Cardiovascular Topics

Periprocedural intermittent contralateral arm ischaemia facilitates radial artery puncture and prevents radial artery spasm

Ahmet Korkmaz, Can Ozkan, Ozgul Ucar Elalmis, Umit Guray

Abstract

Background: Transradial access (TRA) is a common technique used for diagnostic and interventional cardiac procedures. However, there are some challenges and risks of complications. This study aimed to evaluate the impact of periprocedural intermittent ischaemia of the contralateral arm on TRA and radial artery spasm.

Methods: We enrolled 80 patients with an indication for coronary angiography between December 2017 and June 2018. The patients were randomly grouped into two cohorts: intermittent contralateral arm ischaemia ($n = 40$) and control ($n = 40$) groups.

Results: The radial artery puncture success ratio was higher in the intermittent contralateral arm ischaemia group than in the control group ($p = 0.025$). In multivariable logistic regression analysis, intermittent contralateral arm ischaemia was significantly associated with radial artery puncture success (hazard ratio: 8.261, 95% confidence interval: 1.427–47.823, $p = 0.018$).

Conclusion: Periprocedural intermittent contralateral arm ischaemia increased the radial intervention success due to the remote ischaemic preconditioning, vasodilator factors and autonomic nervous system role.

Keywords: intermittent arm ischaemia, radial artery puncture, radial artery spasm

Submitted
Cardiovasc J Afr 2025; 1–3 www.cvja.co.za

DOI: 10.5830/CVJA-2025-001

Transradial access (TRA) is a common technique used for diagnostic and interventional cardiac procedures. It has become the primary access for coronary interventions. Recent studies showed that TRA is related to reduced morbidity and mortality rates.[1,2]

Although TRA provides many advantages for operators, there are some challenges and risks of complications. The radial artery tends to have more spasms and occlusions than other peripheral arteries. Repetitive failed punctures could result in radial artery spasm (RAS) during the procedure or radial artery occlusion, pain and discomfort after the procedure.[3]

It is possible to prevent RAS with some precautions: injection of spasmolytic drugs, radial artery-friendly sheaths, catheters or guidewires, hand exercises, and warming and flow-mediated dilatation (FMD).[4,5] Prevention of RAS is essential for optimal cannulation and reduction of complications.

FMD, which is also used as a diagnostic tool to assess endothelial function, is a physiological response.[6] In similar physiology to FMD, the creation of temporary ischaemia in the contralateral arm could help us vasodilate the radial artery for puncture.[7] This study aimed to evaluate the impact of periprocedural intermittent ischaemia of the contralateral arm on TRA and RAS.

Methods

We enrolled 80 patients with an indication for coronary angiography between December 2017 and June 2018. Detailed baseline demographics were recorded.

The exclusion criteria were admission with an acute coronary syndrome, severe heart failure, haemodynamic instability, uncontrolled hypertension or diabetes, previous radial access-site failure, hypersensitivity to lidocaine, and coronary artery bypass surgery. The patients were randomly placed in two groups: intermittent contralateral arm ischaemia (group 1, $n = 40$) and control (group 2, $n = 40$).

All participants signed the written informed consent. The local ethics committee approved the study as per the Declaration of Helsinki.

All patients underwent radial artery ultrasound before catheterisation. The radial artery was measured using B-mode ultrasound (Mindray M7 system, Mindray Medical International Limited, Shenzhen, PRC) using a 7L4s linear probe (5–10 MHz) before the procedure. The radial artery was located, and radial artery internal diameters were measured 3–5 cm proximal to the styloid process.

Department of Cardiology, Ankara City Hospital, Ankara, Turkey
Ahmet Korkmaz, MD, drahmtkrkmz07@gmail.com
Ozgul Ucar Elalmis, MD
Umit Guray, MD

Department of Cardiology, Bursa City Hospital, Bursa, Turkey
Can Ozkan, MD

Five millilitres of 1% lidocaine were subcutaneously injected for local anaesthesia. Then, an experienced cardiologist performed radial artery puncture with a 20-gauge needle, using standard methods. All patients received unfractionated heparin and an intra-arterial spasmolytic cocktail, which included 2.5 mg diltiazem and 200 µg nitroglycerine. Diagnostic procedures and percutaneous coronary interventions (PCI) were performed using 6Fr hydrophilic sheaths.

