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Radial Artery Occlusion Following Cardiac Catheterization by Conventional Radial Approach versus Distal Radial Approach: Incidence and Predictors

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Abstract

Purpose: In comparison to transfemoral approach, transradial access (TRA) has developed to be the conventional entry site and is quickly expanding. Radial artery occlusion (RAO) which can occur during transradial intervention, impairs radial artery (RA) to be the future access site, and prohibits the artery from being used as an arterial conduit. Aim of this research was comparing incidence and predictors of RAO among individuals receiving elective cardiac catheterization by conventional radial access vs distal radial access.

Methodology: This prospective study enrolled 120 patients from June 2022 to January 2023 (84 males, 36 females; mean age 68.5 (10.4) years with 62 patients had elective cardiac catheterization via conventional radial approach (CRA) and others via distal radial approach (DRA). Clinical follow up at 24 hours and 30 days was recorded with analysis of the incidence and predictors of RAO among all included participants.

Findings: This study reported no substantial difference among groups in terms of socio-demographic and clinical characteristics. Time to sheath insertion and Procedure time were long among patients who had Distal radial approach with statistically significant difference (P <0.01). Moreover, RAO at 24 hours and 30 days follow up was higher among patients had CRA than those had DRA with no significant difference (P >0.05). This research demonstrated that RAO incidence was significantly high among younger patients, smoker, DM and those with previous CAD. Also, time to sheath insertion and hemostasis were long in patients with RAO with statistically significant difference (P <0.05). Smoking, DM, long Procedure time and increased time to hemostasis with diminished blood supply in wrist throughout hemostasis were strong predictors for radial artery occlusion.

Recommendations: Maintaining radial patency must be done with all procedures using the radial approach. DRA may be useful to lower RAO incidence through shortening hemostasis time and sustaining radial artery flow during hemostasis. Encouraging the interventional cardiologists for more practicing about utilizing DRA was recommended due to its advantages like safety with less vascular complications.

Keywords: *RAO, TRA, hemostasis, duplex US, Cardiac catheterization.*

INTRODUCTION

Coronary angiography (CA) may be done through femoral, radial, or ulnar arteries. Femoral artery is favored as an entry site to perform it. Nevertheless, complications at vascular access site are prevalent following transfemoral approach intervention [(1)]. RA is easier to squeeze and anatomically accessible than femoral artery [(2)]. The Conventional radial approach is now regarded as the primary procedure for coronary access. The main benefits are more safety due to a decrease in serious bleeding problems and an improvement in patient comfort due to quick post-procedure mobilization [(3)].

Irrespective of clinical presentation, TRA was suggested as the preferred technique of entry for any percutaneous coronary intervention at 2015 European Society of Cardiology (ESC) recommendations regarding acute coronary syndrome therapy [(4)]. The commonest complication is RAO following TRA (7.5% incidence within first 24 hours and a decline up to 5.5% at 30 days) [(5)]. Novel vascular access option known as DRA (snuffbox route) has recently emerged for cardiac catheterization. Possible benefits of this vascular access technique include maintaining the patency of proximal section of artery with a low rate of RAO and ability to recanalize proximal RAO [(6)].

Although RAO could be with no symptoms as a result of well collateralized hand by forearm and palmar arch arterioles that avoid hand ischemia, it prevents radial artery from being used again in the future. Patent RA may be recannulated for hemodialysis among those having end-stage renal illness, intra-arterial pressure assessment, or used in coronary artery bypass graft (CABG) as a conduit [(7)]. In two recent RCTs, forearm RAO was significantly reduced following DRA in contrast to traditional TRA [(8)], having highest occurrence in the first 24 hours and about 50% of patients experiencing spontaneous recanalization at 30 days [(5)]. With growing utilization of TRA at various interventions, RAO prevention is now a critical aspect in reaching successful radial programme. Nevertheless, worldwide incidence of RAO done by skilled centers remained high, with substantial variation in RAO preventive measures [(5)].

Aim of the Study

Assessment of the prevalence and predictors for RAO among individuals having cardiac catheterization by conventional radial access vs DRA.

PATIENTS AND METHODS

This observational research was conducted from June 2022 to January 2023 at National Heart Institute, Egypt. The protocol was reviewed and authorized by Ethical Committee of GOTHI. This study included 120 individuals who had diagnostic CA or elective PCI through radial approach (conventional or distal route). Written informed consent was collected from all participants.

Inclusion Criteria

Patients who were candidate for coronary angiography had palpable arterial pulse at puncture area and positive Allen's test before intervention.

Exclusion Criteria

- Subjects with cardiogenic shock / hemodynamic instability.
- PCI for chronic total occlusion.
- Weak or impalpable arterial pulse at the puncture site.

- Severe calcification, arterial occlusion or malformation of RA by doppler ultrasound.
- Subjects having CABG history with loss of RA.
- Subjects having coagulation / kidney dysfunction.

Socio-demographic, clinical, and peri-procedural data of participants were documented and evaluated within 24 hours and 30 days follow up of RAO.

Procedure Preparation

The chief operator was free to choose between right and left radial entry. To guarantee patient's convenience, left hand was flexed toward left groin supporting underneath left forearm in event of left-side access. Operator was situated on patient's right side. With DRA, subjects were requested to grab thumb beneath 4 fingers or to grip roll of gauze or 20mL syringe. Artery was pierced with micropuncture needle after sterilization and regional anesthesia delivery. After inserting an introducer radial sheath into RA, an intra-arterial vasodilator cocktail (200 mcg nitroglycerin and 5 mg verapamil) was delivered. Nevertheless, 5000 IU of unfractioned heparin was given IV after inserting the sheath, and heparin dose (80-110 IU/kg/hour) was completed in case of PCI. Activated clotting time (ACT) control was done. After finishing the procedure, hemostasis was done through Closure devices [(9)].

