in 15 patients (11 right radial vs 4 left radial; $P=.007$). Use of a right radial approach, lack of catheterization experience, patient age >70 years, and the absence of hypertension were found to be independently associated with prolonged fluoroscopy duration and failure using the initial approach. Use of the right radial approach in patients aged over 70 years was associated with a 6-fold increase in the risk of an adverse event. Consequently, use of the right radial approach should be avoided in patients aged over 70 years when trainee practitioners are on the learning curve.

Key words: *Angiography. Cardiac catheterization. Coronary angiography.*

Vía radial derecha o izquierda en la coronariografía. Importancia en la curva de aprendizaje

La vía radial izquierda (RI) presenta diferencias anatómicas con la vía radial derecha (RD) que podrían influir en la técnica del cateterismo coronario. Presentamos un estudio aleatorizado que trata de comparar ambas técnicas para valorar los factores relacionados con su complejidad. Se analizó a 351 pacientes consecutivos (180 RI y 171 RD); no se pudo completar el procedimiento por la vía inicial en 15 pacientes (11 RD y 4 RI; $p = 0,007$). El uso de RD, la inexperiencia, la edad mayor de 70 años y la ausencia de hipertensión arterial tienen relación independiente con un tiempo prolongado de fluoroscopia o el abandono de la vía inicial. El uso de RD en pacientes mayores de 70 años se relaciona con un riesgo de eventos 6 veces mayor, por lo que en una curva de aprendizaje se debería excluir el uso de RD esos pacientes.

Palabras clave: *Angiografía. Cateterismo cardiaco. Coronariografía.*

INTRODUCTION

The femoral artery is the access of choice for coronary angiography, although this route is limited in patients with peripheral vascular disease and those receiving anticoagulation therapy. Following the

procedure, a rest period in the decubitus position is required to avert bleeding from the puncture site. However, despite proper bed rest and careful manual compression, complications involving the femoral artery occur in 2% to 8% of cases.¹ This complication rate has not been reduced with the use of new percutaneous femoral closure systems by suture or collagen, and in some series it has increased with these measures.² These factors affect the tolerability, morbidity, length of hospital stay, and cost of the procedure; hence, alternatives to the femoral access have been sought.

The radial artery has become the primary alternative to femoral artery access because of its superficial

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TABLE 1. Characteristics of the Patients*

	Right Radial	Left Radial	P
Patients, n	171	180	NS
Men, %	71	67.4	NS
Age >70 years, %	41	45	NS
Hypertension, %	56.8	61	NS
Diabetes, %	34	33	NS
Aortic valve disease, %	5.8	6	NS
Operator (B), %	25	24	NS
Age, mean±SD	66±10	65±10	NS
Body mass index	28±4	29±4	NS

*SD indicates standard deviation; NS, non-significant.

location, easy compressibility, and low risk of ischemia in the presence of collateral circulation. Nevertheless, the success rate of this access in coronary catheterization is lower than the femoral approach, particularly when it is performed by inexperienced practitioners, making it less popular among catheterization specialists for interventional coronary procedures³ (13.1% of the interventional procedures performed in Spain). This evidence indicates the need for training programs to overcome the learning curve.⁴

The anatomic characteristics of the left radial (LR) artery access are different from those of the right radial (RR) and could influence application of the coronary catheterization technique. The origin of the right subclavian artery from a common brachiocephalic trunk is the most pronounced difference, since there is a vessel segment (innominate artery) that does not exist in the left radial approach. Atheromatous disease in this segment, which has two consecutive bifurcations, would make it more rigid and increase the difficulty of maneuvering the catheter.

The aim of this study was to determine whether use of the right radial approach is associated with more complex coronary catheterization, an increase in the duration of fluoroscopy, and procedure failure as compared with the left radial artery approach, to assess factors that are implicated in the difficulty of coronary angiography with a radial access, and to design a learning curve that will avoid complex procedures at the start of training.

METHODS

This was a prospective study carried out in a single center. Consecutive patients with a negative Allen test and radial pulse in both wrists were randomized for coronary angiography.

Variables theoretically implicated in the catheterization procedure, such as body mass index (BMI), age, sex, presence of severe aortic valve disease, and cardiovascular risk factors were recorded for

analysis with a logistic regression model. Practitioner experience was defined as A, “expert” and B, “non-expert” (fewer than 100 cases by radial access). The study was approved by the local ethics committee and patients gave informed written consent for the procedure.

A 5 French introducer was inserted with the Seldinger technique and a combination of 0.2 mg of nitroglycerin, 2 mg of verapamil, and 5000 U of heparin was infused in all cases. Coronary angiography was performed with 5 French catheters and a 0.035-inch exchange guidewire, without a specific curve design for the radial artery, and preshaped Judkin,⁵ Amplatz and multipurpose catheters. The left coronary artery was imaged in at least three views and the right coronary artery, in at least two views.

Operators were free to use the catheters they deemed appropriate, although they were initially provided with a Judkins left 3.5 curve (JL 3.5) to catheterize the left coronary. The right coronary was catheterized with the same device, or with a Judkins right 4 (JR 4.0) curve, or multipurpose catheter.