In the intermittent ischaemia group, ischaemia was induced by inflating a 13.5-cm-wide blood pressure cuff placed around the upper part of the arm. The cuff was inflated to 200 mmHg for five minutes (ischaemia), followed by a five-minute deflation. Complete occlusion was confirmed with palpitation of the radial artery after inflation. As described in a previous study, the inflation/deflation cycle was performed three times.[7] The number of puncture attempts, success or failure of cannulation, and occurrence of RAS were recorded.

The number of radial artery puncture attempts was defined as the number of forwarding movements of the cannula to cannulate the radial artery. The study endpoint was puncture success, defined as successful puncture at the first attempt.

Statistical analysis

SPSS 21.0 for Windows (IBM SPSS Inc, Chicago, IL, USA) was used for statistical analysis. Continuous variables are expressed as means ± standard deviation and categorical variables as numbers and percentages. The Kolmogorov–Smirnov test was used to test the normality of distribution. Parametric and non-parametric continuous variables were compared using the Student's *t*-test and Mann–Whitney *U*-test. Differences between treatment groups for categorical variables were analysed using the chi-square test. Logistic regression was used for multivariate analysis of success predictors of radial artery puncture. A *p*-value less than 0.05 was accepted to indicate a statistically significant difference.

Results

Eighty patients were enrolled in the study, and 40 patients in each group were randomised to intermittent contralateral arm ischaemia (group 1) and the control group (group 2). Baseline demographic and clinical features are given in Table 1. The mean age of the participants was 61 ± 11 years and 70% were male.

Basal characteristics were similar in the two groups. There were also no significant differences in radial artery diameters before intervention between the groups [2.21 mm (2.0–2.70) for group 1 and 2.40 mm (2.1–2.7) for group 2, $p = 0.301$].

The radial artery puncture success ratio was higher in group 1 than in group 2 ($p = 0.025$) (Table 1). In multivariable logistic regression analysis, intermittent contralateral arm ischaemia was significantly associated with radial artery puncture success [hazard ratio (HR): 8.261, 95% confidence (CI): 1.427–47.823, $p = 0.018$)] (Table 2).

Discussion

This study showed that intermittent contralateral arm ischaemia improved radial artery access success with reduced puncture attempts and decreased cannulation failure.

Failure of TRA is highly variable between centres, with rates up to 10% reported in different trials.[1] Previous studies determined female gender, small radial arteries, radial artery anomaly, hypertension, diabetes mellitus, dyslipidaemia and inexperienced operator as risk factors for difficult access to the radial artery. It is reported that these factors result in radial artery spasms or occlusion.[8,9]

Many approaches are used, such as different spasmolytic drugs, subcutaneous and topical medications, various sheaths, catheters and guidewires, hand exercises and hand warming, to deal with RAS and facilitate radial artery cannulation.[4,5,10] In addition to these manipulations, our study showed that intermittent periprocedural contralateral arm ischaemia effectively increased the success of radial artery puncture and access.

Several studies aimed to develop a preventative method against RAS for the transradial approach. In one of the studies carried out for this purpose, Ying *et al.* demonstrated their

Table 1. Baseline characteristics and laboratory parameters of the study patients according to intermittent contralateral arm ischaemia

