Contemporary analysis of the ulnar technique as an alternative arterial access in invasive coronary procedures

Análise contemporânea da técnica ulnar como acesso arterial alternativo em procedimentos coronários invasivos

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DOI: 10.31160/JOTCI201927A20190005

ABSTRACT – Background: When it is not suitable to use the radial access in invasive coronary procedures, the ulnar technique is a feasible and safe alternative. The objective of the present study was to characterize the relevance of the ulnar technique in the daily practice of a center that adopts the radial strategy as the first option. **Methods:** The sample was extracted from a single-center prospective registry, from May 2008 to October 2018, including all patients undergoing invasive coronary procedures in a large tertiary care hospital. The efficacy of the technique was determined by the need for crossover to another access route to finish the procedure. Vascular complications, such as hematoma, pseudoaneurysm, arterial occlusion, ischemic injury of the hand, compartment syndrome, arteriovenous fistula, infection, and the need for repairing vascular surgery, were evaluated at the time of hospital discharge, defining the safety outcomes. **Results:** In the analyzed period, 608 patients underwent ulnar access procedures. The mean age was 62.4 years, with a predominance of female patients (52.6%) and a high prevalence of cardiovascular risk factors. The procedures were mostly diagnostic (71.4%) and were performed by right ulnar access (86.7%). The efficacy of the technique was high (98.2%), and complications associated with the access route were infrequent, with a rate of 1.6% for asymptomatic ulnar artery occlusion, and of 3.1% for hematoma. **Conclusion:** The ulnar technique as an alternative access route is not very often used, but it is useful when the radial access is inadequate or in cases of failed radial artery cannulation.

Keywords: Ulnar artery; Radial artery; Cardiac catheterization

RESUMO – Introdução: Mediante a impossibilidade de utilização do acesso radial em procedimentos coronários invasivos, a técnica ulnar apresenta-se como alternativa factível e segura. O objetivo do presente estudo foi caracterizar sua relevância na prática diária de um centro que adota a estratégia radial como primeira opção. **Métodos:** A amostra foi extraída de um registro prospectivo unicêntrico, no período de maio de 2008 a outubro de 2018, incluindo a totalidade de pacientes submetidos a procedimentos coronários invasivos em hospital terciário de grande porte. A eficácia da técnica foi determinada pela necessidade de cruzamento da via de acesso para a conclusão do procedimento. Complicações vasculares, como hematoma, pseudoaneurisma, oclusão arterial, injúria isquêmica da mão, síndrome compartimental, fistula arteriovenosa, infecção ou necessidade de cirurgia vascular reparadora, foram avaliadas no momento da alta hospitalar, configurando os desfechos de segurança. **Resultados:** No período analisado, 608 pacientes foram submetidos a procedimentos pelo acesso ulnar. A média de idade foi de 62,4 anos, com predomínio de pacientes do sexo feminino (52,6%) e elevada prevalência de fatores de risco cardiovasculares. Os exames foram majoritariamente diagnósticos (71,4%) e efetivados pelo acesso ulnar direito (86,7%). A eficácia da técnica foi elevada (98,2%) e as complicações relacionadas à via de acesso foram infrequentes, com taxa de oclusão arterial ulnar assintomática de 1,6% e de hematomas de 3,1%. **Conclusão:** É baixa a utilização da técnica ulnar como via de acesso alternativa, mas mostra-se útil em situações nas quais a artéria radial apresenta-se inadequada à punção ou em casos de insucesso na tentativa de sua canulação.

Descritores: Artéria ulnar; Artéria radial; Cateterismo cardíaco

How to cite this article:

Andrade PB, Rinaldi FS, Bienert IR, Barbosa RA, Tebet MA, Esteves VC, et al. Contemporary analysis of the ulnar technique as an alternative arterial access in invasive coronary procedures. J Transcat Interv. 2019;27:eA20190005. <https://doi.org/10.31160/JOTCI201927A20190005>

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Received on:

Jan 13, 2019

Accepted on:

Mar 7, 2019

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INTRODUCTION

The radial technique is the preferential strategy in invasive coronary procedures, especially in acute coronary syndromes, in which it is associated with lower rates of severe bleeding, morbidity and mortality.¹ Patients with a history of failure in a previous attempt of radial catheterization, either by spasm, excessive tortuosity or inadequate support, with radial stenosis secondary to multiple procedures, or with chronic asymptomatic arterial occlusion, are common in centers that routinely adopt the radial access route.² In this context, the ulnar technique is a feasible and safe alternative, with the same benefits provided by the radial technique, especially in patients at higher risk for hemorrhagic complications, such as obese, elderly, female, anticoagulated patients or individuals undergoing an aggressive antiplatelet regimen.³

In 2008, we reported our initial experience with the first 102 procedures in 90 patients using the ulnar approach.⁴ The success rate was high — 94.5% and 100% for coronary angiography and percutaneous coronary intervention (PCI), respectively. There was a low prevalence of complications, including 2% of asymptomatic occlusion of the ulnar artery and 1% of hematoma, with no need for vascular repair or blood transfusion.

After 10 years since the adoption of the ulnar access into our routine, and after overcoming the learning and interest curve in the technical development and refinement, in this study we aimed to characterize the relevance of the ulnar technique to the daily practice of a center that uses the radial technique in more than 90% of cases, focusing on the characteristics of the procedures, its efficacy and safety.

METHODS

Population

The sample was extracted from a prospective registry, which included all patients undergoing invasive diagnostic or therapeutic coronary procedures at the hospital Santa Casa de Marília, considering the clinical, angiographic and procedural characteristics of the population. Excluding the 90 patients who participated in the index publication on the feasibility of the ulnar technique in our center, we analyzed all patients in whom this access route was used between May 2008 and October 2018.

Study procedures

After hyperextending the wrist and infiltrating 1 to 2mL of 2% xylocaine, the ulnar artery was punctured 1 to 3cm proximal to the pisiform bone, using a needle with a 20-22 gauge polyethylene catheter, by the Seldinger or modified Seldinger technique. After the puncture, a 0.021 inch guidewire was introduced, followed by a small cutaneous incision with a scalpel blade number 11, and the insertion of a short (10cm) 5 or 6F hydrophilic introducer (Terumo Corporation, Tokyo, Japan). A solution containing

5,000IU of heparin sulfate and 10mg of isosorbide mononitrate was injected through the introducer extension. At the end of procedure, the catheter was immediately removed, and hemostasis was obtained using a compressive dressing, with porous adhesive elastic bandage, in diagnostic procedures, or a selective compressor wristband, in therapeutic procedures. A clinical examination of the puncture site and an assessment of the ulnar pulse were performed at hospital discharge.

The efficacy of the technique was determined by the need for crossing over to another access route to complete the procedure. Vascular complications, such as hematoma, pseudoaneurysm, arterial occlusion, ischemic injury of the hand, compartment syndrome, arteriovenous fistula, infection, and the need for repairing vascular surgery, were evaluated at hospital discharge, defining the safety outcomes. The hematomas were graded according to the EASY (Early Discharge after Transradial Stenting of Coronary Arteries) study classification: Type I, ≤ 5 cm in diameter; type II, ≤ 10 cm in diameter; type III, > 10 cm, without reaching the elbow; type IV, hematoma extending beyond the elbow; type V, any hematoma with ischemic hand injury.⁵ Clinical adverse outcomes, including death, acute myocardial infarction (MI), and stroke were evaluated during the in-hospital period.

Statistical analysis

Absolute and relative frequencies were presented for categorical variables, and summary measures (mean and standard deviation) were presented for numerical variables. The study was approved by the organization Research Ethics Committee (CAAE: 02879518.2.0000.54130), and a Free and Informed Consent was obtained from all participants.

RESULTS

In the period from May 2008 to October 2018, a sample of 20,894 patients underwent invasive coronary procedures, of which 19,123 (91.5%) by radial access, including 113 cases by distal radial access through the anatomical snuffbox, 1,163 (5.6%) by femoral access, and 608 (2.9%) by ulnar access.

The mean age was 62.4 years, with a predominance of female patients (52.6%) and a high prevalence of risk factors, such as hypertension (84.9%), dyslipidemia (55.6%), and diabetes mellitus (39.9%). An acute coronary syndrome corresponded to 42% of indications, and 40% of sample had already undergone a previous myocardial revascularization procedure (Table 1).

