

Trends in the Use of the Transradial Approach in More Than a Decade: The InCor's Experience

Carlos Vinícius Abreu do Espírito Santo, Pedro Henrique Magalhães Craveiro de Melo, Celso Kiyochi Takimura, Carlos Augusto Homem de Magalhães Campos, Pedro Eduardo Horta, André Gasparin Spadaro, Marcus Nogueira da Gama, Marco Antonio Perin, Expedito Eustáquio Ribeiro da Silva, Roberto Kalil Filho, Pedro Alves Lemos Neto

ABSTRACT

Background: The use of the radial approach for diagnostic cardiac catheterization and percutaneous coronary interventions varies among different interventional cardiology centers in the world. We describe the trends in the use of this approach over the past 14 years at a tertiary hospital. **Methods:** Consecutive coronary procedures performed from 1999 to 2013 at a single center, in patients aged ≥ 35 years were identified. Age, gender, resource provider (Public or Private Healthcare System) and the complexity of the procedure (diagnostic or therapeutic) were retrospectively analyzed. **Results:** 103,253 procedures were included. The Brazilian Public Healthcare Service (SUS – *Sistema Único de Saúde*) was the resource provider in 77% of the cases. Mean age of patients was 62.2 ± 11.3 years and 58% were male. The radial approach was used in 6,402 (6.2%) procedures, showing a significant rise over time, which was more evident when analyzed comparatively for the six timepoints of service experience: 0.2%; 0.6%; 3.1%; 2.1%; 6.9%, and 24.4% respectively ($p < 0.01$). Even larger percentages of radial approach were observed when only the procedures performed by the SUS and diagnostic cardiac catheterizations were taken into account. There were also changes in the profile of vascular access, even though smaller, in the Private Healthcare System. **Conclusions:** We demonstrated progressive changes in the profile of the use of access routes for diagnostic cardiac catheterization and percutaneous coronary interventions at a large center over time. These data are consistent with the global trend and are significantly robust, especially when the last sextile is analyzed.

DESCRIPTORS: Radial artery. Femoral artery. Cardiac catheterization. Percutaneous coronary intervention.

RESUMO

Tendências da Utilização da Via de Acesso Transradial em Mais de Uma Década: A Experiência do InCor

Introdução: A utilização da via radial para a realização de cateterismo cardíaco diagnóstico e intervenção coronária percutânea varia entre os diversos centros de hemodinâmica. Descrevemos as tendências do uso dessa via de acesso ao longo dos últimos 14 anos num serviço terciário. **Métodos:** Foram identificados procedimentos coronarianos consecutivos realizados de 1999 a 2013, em um único centro, em pacientes com idade ≥ 35 anos. Dados como idade, sexo, fonte provedora de recursos (Sistema de Saúde Público ou Saúde Suplementar/Privado) e complexidade do procedimento (diagnóstico ou terapêutico) foram retrospectivamente analisados. **Resultados:** Foram incluídos 103.253 procedimentos, dos quais o Sistema Único de Saúde (SUS) foi o provedor de recursos em 77% dos casos. A média de idades dos pacientes foi $62,2 \pm 11,3$ e 58,8% eram do sexo masculino. A via radial foi utilizada em 6.402 (6,2%) dos procedimentos, apresentando ascensão significativa ao longo do tempo, mais evidente quando analisada comparativamente nos seis períodos de experiência do serviço: 0,2%, 0,6%, 3,1%, 2,1%, 6,9% e 24,4%, respectivamente ($p < 0,01$). Percentuais ainda maiores do uso da via radial foram encontrados, restringindo-se aos procedimentos realizados pelo SUS e quando apenas os cateterismos cardíacos diagnósticos foram contabilizados. Houve também mudança no perfil da via de acesso, ainda que de menor monta, no setor de Saúde Suplementar/Privado. **Conclusões:** Demonstramos a progressiva modificação do perfil de utilização das vias de acesso para a realização de cateterismo cardíaco diagnóstico e intervenção coronária percutânea de um centro de grande porte ao longo do tempo. Esses dados são condizentes com a tendência mundial e de significativa robustez, principalmente quando analisado o último sextil.