Variables	*No arm ischaemia*	*Arm ischaemia*	p-*value*
Age (years) median (min–max)	61.2 (53–65)	64.5 (58–67)	0.089
BMI (kg/m^2) (mean ± SD)	24.6 ± 4.9	25.0 ± 5.0	0.535
Creatinine (µmol/l) median (min–max)	79.58 (74.27–99.03)	90.19 (79.58–109.64)	0.069
Haemoglobin (µmol/l) (mean ± SD)	8.56 ± 1.42	8.69 ± 1.3	0.235
Radial diameter (mm) median (min–max)	2.21 (2.0–2.70)	2.40 (2.09–2.68)	0.301
Smoking, *n* (%)	17 (43)	18 (45)	1
HT, *n* (%)	20 (50)	27 (68)	0.173
HL, *n* (%)	19 (48)	13 (33)	0.254
DM, *n* (%)	8 (20)	16 (40)	0.087
CAD, *n* (%)	16 (40)	20 (50)	0.5
RAAS blocker, *n* (%)	20 (50)	26 (65)	0.215
BB, *n* (%)	26 (65)	27 (68)	1
CCB, *n* (%)	7 (18)	9 (23)	0.781
ASA, *n* (%)	27 (68)	34 (85)	0.114
P2Y12 inhibitors, *n* (%)	5 (13)	6 (15)	1
Right arm, *n* (%)	33 (83)	27 (68)	0.196
Puncture success, *n* (%)	30 (75)	38 (95)	0.025*
Number of puncture attempts			
1	30 (75)	38 (95)	0.031*
2	6 (15)	2 (5)	
3 or more	4 (10)	0 (0)	
Successful cannulation	38 (95)	40 (100)	0.152
Radial artery stenosis	6 (15)	3 (7.5)	0.288

ASA: acetyl salicylic acid, BB: beta-blocker, BMI: body mass index, CAD: coronary artery disease, CCB: calcium channel blocker, DM: diabetes mellitus, HT: hypertension, HL: hyperlipidaemia, RAAS: renin–angiotensin–aldosterone system.
*$p < 0.05$

Table 2. Multivariable logistic regression analysis of the association between radial puncture success and variables in the study patients

Variables	*Odds ratio*	*95% CI*	p-*value*
Age	0.970	0.901–1.044	0.411
Creatinine	7.467	0.206–28.346	0.270
Diabetes mellitus	0.535	0.120–2.378	0.411
Intermittent arm ischaemia	8.261	1.427–47.823	0.018*

*$p < 0.05$

success in resolving radial artery spasms during PCI by inflating the sphygmomanometer cuff for five minutes on the upper arm.[11] In another study, researchers found that prolonged occlusion FMD was used to dilate the radial artery. It was related to increased cannulation success, reduction of puncture attempts and complications.[12] Similarly, Pancholy *et al*. presented two successful cases using FMD to remove an entrapped radial sheath after PCI due to severe radial spasm after other treatment failures.[13]

FMD was established in these studies using local ischaemic preconditioning. Remote ischaemic preconditioning (RIPC) is another promising form of ischaemic preconditioning. It has a more complicated mechanism, including circulating factors such as adenosine, bradykinin and kinase pathways.[14] In this trial, we applied the RIPC by using the intermittent contralateral arm ischaemia technique and evaluated its effects on radial artery puncture.

Evaluation of RIPC was done in two previous studies. These studies showed that RIPC prevented radial artery endothelial dysfunction, and intermittent arm ischaemia induced vasodilatation of the contralateral upper limb.[7,15] RIPC is an approach that aims to provide a brief ischaemic event in one region or organ for the protection of distant tissue or organs from a sustained event of ischaemia.[15,16]

The mechanism of RIPC is not precise. However, there are several hypotheses. Humoral factors, such as adenosine, bradykinin and nitric oxide could be some of the possible mechanisms of RIPC.[17] Recent trials have shown a relationship between the autonomic nervous system and RIPC via increasing parasympathetic activity.[15,18] We believe that these mechanisms could explain our significant results.

Our study has some limitations. First, the study was designed as a single-centre study, so it had a relatively small population, and further investigation is needed. Second, even if the radial artery was evaluated before the procedure in all patients, puncture of the radial artery is routinely based on the operators' palpation. Therefore, operator bias based on experience with the transradial approach cannot be excluded completely. Third, our study did not assess the direct relationship between brachial artery dilatation and parasympathetic nerve activity stimulated by intermittent arm ischaemia.

Conclusion

Periprocedural intermittent contralateral arm ischaemia increased radial interventional success due to RIPC, vasodilatory factors and autonomic nervous system role.

