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Distal transradial access in the anatomic snuffbox: comparison with the proximal transradial access in the styloid process and the transfemoral access

Acesso transradial distal na tabaqueira anatômica: comparação com os acessos transradial proximal no processo estiloide e transfemoral

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ABSTRACT – Background: The transradial access has gained great prominence in interventional coronary procedures due to lower complication rates, especially when the radial artery is punctured distally, in the anatomical snuffbox. The objective of this study was to analyze the complication and crossover rates of the access routes in invasive coronary procedures, comparing the distal radial artery to the proximal transradial route in the styloid process and the transfemoral access. **Methods:** This was a prospective, observational, and single-center cohort study. The results of access routes were compared, using the primary outcomes of puncture site-related complications and initial arterial access crossover. **Results:** A total of 748 patients were included; in that, 152 (20.3%) in the Distal Transradial Access Group, 388 (51.9%) in the Proximal Transradial Access Group, and 208 (27.8%) in the Transfemoral Access Group. No complications were observed in the Distal Transradial Access Group, whereas two patients (0.5%) had mild local hematomas in the Proximal Transradial Access Group, and six participants (2.9%) had complications in the Transfemoral Access Group, with mild local hematomas in four patients (1.9%), a pseudoaneurysm in one (0.5%), and an active bleeding in one (0.5%) – all with no need for surgical intervention ($p=0.01$). The crossover rate was 9.2% in the Distal Transradial Access Group, 5.9% in the Proximal Transradial Access Group, and 0.9% in the Transfemoral Access Group ($p=0.001$). **Conclusion:** The distal radial artery access had a lower rate of vascular/hemorrhagic complications when compared to the proximal transradial access in the styloid process and the transfemoral access. However, the crossover rate was higher when the distal radial artery access was the operator's first choice.

Keywords: Vascular access devices; Radial artery; Cardiac catheterization; Percutaneous coronary intervention; Angioplasty

RESUMO – Introdução: A via de acesso transradial tem ganhado grande destaque em procedimentos coronários intervencionistas, devido às menores taxas de complicações, principalmente quando puncionada a artéria radial distal, na tabaqueira anatômica. O objetivo deste estudo foi analisar as taxas de complicação e de *crossover* das vias de acesso em procedimentos coronários invasivos, comparando-se a via pela artéria radial distal às vias transradial proximal no processo estiloide e transfemoral. **Métodos:** Estudo de coorte prospectivo, observacional e unicêntrico. Foram comparados os resultados das vias de acesso, utilizando-se como desfechos primários as complicações relacionadas ao sítio de punção e o *crossover* da via de acesso arterial inicial. **Resultados:** Foram incluídos 748 pacientes, sendo 152 (20,3%) no Grupo Transradial Distal, 388 (51,9%) no Grupo Transradial Proximal e 208 (27,8%) no Grupo Transfemoral. Nenhuma complicação foi observada no Grupo Transradial Distal, enquanto dois pacientes (0,5%) apresentaram hematomas locais discretos no Grupo Transradial Proximal e seis participantes (2,9%) apresentaram complicações no Grupo Transfemoral, sendo hematomas locais discretos em quatro (1,9%), pseudoaneurisma em um (0,5%) e sangramento ativo em um (0,5%) – todos sem necessidade de intervenção cirúrgica

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($p=0,01$). A taxa de *crossover* foi de 9,2% no Grupo Transradial Distal, 5,9% no Grupo Transradial Proximal e 0,9% no Grupo Transfemoral ($p=0,001$). **Conclusão:** A via de acesso pela artéria radial distal apresentou menor índice de complicações vasculares/hemorragias quando comparada às vias transradial proximal no processo estilete e transfemoral. Entretanto, a taxa de *crossover* foi maior quando a via artéria radial distal foi a primeira escolha do operador.

Descritores: Dispositivos de acesso vascular; Artéria radial; Cateterismo cardíaco; Intervenção coronária percutânea; Angioplastia

INTRODUCTION

The use of vascular access routes for performing coronary angiography (CA) and percutaneous coronary interventions (PCI) has undergone significant changes over time worldwide. Although the transfemoral access (TFA) has accompanied the evolution of interventional cardiology for a long time, the transradial access (TRA) has gained prominence in the performance of percutaneous coronary procedures since the 1990s.¹ Robust studies, such as the RIVAL² and the RIFLE-STEACS,³ have demonstrated greater safety using the TRA compared to TFA, with lower rates of bleeding complications and major adverse clinical events.¹⁻⁵

These results were so consistent that they culminated in the modification of the guidelines, which were revised to recommend the preferential use of the TRA in patients admitted for acute coronary syndrome (ACS), in centers with expertise in this vascular access.⁶⁻⁹ The 2021 *Sociedade Brasileira de Cardiologia* (SBC) guideline on unstable angina and non-ST-segment elevation myocardial infarction, on the other hand, reinforces the recommendation for the preferential use of TRA, with significant evidence in the reduction of bleeding and mortality in patients with ACS.¹⁰

Recently, the TRA punctured in its most distal portion, in the anatomical snuffbox, emerged as an attractive alternative access, since it maintains the already evident benefits of the proximal TRA (pTRA) in its conventional topography, close to the styloid process, with additional advantages, such as lower occlusion rates of the distal portion of the radial artery,^{1,11} and greater comfort for patients.^{1,12,13} Although apparently interesting, there is limited evidence regarding the potential complications of the distal TRA (dTRA). In addition, it is presumed that its technical mastery requires a longer learning curve.