DESCRIPTORES: Artéria radial. Artéria femoral. Cateterismo cardíaco. Intervenção coronária percutânea.

Faculdade de Medicina da Universidade de São Paulo, São Paulo, SP, Brazil.

Correspondence to: Pedro Alves Lemos Neto. Avenida Dr. Enéas Carvalho de Aguiar, 44 – Jardim Paulista – CEP: 05403-000 – São Paulo, SP, Brazil
E-mail: pedro.lemos@incor.usp.br

Received: 03/28/2014 • Accepted: 05/28/2014

The profile of the use of vascular access routes when performing diagnostic cardiac catheterization and percutaneous coronary intervention (PCI) has undergone a significant change around the world, especially in Europe, Asia, and Canada, due to the increased use of the transradial (TR) approach. Coronary procedures performed in this way are related to a decrease in the risk of vascular complications, lower hospital costs, earlier return to work activities, and, therefore, higher degree of patient satisfaction when compared to the femoral route.¹

The pioneering use of this technique is new and comes from Lucien Campeau (1989) and Ferdinand Kiemeneij (1993) who, respectively, performed the first diagnostic cardiac catheterization and the first PCI using this access route.^{2,3}

Despite the potential benefits, the use of the transradial technique has a growth rate that varies significantly between different centers, which may be affected by factors such as patients, age profile, complexity of procedures, availability of beds, and surgeons' experience. In the United States, for instance, by 2007, only 1.3% of cases were performed through TR access. Most hospitals used the TR approach in less than 10% of cases, with only seven centers performing transradial coronary interventions in more than 40% cases. More recent data from the largest U.S. registry of Interventional Cardiology, the CathPCI Registry, of the National Cardiovascular Data Registry (NCDR), showed that the femoral artery was the most widely used access route, with only 8.3% and 6.9% of diagnostic and therapeutic catheterizations performed by radial access, respectively.^{1,4}

The present study describes the trends of use of this access route during the past 14 years, in a large service linked to Brazilian Unified Health System (Sistema Único de Saúde – SUS) and the Supplementary/Private Health Care System.

METHODS

Consecutive coronary procedures performed from January 1999 to February 2013 in patients aged ≥ 35 years in a single center were identified and retrospectively analyzed. Outpatient examinations, as well as urgency and emergency procedures, were included.

In order to determine the evolution and changes in the profile of access route use, variables, such as age, gender, provider of health resources (SUS or Supplementary Health/Private Health Care Service), and complexity of the procedure (diagnostic or therapeutic examination) were retrospectively collected and analyzed.

Procedure

It has been established in the present service that, especially for the last three years (2011-2013), due to

the large number of cases and the limited availability of beds, only patients in the final stages of kidney disease, patients with scheduled right and left catheterization, and those that have undergone coronary artery bypass graft surgery (CABG) using the left mammary artery graft should preferably be screened via femoral access; however, radial access can be used, at the discretion of the surgeon in charge, taking into account the clinical characteristics of the patient. For all other procedures, the use of the TR approach was stimulated, although the choice of the approach, techniques, materials and diagnostic methods, and intervention were at the surgeon's discretion.