The procedures were mostly diagnostic (71.4%) and were performed via right ulnar access (86.7%). Among the patients, 62% of them had a history of invasive coronary procedure via the ipsilateral upper limb, of which 17.8% were performed by ulnar access (Table 2). Figure 1 shows the main indications for the technique, prevailing the finding

of a stronger ulnar pulse at the clinical examination when compared to the radial pulse, rendering the puncture more feasible. Previous failed attempts to perform procedures by radial access, arterial spasm, or chronic radial artery occlusion

Table 1. Clinical characteristics

Variables	Patients (n=608)
Female	320 (52.6)
Age	62.4±10.9
Diabetes mellitus	243 (39.9)
Hypertension	516 (84.9)
Smoking	133 (21.9)
Dyslipidemia	338 (55.6)
Previous myocardial infarction	143 (23.5)
Previous percutaneous coronary intervention	178 (29.3)
Previous coronary artery bypass grafting	65 (10.7)
Clinical presentation	
Silent ischemia	170 (27.9)
Stable angina	183 (30.1)
NSTEMI-ACS	189 (31.1)
STEMI	66 (10.9)

Results expressed as n (%) or mean±standard deviation. NSTEMI-ACS: non-ST segment elevation acute coronary syndrome; STEMI: ST-elevation myocardial infarction.

Table 2. Characteristics of procedures

Variables	Procedures (n=608)
Right ulnar access	527 (86.7)
Type of procedure	
Coronary angiography	434 (71.4)
Coronary angiography + ad hoc PCI	49 (8.1)
PCI	125 (20.5)
Previous invasive procedure via upper limb	377 (62.0)
Previous procedure by ipsilateral ulnar access	67 (17.8)
Number of catheters used	1.9±0.8
Diameter of introducer	
5F	415 (68.2)
6F	191 (31.4)
7F	2 (0.4)
Duration of procedure, minutes	23.3±14.7
Fluoroscopy time, minutes	5.2±4.4
Crossover	11 (1.8)
Spasm	31 (5.1)
Hematoma in access route, type	
I/II	15 (2.4)
III/IV	4 (0.7)
V	0 (0)
Asymptomatic arterial occlusion	10 (1.6)

Results expressed as n (%) or mean±standard deviation. PCI: percutaneous coronary intervention

secondary to previous procedures using this approach were also criteria adopted in the selection of cases.

The efficacy of the technique was high (98.2%), and the main causes of crossover were non-progression of the guidewire after artery cannulation, ulnar spasm, excessive tortuosity, chronic ulnar artery occlusion, and inadequate support for the conclusion of the therapeutic procedure (Table 3). Access-related complications were infrequent, with a rate of 1.6% of asymptomatic ulnar artery occlusion, and a rate of 3.1% of hematomas, with only four cases extending beyond 10cm, in all therapeutic procedures. No ischemic complications, pseudoaneurysm, arteriovenous fistula or need for reconstructive vascular surgery were reported in the upper limb.

During the in-hospital time, there were one death from cardiac cause of a patient with cardiogenic shock after an anterior wall myocardial infarction, and four type 4a myocardial infarctions, among the 167 therapeutic procedures performed, totaling up a complication rate of 2.4%, and no cerebrovascular event.

Table 3. Causes of ulnar access failure

Causes of technical failure	Crossover (n=11)
No progression of guidewire after puncture	4 (36.3)
Spasm of ulnar artery	3 (27.3)
Marked brachiocephalic tortuosity	2 (18.2)
Chronic occlusion of the ulnar artery	1 (9.1)
Inappropriate support to perform percutaneous coronary intervention	1 (9.1)

Results expressed as n (%).

Figure 1. Indications for use of ulnar access.

DISCUSSION

In our series, we found that in the contemporary practice of a service that adopts radial strategy as the first vascular access option, the use of ulnar technique as an alternative access route to perform invasive coronary procedures is not frequent (approximately 3%). However, it is an effective technique, with a high success rate, and it is safe, sharing the same advantages obtained with the radial

access in reducing access-related vascular complications. It is an attractive option, especially for women, the most prevalent gender in our sample, and for patients with a reduced radial artery diameter, which accounted for 77.8% of indications for ulnar access, resulting from a stronger pulse at the clinical examination, which rendered the puncture more feasible. In fact, female gender, advanced age, short stature, previous coronary artery bypass grafting (CABG), and cardiogenic shock were among the main predictors of radial access failure,⁶ whereas severe vaso-occlusive disease, documented small diameter of the radial artery, and complex anatomy of the upper limb and the brachiocephalic trunk were contraindications to this approach.⁷