The objective of this study was to analyze the complications and access crossover rates in invasive coronary procedures, comparing the dTRA to the pTRA and the TFA.

METHODS

Study design and population

This was a prospective, observational, single-center cohort study, which included patients undergoing both elective and urgent coronary procedures in interventional cardiology.

The sample consisted of consecutive patients admitted to a regional reference service, coming from home or from inpatient units of the same hospital or other hospitals, between December 2018 and January 2020. Patients aged over 18 years who underwent CA and/or PCI, presenting with acute or chronic coronary syndrome were included. Those undergoing extracardiac diagnostic or therapeutic procedures, other procedures in interventional cardiology and those performed with an initial attempt via the ulnar artery, were excluded.

Among the vascular puncture sites, the first choice/attempt for arterial access was defined by the interventional cardiologist at the beginning of the procedure. The Distal Transradial Access, the Proximal Transradial Access and the Transfemoral Access Groups were defined according to the first arterial puncture attempt by the interventional cardiologist.

In all patients, aseptic techniques, positioning the patient on the procedure table, preparation of sterile drapes, and removal of the introducer with hemostatic technique were complied with. No hemostatic devices were used to compress the dTRA and pTRA, but simple bandaging with gauze and transparent adhesive tape. For TFA, manual compression was performed in all cases, followed by bandaging for a compression dressing. We chose to use the needle of the percutaneous introducer kit, with a single puncture on the anterior wall, with no vessel transfixation, as standard technique in all accesses, both TRA and TFA. Access crossover was performed whenever necessary, with the second arterial option being chosen by the operator. After the procedures, all patients were followed up during observation or hospitalization, with at least one medical evaluation of the puncture site within one week. The patients who were not hospitalized were oriented to return to the Cath Lab to assess possible puncture site-related complications.

Analyzed variables

Clinical data, such as sex, age, hypertension (HTN), diabetes mellitus (DM), dyslipidemia, smoking, chronic renal failure (CRF), heart failure (HF), peripheral arterial obstructive disease (PAOD), previous coronary artery disease (CAD), previous PCI, previous coronary artery bypass grafting (CABG), type of procedure performed (CA alone, PCI alone, or CA followed by *ad hoc* PCI) were evaluated.

Outcomes

The primary study outcomes were any puncture site-related complications (hematoma, pseudoaneurysm, active bleeding, symptomatic arterial occlusion, distal ischemia of the punctured limb, retroperitoneal hematoma, and compartment syndrome) and crossover of initial arterial access.

Statistical analysis

Categorical variables were expressed as absolute numbers and percentages and compared using the Pearson's

Chi-square test, one-way or two-way. Continuous variables were described as mean and standard deviation. In cases of comparison between two means, the Student's *t* test and analysis of variance (Anova) were used. P-values were considered statistically significant when <0.05 .

The study was approved by the Research Ethics Committee of the organization, under number 18610619.9.0000.5065. The ethical norms in clinical research were respected in accordance with the Declaration of Helsinki and the Resolution 466/2012.

RESULTS

In the period evaluated, 785 patients consecutively underwent diagnostic and/or therapeutic invasive coronary procedures. Thirty-seven patients (4.7%) were excluded due to loss of follow-up (difficulties in contacting the patient or inability to return for face-to-face evaluation after the procedure), and 748 patients remained included in the final sample. As for vascular puncture sites, the first choice/attempt for arterial access was the dTRA in 152 (20.3%) procedures, pTRA in 388 (51.9%) procedures, and TFA in 208 (27.8%) procedures. Among the patients included, 433 (57.9%) were male, with a mean age of 64.9 ± 10.7 years. The other clinical characteristics are described in table 1.

Of the total sample, 541 procedures (72.3%) were CA, 128 (17.1%) were PCI, and 79 (10.5%) were CA followed by *ad hoc* PCI. A total of 506 patients (67.6%) were submitted to elective procedures, 161 underwent urgent/emergency procedures (21.5%), and 81 were hospitalized for causes other than ACS (10.8%). A total of 654 (87.4%) procedures were performed by the Public Health System (SUS) and 94 (12.6%) by the private health system (health insurance plans). The median time until medical contact after the procedure was 3 days.