A further selection of patients for TR approach was performed by palpating the radial pulse, followed by an evaluation of the palmar arch patency through Allen's test (visual or oximetric identification of effective hand perfusion after the release of compression of the ulnar artery, while the radial artery remains compressed).⁵

The radial artery puncture was performed with the patient's upper limb in extension, along the body, using local anesthesia with 5 to 10 mL of 2% lidocaine and a Jelco 20G or 22G catheters. Before all radial procedures, 200-400 mg of nitroglycerin and 50 IU/kg of unfractionated heparin were administered, adding to the dose until reaching 70 to 100 IU/kg, aiming to achieve an activated clotting time between 250 and 300 seconds in cases of coronary intervention. Long Glidesheath® arterial sheaths (Terumo Medical®, Tokyo, Japan), specific for the radial artery (5-7F) were used, which are withdrawn in the intervention room without heparin reversal, followed by hemostatic dressing with the TR Band® (Terumo Medical, Tokyo, Japan) compression device, maintained for three to six hours and withdrawn according to specific protocol of the institution.^{6,7}

Data collection

Demographic and procedural characteristics were compared, which were obtained from the database of the Service of Hemodynamic and Interventional Cardiology of Instituto do Coração, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo (InCor/HCFMUSP). Additional data were obtained by chart review and telephone contact.

Statistical analysis

Data analysis was performed using the SPSS, version 19.0. All tests were performed considering bilateral hypotheses and a significance level of $\alpha = 5\%$. Categorical variables were described as frequencies and percentages and compared with the chi-squared test. Continuous variables were shown as mean \pm standard deviation.

RESULTS

During this 14-year period, a total of 103,253 procedures were recorded. SUS was the healthcare service

provider in 77% of diagnostic cardiac catheterizations and PCIs. The demographic characteristics of the patients are shown in Table 1. Median age of patients was 62.2 ± 11.3 years, and 58.8% were male.

The TR approach was used in 6,402 (6.2%) of these procedures, most of which (95.5%) were diagnostic examinations, and only 160 (2.6%) were performed using the left radial artery (Table 2). The use of this access route for both diagnostic and therapeutic purposes, however, showed a significant rise over time, more evident when divided and analyzed comparatively,

TABLE 1
Characteristics of coronary procedures

	n = 103,253
Age, years	62.2 ± 11.3
Male gender, n (%)	60,712 (58.8)
Procedures performed through SUS, n (%)	79,505 (77)
Procedures performed through Supplementary/Private Health Care Network	23,748 (23)
Vascular access, n (%)	
Femoral	63,545 (61.5)
Radial	6,402 (6.2)
Other access routes (brachial, axillary, ulnar etc.)	33,306 (32.3)

SUS, Brazilian Unified Health System.

TABLE 2
Characteristics of the transradial access route

	n = 6,402
Age, years	61.8 ± 12.3
Male gender, n (%)	3,860 (60.3)
Right radial, n (%)	6,242 (97.4)
Left radial, n (%)	160 (2.6)
Procedures according to health care service provider, n (%)	
Diagnostic catheterization through SUS	4,689 (4.5)
Diagnostic catheterization through Supplementary/Private Health Care Network	1,426 (1.4)
PCI through SUS	241 (0.2)
PCI through Supplementary/Private Health Care Network	46 (0.04)

SUS, Brazilian Unified Health System; PCI, percutaneous coronary intervention.

during six consecutive and equivalent periods of the service experience: 0.2% in the first period; 0.6% in the second; 3.1% in the third; 2.1% in the fourth; 6.9% in the fifth; and 24.4% in the last 28-month period ($p < 0.01$) (Figure 1). Even greater percentages of TR approach were found when the assessment was restricted to procedures performed by the SUS and when only the diagnostic cardiac catheterizations were recorded (respectively, 29.3% and 37.2% of examinations in the last sextile) (Figures 2 and 3).

There were also changes in the access route profile, albeit of lower magnitude, in the Supplementary Health/Private Sector: 0.05% of all procedures performed in the first two periods vs. 5.9% in the last assessment period, with statistical significance ($p < 0.01$) (Figure 2). When only diagnostic examinations paid by private healthcare providers were considered, the percentage of procedures also increased from 0.05%, in the first 56 months evaluated, to 7.1%, in the last 28 months (Figure 3).