References

1. 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, multicentre trial. *Lancet* 2011; **377**(9775): 1409–1420.
2. Kok MM, Weernink MG, von Birgelen C, Fens A, van der Heijden LC, van Til JA. Patient preference for radial versus femoral vascular access for elective coronary procedures: the PREVAS study. *Catheter Cardiovasc Interv* 2018; **91**(1): 17–24.
3. Costa F, van Leeuwen MA, Daemen J, Diletti R, Kauer F, van Geuns R-J, *et al*. The Rotterdam radial access research: ultrasound-based radial artery evaluation for diagnostic and therapeutic coronary procedures. *Circ Cardiovasc Interv* 2016; **9**(2): e003129.
4. Ünal S, Açar B, Yayla Ç, Balci MM, Ertem AG, Kara M, *et al*. Manual heating of the radial artery (Balbay maneuver) to facilitate radial puncture prior to transradial coronary catheterization. *Revista Portuguesa de Cardiologia (English edn)* 2017; **36**(6): 409–414.
5. Candemir B, Kumbasar D, Turhan S, Kilickap M, Ozdol C, Akyurek O, *et al*. Facilitation of radial artery cannulation by periradial subcutaneous administration of nitroglycerin. *J Vasc Interv Radiol* 2009; **20**(9): 1151–1156.
6. Quinaglia T, Matos-Souza JR, Feinstein SB, Sposito AC. Flow-mediated dilation: an evolving method. *Atherosclerosis* 2015; **241**(1): 143–144.
7. Enko K, Nakamura K, Yunoki K, Miyoshi T, Akagi S, Yoshida M, *et al*. Intermittent arm ischemia induces vasodilatation of the contralateral upper limb. *J Physiolog Sci* 2011; **61**: 507–513.
8. Kolkailah AA, Alreshq RS, Muhammed AM, Zahran ME, El-Wegoud MA, Nabhan AF. Transradial versus transfemoral approach for diagnostic coronary angiography and percutaneous coronary intervention in people with coronary artery disease. *Cochrane Database Systemat Rev* 2018(4).
9. Bernat I, Aminian A, Pancholy S, Mamas M, Gaudino M, Nolan J, *et al*. Best practices for the prevention of radial artery occlusion after transradial diagnostic angiography and intervention: an international consensus paper. *Cardiovasc Interv* 2019; **12**(22): 2235–2246.
10. Tatlı E, Yılmaztepe MA, Vural MG, Tokatlı A, Aksoy M, Ağaç MT, *et al*. Cutaneous analgesia before transradial access for coronary intervention to prevent radial artery spasm. *Perfusion* 2018; **33**(2): 110–114.
11. Ying L, Xu K, Gong X, Liu X, Fan Y, Zhao H, *et al*. Flow-mediated dilatation to relieve puncture-induced radial artery spasm: a pilot study. *Cardiol J* 2018; **25**(1): 1–6.
12. Doubell J, Kyriakakis C, Weich H, Herbst P, Pecoraro A, Moses J, *et al*. Radial artery dilatation to improve access and lower complications during coronary angiography: the RADIAL trial. *EuroIntervention* 2021; **16**(16): 1349–1355.
13. Pancholy SB, Karuparthi PR, Gulati R. A novel nonpharmacologic technique to remove entrapped radial sheath. *Catheter Cardiovasc Interv* 2015; **85**(1): E8–E35.
14. Veighey K, MacAllister RJ. Clinical applications of remote ischemic preconditioning. *Cardiol Res Prac* 2012; **2012**(1): 620681.
15. Loukogeorgakis SP, Panagiotidou AT, Broadhead MW, Donald A, Deanfield JE, MacAllister RJ. Remote ischemic preconditioning provides early and late protection against endothelial ischemia–reperfusion injury in humans: role of the autonomic nervous system. *J Am Coll Cardiol* 2005; **46**(3): 450–456.
16. Heusch G, Bøtker HE, Przyklenk K, Redington A, Yellon D. Remote ischemic conditioning. *J Am Coll Cardiol* 2015; **65**(2): 177–195.
17. Hausenloy DJ, Yellon DM. Remote ischaemic preconditioning: underlying mechanisms and clinical application. *Cardiovasc Res* 2008; **79**(3): 377–386.
18. Donato M, Buchholz B, Rodríguez M, Pérez V, Inserte J, García-Dorado D, *et al*. Role of the parasympathetic nervous system in cardioprotection by remote hindlimb ischaemic preconditioning. *Exp Physiol* 2013; **98**(2): 425–434.