The distribution of patients by sex and the mean age in each group are shown in table 2. As for complications related to the vascular access, no complications were observed in the Distal Transradial Access Group. In the Proximal Transradial Access Group, vascular complications occurred in two patients (0.5%), both cases were discrete local hematomas with no hemodynamic repercussions and no need for medical intervention. Six patients (2.9%) had TFA-related complications, with mild local hematomas in four of them (1.9%), no hemodynamic repercussions and no need for medical intervention, pseudoaneurysm in one (0.5%), and active bleeding in one (0.5%) – all with no need for surgical intervention ($p=0.01$). The crossover rate was 9.2% in the Distal Transradial Access Group (6.6% for pTRA and 2.6% for TFA), 5.9% in the Proximal Transradial Access Group (0.8% for dTRA and 5.1% for TFA), and 0.9% in the Transfemoral Access Group (all for the pTRA), $p=0.001$.

Table 1. Baseline clinical characteristics of participants

Clinical data	n (%)
Hypertension	589 (78.7)
Diabetes mellitus	243 (32.4)
Dyslipidemia	424 (56.7)
Smoking	72 (9.6)
Former smoker	116 (15.5)
Chronic renal failure	96 (12.8)
Peripheral arterial obstructive disease	27 (3.6)
Previous coronary artery disease	184 (24.6)
Previous percutaneous coronary intervention	128 (17.1)
Previous coronary artery bypass graft	49 (6.5)
Heart failure	134 (17.9)

Table 2. Distribution between sexes and mean age according to first choice of arterial puncture site

Group	n (%) [*]	Age (mean $\pm$ SD) [†]
Distal Transradial Access		
Male	74 (48.6)	63.0 $\pm$ 10
Female	78 (51.4)	
Proximal Transradial Access		
Male	217 (55.9)	64.3 $\pm$ 11
Female	171 (44.1)	
Transfemoral Access		
Male	144 (69.2)	67.6 $\pm$ 13
Female	64 (30.8)	

SD: standard deviation.

^{*} p-value for sex differences among groups: 0.001; [†] p-value for age difference among groups: 0.09.

DISCUSSION

In this study, the vascular complications of three different arterial accesses for CA and/or PCI in the real world were evaluated, considering the first choice by the interventional cardiologist. The prevalence of complications related to access was low, occurring mainly when TFA was chosen, in most cases consisting of hematomas with no major clinical repercussion. There were no puncture site complications related to the dTRA.

Despite the excellent safety profile demonstrated by dTRA in this series, it had the highest crossover rate (9.2%), occurring mainly for pTRA, maintaining the option for the radial access, followed by the Proximal Transradial Access Group (5.9%) and, to a lesser extent, by the Transfemoral Access Group (0.9%). This data can be explained by the need for a longer learning curve for achieving technical mastery of the dTRA, due to the smaller caliber, need for greater precision, and higher incidence of tortuosity and anatomical variation of this route.¹ However, the reason for crossover was not specifically evaluated in this study. In general, the highest crossover rate in TRA occurs mainly in

females (10.8% in women *versus* 6.3% in men).^{14,15} Regarding the TFA, there is no difference between the sexes, with crossover rates of approximately 2.0%.¹⁵ Other significant predictors of access failure and need for crossover are age over 75 years and the operator experience.¹⁶

The use of ultrasound to assist arterial puncture can increase first-time success rates and reduce the risk of complications, as well as the time devoted to this step and the crossover rate, with additional advantages over the conventional arterial puncture technique.^{17,18} However, in this study, we did not use ultrasound due to the routine unavailability of the equipment in the Cath Lab. Despite this fact, very low complication rates were observed, and most dTRA crossovers were to the pTRA.

PCI in the context of ACS, a situation in which the risk of bleeding is greater due to the widespread use of antiplatelet agents and anticoagulants, also obtained favorable results when performed via TRA.⁶⁻¹⁰ The RIVAL clinical trial, which included 7,021 ST-segment elevation and non-ST-segment elevation ACS patients showed similar efficacy results, in a comparison between TRA and TFA, regarding the combined outcome of death, acute myocardial infarction, stroke and major bleeding not related to CABG in 30 days (3.7% *versus* 4.0%; $p=0.50$), but with greater benefit in the transradial access group, to reduce major vascular complications, such as local hematomas and pseudoaneurysm requiring intervention (1.4 % *versus* 3.7%; $p<0.0001$) and major bleeding rates (1.9% *versus* 4.5%; $p<0.0001$).² In the RIFLE-STEACS study, which included 1,001 patients diagnosed as of ST-segment elevation ACS, the TRA resulted superior to TFA, with lower 30-day mortality (5.2% *versus* 9.2%; $p=0.02$), lower bleeding rate (7.8% *versus* 12.2%; $p=0.026$) and lower length of stay (4 to 7 days *versus* 5 to 8 days; $p=0.03$).³ Although the type of ACS was not specified in the study, approximately one in five patients included had a diagnosis of ACS, and the puncture site-related bleeding rates were considered very low.