Restricting the analysis to PCI, only 1.2% of examinations were performed via transradial approach. Of the 287 procedures performed through TR approach,

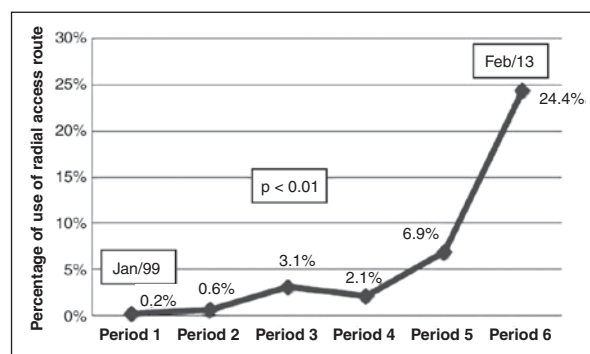


Figure 1 – General evolution of radial access use for all coronary procedures (diagnostic cardiac catheterization and percutaneous coronary intervention).

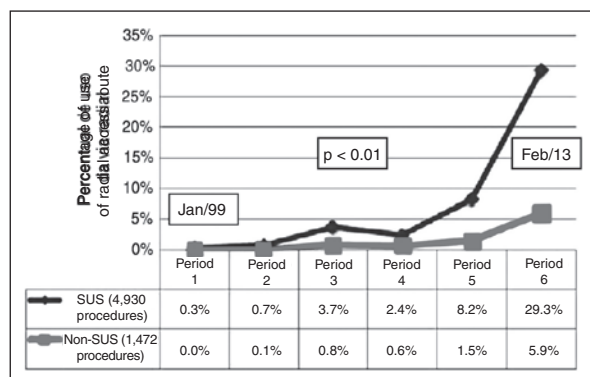


Figure 2 – Evolution of radial access use for all coronary procedures, according to the health care service provider. SUS, Brazilian Unified Health System.

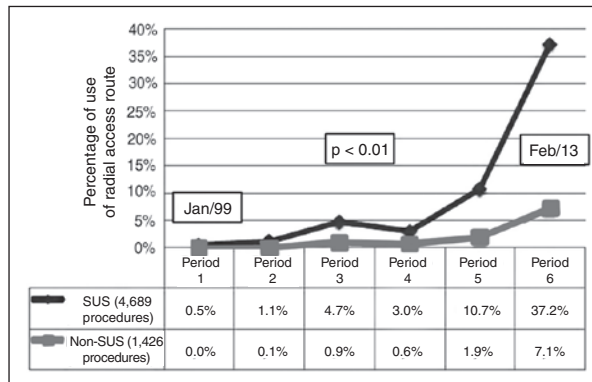


Figure 3 – Evolution of radial access use only in diagnostic coronary procedures, according to the health care service provider. SUS, Brazilian Unified Health System.

92 (32.1%) were women, with an overall mean age of 61.8 ± 12.3 years. It was also possible to identify a rapid rise throughout the assessment period, even more pronounced in the last period, when 50.8% of the interventions were performed, mostly in the SUS patients (83.9%) (Figure 4).

DISCUSSION

Although the transradial approach had been used for the past 24 years, most interventional cardiologists were first trained to use the transfemoral approach. Data from 2004 to 2007 from the NCDR showed that only 1.32% of the nearly 600,000 PCIs were performed through this access route in the United States. Conversely, in China, the choice of this approach was made in 60.23% of coronary angiograms, an increase of about 13% when compared to the year 2006.^{8,9}

This study evaluated the temporal evolution of the use of the main arterial routes of access for coronary procedures in a tertiary hospital, which includes a clientele that uses both SUS and the Supplementary/Private Health Care network, and comprehends examinations performed at outpatient and emergency levels. This research may be considered relevant through allowing comparison with world data on TR approach use, thus