Thus, for operators experienced in the radial technique, the ulnar access is a viable alternative, which can reproduce the favorable results of the radial technique after getting past a quick learning curve.⁸ However, the ulnar technique is not the first choice in obtaining vascular access, which explains its use rate of 2.9% found in our survey. In the AURA of ARTEMIS (The Transulnar or Transradial Instead of Coronary Transfemoral Angiographies Study) clinical study, which included 902 patients randomized 1:1 to radial or ulnar access, without prior pulse assessment, the ulnar group had greater number of puncture attempts, longer arterial access time, total procedure time, and fluoroscopy time, and a significant crossover rate when compared to the radial group (32.3% vs. 5.9%; $p=0.004$).⁹ In the analysis of contemporary data, such as those reported in a meta-analysis of 6 randomized studies, involving 5,299 patients, there was no significant difference in the occurrence of major adverse cardiac events, access-related complications, artery access time, fluoroscopy time or use of contrast, confirming the efficacy and safety of the ulnar technique in current practice, based on the preliminary assessment of technical feasibility.¹⁰

In 11.7% of patients included in our register, the ulnar access was chosen due to the finding of an ipsilateral radial artery occlusion after an invasive coronary procedure (5.6%) or radial spasm while attempting an arterial cannulation (6.1%). Despite these findings, there were no documented complications such as ischemia or the need for vascular repair surgery. Similar results were reported in a sample of 476 patients undergoing coronary angiography (42%), PCI (38%), or carotid angioplasty (17%) via ulnar access, with 240 of them presenting angiographic documentation of radial artery occlusion.¹¹ No ischemic injury of the hand was identified after a 30-day follow-up, despite a ulnar occlusion rate of 3.1%. The extensive collateralization of the upper limbs arteries could justify these findings, confirming the inefficacy of assessing palmar arch permeability to predict future events after radial or ulnar access.^{12,13} Furthermore, in the SWITCH multicenter registry, the ipsilateral ulnar artery was effectively used in 85.7% of 42 patients with attempted failure of radial artery cannulation, with only one case of pseudoaneurysm of the

radial artery, corrected by extrinsic compression, and absence of ischemic complications.¹⁴

The ulnar artery is less prone to spasm, because it has a lower concentration of alpha-adrenergic receptors when compared to the radial artery.¹⁵ Both have similar diameters, but the deeper course of the ulnar artery, its contiguity with the ulnar nerve medially and the absence of bone structures, which render the hemostasis process less predictable, increase the risk of hematoma formation, with possible neural compression and sensory and/or motor dysfunction of the upper limb.¹⁶ This would be a premise to performing the ulnar puncture guided by vascular ultrasound.¹⁷ Though we have not used this feature, vascular complications were infrequent in our registry, with predominance of type I or type II hematomas, and low rates of asymptomatic artery occlusion, or the need for crossover. In a prospective analysis of 1,600 patients undergoing invasive coronary procedures via radial or ulnar access, the rate of access-related severe complications was only 0.44%, and the occurrence of pseudoaneurysm or ulnar arteriovenous fistula was 0.06%, confirming the safety of the ulnar technique as an alternative access route.¹⁸

Among the limitations of our analysis, we highlight the observational nature of the study, the small size of the sample, the lack of routine ultrasound assessment of vascular access complications, no late follow-up of patients, data from a single center registry, and procedures conducted by operators experienced in the radial technique, restricting thus, the reproducibility of the study.

CONCLUSION

The use rate of the ulnar technique as an alternative access route when performing invasive coronary procedures is low in a service that uses the radial strategy as the first choice. However, the ulnar technique is useful in situations when the radial access is inadequate, minimizing the risk of discomfort to patients, or in cases of failed radial artery cannulation, avoiding the need to crossover to the other upper limb or to a femoral access, with potential reduction in consumption of materials and time for procedure completion.

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: PBA, FSR, IRCB, AL and LAPM; data collection: PBA, FSR, IRCB, RAB, MAT,

FSMS, EFN and AL; data interpretation: PBA, VCE, SK and CZ; text writing: PBA, AL and LAPM; approval of the final version to be published: PBA, FSR, IRCB, RAB, MAT, VCE, SK, FSMS, CK, EFN, AL and LAPM.

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