These consistent findings concerning superiority of TRA were confirmed in several meta-analyses. The first meta-analysis, published in 2009, involved 21 randomized studies, with evidence of a significant reduction by roughly 73% in major bleeding rate using TRA (0.05% *versus* 2.3%; odds ratio – OR – 0.27; 95%CI 0.16-0.45; $p<0.001$).¹⁹ The second meta-analysis, published in 2016, included 17 studies and 19,328 patients with ACS, and demonstrated the use of the TRA was associated with a reduction in mortality (relative risk – RR – 0.73; 95%CI 0.60-0.88; $p=0.001$), major adverse cardiovascular events (RR 0.86; 95%CI 0.77-0.95; $p=0.005$) and major bleeding (RR 0.60; 95%CI 0.48-0.76; $p<0.001$).²⁰ Another recent meta-analysis, published in 2019, assessed TRA in the scenario of chronic total occlusions, including 10,590 patients (10,617 lesions), with a similar technical success rate of TRA as compared to TFA (78.7% *versus* 78.5%; OR 1.11; 95%CI 0.94-1.31; $p=0.24$), lower risk of complications at the puncture site (0.73% *versus* 1.79%; OR 0.34; 95%CI 0.22-0.51; $p<0.001$) and reduction of major bleeding (0.18% *versus* 0.9%; OR 0.22; 95%CI 0.10-0.45; $p<0.001$).²¹

At the beginning of the last decade, the TRA was still considered underused in many centers around the world, with a use rate of approximately 3% in the United States and 15% in Brazil.^{22,23} The TFA prevailed in percutaneous coronary procedures mainly due to the lack of expertise of the operating physician in the use of other routes. With consistent evidence for differences among the accesses, the scenario started to show changes towards greater use of TRA. In Portugal, in 2016, the use of TRA rose to approximately 75.5% of procedures (with a previous proportion of 4.1% in 2004, and 57.9% in 2013).²⁴ The local practice, documented in the present study, respects the international recommendations, which are already well consolidated, to prefer TRA whenever technically feasible, with a utilization rate higher than 70% when the dTRA and the pTRA are added (20.3% and 51.9%, respectively).

Initially used for invasive blood pressure monitoring in the 1970s and 1980s,^{25,26} the use of dTRA for coronary procedures was first reported in 2011.²⁷ Recently, significant benefits have been demonstrated with this arterial access, including high safety index, with lower rates of bleeding complications and reduction of major adverse clinical events; lower proportion of distal occlusion of radial artery (2.0% in dTRA *versus* 4.2% in pTRA); possibility of greater mobility of the punctured region right after the end of the procedure; earlier ambulation; less time spent observing the puncture site in the service, resulting in earlier hospital discharge, and a significant reduction in costs.^{1,12} The safety data observed are encouraging, especially combined with greater comfort level due to the position of the hand and the probable lower incidence of vasospasm in the dTRA puncture. However, vasospasm and comfort of dTRA reported by patients were not evaluated in this study.

The dTRA is an increasingly frequent choice in the real world, especially in centers with trained interventional cardiologists with expertise. The benefits range from greater comfort during and after the procedure to increased safety regarding the risk of bleeding in complex patients, and in those requiring anticoagulation. The progression of the learning curve tends to reduce the crossover rate, as it occurs with the pTRA. Professionals with experience in the pTRA should find it easier to master the dTRA puncture technique. Finally, the dTRA can be the route of choice in diagnostic or therapeutic coronary procedures in different scenarios. However, greater difficulty can be found in situations of shock, small-caliber radial artery, or the operator nor being familiar with radial access in general.

Although relevant, this study has limitations, such as its observational nature, mainly because the choice of access was determined by the operator. In addition, data on the side of the puncture, the caliber of the introducer, and the catheters used were not evaluated, which could influence the results, even if only slightly. The short clinical follow-up, although sufficient to assess common and immediate complications, does not allow assessing late complications. Nonetheless, feasibility and safety of dTRA in the real world, in a Brazilian center, are evident.

CONCLUSION

The distal transradial access had lower rate of vascular/hemorrhagic complications when compared to the proximal transradial and the transfemoral approaches. However, the crossover rate was higher when this was the operator's first choice.

SOURCE OF FINANCING

None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: RCS, POL, VMBR, LFMB and RRB; data collection: IAC, RCM, LRP, GFN, VAA and POL; data interpretation: RCS, RGS, OAC, LFMB and RRB; text writing: RCS and RRB; approval of the final version to be published: RCS, RGS, OAC, LFMB and RRB.

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