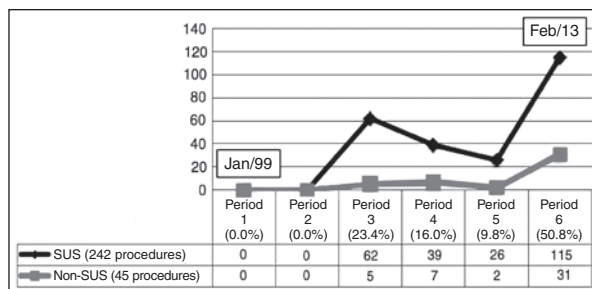


Figure 4 – Temporal evolution of radial access use in percutaneous coronary interventions, according to the health care service provider (total of 287 procedures). SUS, Brazilian Unified Health System.

creating the possibility of establishing a new paradigm for the service, aiming at reducing vascular and hemorrhagic complications, and their correlated adverse outcomes, in addition to building a training profile of interventional cardiologists familiar with the technical peculiarities related to this access route.

The main findings of this analysis were: (1) the utilization rates of TR approach showed progressive increase, reaching 40% of diagnostic tests performed by the SUS, which is comparable to European and Canadian centers that have more experience with this access route, and superior to most American centers; (2) although the patient's choice and the higher degree of post-procedure comfort are decisive factors in the choice of the TR approach, it is still underutilized in the private sector and in the Supplementary Health Care Network, probably due to the greater availability of beds in this sector, perhaps associated with the personal preference of some surgeons, due to the possibility of performing *ad hoc* procedures; (3) in relation to the demographic characteristics of the patients, this study actually observed a smaller percentage of use of the TR approach in females (39.7%) and those older than 75 years (mean age: 61.8 ± 12.3 years), which can be attributed to the greater technical complexity in these groups; (4) despite the large number of patients with end-stage chronic renal failure and undergoing CABG treated in this service, in addition to the significant number of requests for procedures that included left and right heart catheterization, which reduces the rates of use of the radial access route as preferential access, the percentage of use for this relatively new vascular access showed exponential growth in all analyzed groups (SUS and Supplementary/Private Health Care Network, diagnostic examinations and percutaneous interventions, and male and female genders).

With the refinement of the materials technology currently available in interventional cardiology, it has become possible to perform many procedures, even those which are complex, using the transradial approach. The advantages related to this access route are many: (1) lower risk of bleeding related to the access route, even with the use of aggressive adjunctive therapy.¹⁰⁻¹² For patients with acute coronary syndrome receiving combined therapy, including IIb/IIIa glycoprotein inhibitors, for instance, the risk of bleeding requiring blood transfusion is as low as nil vs. 4.4% for the transfemoral route. Even under oral anticoagulation, the safety of the TR approach has been tested, with a risk of major bleeding of 1.5%;¹³ (2) reduced costs and duration of hospitalization. The reduction in costs when compared to the more traditional access route is approximately 15%, or about US\$ 300.00, primarily related to shorter hospitalization (3.0 vs. 4.5 days in one study, and 1.5 vs. 1.8 days in another), lower frequency of necessity of blood products or revision surgery, and elimination of occlusion systems for hemostasis.^{14,15} (3) greater patient

comfort and satisfaction. In addition to eliminating the need for bed rest during the post-procedure period, which is of significant importance for patients with osteoarthritis of the spine and chronic pain, the transradial technique allows an earlier discharge of patients after both diagnostic and therapeutic examinations.¹⁶

Limitations

Due to its observational and descriptive nature, this study has significant limitations regarding the generation and confirmation of clinical hypotheses, and was conducted in a single center. It is evident, however, that there was progressive incorporation of the transradial approach to the routine of a large, traditional, tertiary service, which is in agreement with the global trend of use of this access route, associated with lower risk of vascular complications and bleeding.

CONCLUSIONS

This study demonstrated the progressive incorporation of the radial technique and the consequent modification of the profile of vascular access use in a large center over time. The data are in agreement with the global trend, and are significantly robust, especially in the last 28 months of the analysis.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING SOURCE

None.