Univariate analysis was used to study the time required for angiography of the left coronary and the right coronary, starting from the moment when the introducer was inserted. The total fluoroscopy time and the total time of the procedure (from introducer insertion to completion of angiography) were also analyzed. A logistic regression model was created to determine the factors implicated in the development of incidents during the radial procedure. For this purpose, an event was defined as either a complex procedure in which the initially assigned access route could not be completed, or prolonged fluoroscopy, which was arbitrarily established as a time exceeding the last quartile of the distribution of all the fluoroscopy times. We estimated that the approach would not be completed in 5%-7% of cases and there would be an additional 25% of events due to lengthy procedures, which yielded a sample size requirement of more than 350 patients to study the predefined variables in the multivariate analysis.

RESULTS

From November 2003 to May 2004, 351 consecutive patients were randomized (171 RR and 180 LR). The assigned radial artery could not be canalized in 10 patients, and these were excluded from the analysis.

The subgroups of right and left radial artery access were well distributed for the variables studied: the proportion of type B operators was 24% for the left radial and 25% for the right radial, and the proportion of patients over 70 years old was 45% for the left radial and 41% for the right radial ($P=NS$) (Table 1).

The procedure could not be completed in 15 patients (11 RR and 4 LR; $P=.007$) mainly because of tortuosity and calcification of the subclavian artery in 11 patients (10 RR and 1 LR) and for reasons related

to the radial artery in 4 patients (calcification, 2 patients [LR], radial loop with arterial remnant, 2 patients [1 RR and 1 LR]).

Univariate analysis showed that use of the RR approach was associated with a lengthier procedure and longer total duration of fluoroscopy (4.35 min with RR vs 3.05 min with LR; $P=.0001$) (Table 2).

With regard to catheter use, there were no significant differences between the groups in the percent of patients that required more than 1 catheter. For the left coronary, more than one catheter was needed in 3.6% of cases in the LR group versus 0% in the RR group ($P=NS$). For the right coronary, more than 1 catheter was needed in 12% of the LR group versus 17% of the RR group ($P=NS$).

Among the cases treated with a radial access (336), an interventional procedure was performed following the diagnosis in 96 patients (28%), 49 LR and 47 RR ($P=NS$), with one RR procedure requiring a change of access due to arterial spasm. The intervention was deferred in 14 patients and a different access route was chosen for 5 patients, 3 RR and 2 LR ($P=NS$), on the basis of the operator's criteria.

Excessive duration of fluoroscopy was considered to be a length of time greater than the last quartile of the distribution of all the fluoroscopy times (5.10 min). Thus, 25% of the patients arbitrarily presented excessive times, and were included in the final combined analysis.

In the logistic regression model, the following variables were significant: operator experience, presence of hypertension, radial access route used, and age over 70 years, with an interaction between these last 2 factors. Use of the RR in patients over 70 was related with a 6-fold greater risk than use of the LR in patients under 70 (odds ratio [OR] =6.01; $P=.0001$) (Table 3).

Use of the RR approach was an independent variable with no link to the experience of the operator; thus, it was associated with greater complexity of the procedure and would not be resolved by simply overcoming the initial learning curve.

DISCUSSION

At the start of the analysis, the univariate model had already shown that success following insertion of the introducer differed between the two approaches, such that the access route had to be changed more frequently with the RR approach than with the LR approach. The independent nature of this effect was demonstrated in the multivariate analysis, which revealed a higher risk of prolonged procedures in patients catheterized through the RR approach.

These findings contrast with the results of Saito et al,⁶ who reported that the LR approach was associated with a larger number of procedure failures due to radial artery anatomic anomalies and left subclavian tortuosity. Wu et al⁷ and Kawashima,⁸ however, reported

TABLE 2. Fluoroscopy and Catheter Manipulation Times

Time	Right Radial, min*	Left Radial, min*	P
Left coronary	4.33 (3.33-6.30)	3.35 (2.28-4.50)	.0001
Right coronary	4.21 (3.00-6.51)	3.01 (2.45-4.03)	.0001
Total time	8.90 (6.05-12.11)	6.13 (4.68-8.24)	.0001
Total examination	4.35 (3.83-6.25)	3.05 (2.22-4.39)	.0001

*Median and interquartile range.

TABLE 3. Odds ratios (OR) of the Variables Implicated in Complex Catheterization Procedures by Radial Access

Variable	OR	P
Right radial in patients over age 70	6.01	.0001
Non-expert practitioner	2.63	.0005
Right radial	1.69	.12
Over age 70	0.90	.81
No hypertension	2.15	.038

a higher frequency of failures with the RR approach, attributable to right subclavian tortuosity, which impeded the procedure or lengthened fluoroscopy time.

Atheromatosis of the right subclavian artery would have a different influence on the procedure because this vessel arises from the innominate artery, which it shares with the right common carotid, a circumstance that does not occur with the left subclavian.

One piece of evidence supporting the hypothesis of calcification and atheromatosis of this segment is the interaction seen between the factors age over 70 years and use of the RR, which carried a 6-fold higher risk of prolongation of the procedure than age under 70 and use of the LR access route.

We believe that the finding that patients with hypertension present a lower risk of undergoing complex procedures currently has no biological explanation; thus we consider it an incidental finding that should be confirmed in other studies.

Even though this study has some limitations related to the use of arbitrary criteria to define the level of operator expertise and what constitutes a complex procedure, we conclude that the right radial approach should be avoided in patients over 70 years of age when trainee radial operators are at the beginning of the learning curve.

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