REFERENCES

1. Dandekar VK, Vidovich MI, Shroff AR. Complications of transradial catheterization. *Cardiovasc Revasc Med.* 2012;13(1):39-50.
2. Campeau L. Percutaneous radial artery approach for coronary angiography. *Cathet Cardiovasc Diagn.* 1989;16(1):3-7.
3. Kiemeneij F, Laarman GJ. Percutaneous transradial artery approach for coronary stent implantation. *Cathet Cardiovasc Diagn.* 1993;30(2):173-8.
4. Dehmer G, Weaver D, Roe MT, Milford-Beland S, Fitzgerald S, Hermann A, et al. A Contemporary view of diagnostic cardiac catheterization and percutaneous coronary intervention in the United States. a report from the CathPCI Registry of the National Cardiovascular Data Registry, 2010 through June 2011. *J Am Coll Cardiol.* 2012;60(20):2017-31.
5. Abdelaal E, Molin P, Plourde G, Machaalany J, Bataille Y, Brousseau-Provencher C, et al. Successive transradial Access for coronary procedures: Experience of Quebec Heart-Lung Institute. *Am Heart J.* 2013;165(3):325-31.
6. Tremmel JA. Launching a successful transradial program. *J Invasive Cardiol.* 2009;21(8 Suppl A):3A-10A
7. Minami FCBR, Ferreira LM, Pereira DC, Palomo JSH, Teixeira FF, Marquesini EA. Protocolo de enfermagem para uso do dispositivo hemostático: segurança ao paciente e profissional. In: Resumos do 35º Congresso da Sociedade de Cardiologia do Estado de São Paulo; 2014 mar. 21-23; São Paulo, SP, Brasil.
8. Rao SV, Ou FS, Wang TY, Roe MT, Brindis R, Rumsfeld JS, et al. Trends in the prevalence and outcomes of radial and femoral approaches to percutaneous coronary intervention. *JACC Cardiovasc Interv.* 2008;1(4):379-86.
9. Wang L, Yang Y, Zhou Y, Xu B, Zhao L; TRI-China Collaboration Group. Prevalence of transradial coronary angiography and intervention in China: report from the transradial coronary intervention Registration Investigation in China (TRI-China). *Int J Cardiol.* 2010;145(2):246-7.
10. Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, Widimsky P, et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicenter trial. *Lancet.* 2011;377(9775):1409-20.
11. Mann T, Cubeddu G, Bowen J, Schneider JE, Arrowood M, Newman WN, et al. Stenting in acute coronary syndromes: a comparison of radial versus femoral access sites. *J Am Coll Cardiol.* 1998;32(3):572-6.
12. Kiemeneij F, Laarman GJ, Odekerken D, Slagboom T, van der Wieken R. A randomised comparison of percutaneous transluminal coronary angioplasty by the radial, brachial and femoral approaches: the access study. *J Am Coll Cardiol.* 1997;29(6):1269-75.
13. Philippe F, Larrazet F, Meziane T, Dibie A. Comparison of transradial vs. transfemoral approach in the treatment of acute myocardial infarction with primary angioplasty and abciximab. *Catheter Cardiovasc Interv.* 2004;61(1):67-73.
14. Cooper CJ, El-Shiekh RA, Cohen DJ, Blaessing L, Burket MW, Basu A, et al. Effect of transradial access on quality of life and cost of cardiac catheterization: a randomized comparison. *Am Heart J.* 1999;138(3 Pt 1):430-6.
15. Mann T, Cowper PA, Peterson ED, Cubeddu G, Bowen J, Giron L, et al. Transradial coronary stenting: comparison with femoral access closed with an arterial suture device. *Catheter Cardiovasc Interv.* 2000;49(2):150-6.
16. Ziakas A, Klinkle P, Fretz E, Mildemberger R, Williams MB, Siega AD, et al. Same-day discharge is preferred by the majority of the patients undergoing radial PCI. *J Invasive Cardiol.* 2004;16(10):562-5.