Homeostasis Protocol

The closure tool was placed at the puncture site and inflated, then decompressed to the pressure level that resulted in minimum bleeding. Following that, 1-2 mL of air was supplied above bleeding level. 2 minutes of squeezing ulnar artery should be done, and deflation technique began progressively 2 hours later, till the closure device was completely removed following PCI or at 60 minutes after a diagnostic catheterization [(10)]. The physician evaluated existence of flow along RA in wrist and in puncture site by duplex ultrasound 24 hours from procedure's completion or before discharge. One month follow-up was done to verify radial artery patency, and recommended doses of oral anticoagulant were given in case of RAO.

DRA Technique

Anterior wall puncture was done with cautious needle manipulation to avoid hitting periosteum of the underlying bones, which can be uncomfortable and cause spasm. Subsequent steps were similar to traditional TRA [(10)].

Definitions

- Impalpable radial artery with no antegrade flow signal on duplex US was designated as RAO.
- Period between local anesthesia and final catheter removal was defined as procedural time.
- Pain at puncture site or in forearm after hemostasis, +/- swelling throughout hospital admission or follow-up was designated as post-procedural pain.
- A major hematoma was classified as one that was > 5 cm in diameter, whereas a minor hematoma was one that was < 5 cm in diameter.
- EASY (Early Discharge After Transradial Stenting of CA Study) criteria were used to determine puncture site hemorrhage. [(11)]

- Failure of initial effort to achieve vascular access at DRA or traditional TRA due to (refractory spasm, unreasonable pain, vessel injury, or tortuous vessels), with shift to another arterial access in the same or other limb was called crossover.
- Prolonged occlusive hemostasis is characterized as long duration of compression with flow absence during hemostasis, particularly during the last evaluation pre taking off radial band.

Statistical Analysis

SPSS 23.0 was used for data analysis. Quantitative data was shown as mean (SD) and qualitative data was given as number (%). T-Test was used for comparing 2 means, while Mann Whitney U test was employed for two-group comparison in non-parametric data. Chi-square test compared groups utilizing qualitative data, and Fisher's exact test were substituted in place of Chi-square test if anticipated value was < 5. Logistic regression analysis, including univariate and multivariate was used to overall connections across each probable risk factor and incidence of RAO, odds ratio (OR) with 95% CI were computed. The CI was set at 95%, while margin of error was adjusted to 5%. P-value was deemed significant as follow; P-value less than 0.05: significant; P-value less than 0.001: extremely significant; and P-value greater than 0.05: insignificant.

RESULTS

Table 1: Baseline socio-demographic and clinical characteristics of both groups

	Conventional radial approach (No: 62 patients)	**Distal radial approach (No: 58 patients)**	**Test value**	**P-value**
Age (years)	67.8±10.9	69.1±9.8	t:0.685	0.494
Gender (female)	19 (30.6%)	17 (29.3%)	x^2:0.024	0.877
Smoking	14 (22.6%)	15 (25.9%)	x^2:0.176	0.674
DM	18 (29.0%)	17 (29.3%)	x^2:0.001	0.971
Hypertension	29 (46.8%)	28 (48.3%)	x^2:0.027	0.870
Dyslipidemia	34 (54.8%)	30 (51.7%)	x^2:0.115	0.735
Previous CAD	42 (67.7%)	39 (67.2%)	x^2:0.003	0.954
Previous CABG	3 (4.8%)	2 (3.4%)	*FE*	0.701
PAD	7 (11.3%)	5 (8.6%)	x^2:0.241	0.624
Previous stroke	2 (3.2%)	1 (1.7%)	*FE*	0.599
A.Fib.	5 (8.1%)	4 (6.9%)	*FE*	0.804
Valvular dis.	7 (11.3%)	8 (13.8%)	x^2:0.170	0.680
S. Creatinine	0.95±0.26	0.90±0.23	t:1.113	0.268
Bl. platelet count (10xmm^3)	234±74.2	236±71.4	t:0.150	0.881
Oral anticoagulant	8 (12.9%)	10 (17.2%)	x^2:0.431	0.511
LVEF%	48.3±5.9	47.5±8.6	*t:0.597*	0.551

Using: U=Mann-Whitney test; t-Independent Sample t-test for mean±SD; x^2: Chi-square test or Fisher's Exact test for Number (%)

Table 2: Peri-procedural characteristics of both groups

	Conventional radial approach (No: 62 patients)	Distal radial approach (No: 58 patients)	Test value	P-value
Diagnostic CA only	38 (61.3%)	36 (62.1%)	x^2:0.008	0.929
PCI	24 (38.7%)	21 (36.2%)	x^2:0.079	0.778
Introducer sheath used				
- *6F*	60 (96.8%)	57 (98.3%)	x^2:0.277	0.599
- *7F*	2 (3.2%)	1 (1.7%)	*FE*	0.587
Time to sheath insertion (min.)	0.8±0.2	1.5±0.5	t:10.189	<0.001**
One puncture attempt	60 (96.8%)	54 (93.1%)	x^2:0.858	0.354
Crossover rate	3 (4.8%)	6 (10.3%)	*FE*	0.254
Procedure time (min.)	27.06±7.29	30.50±7.63	t:2.526	0.013*
Contrast vol.(ml.)	92.9±68.3	94.1±70.2	U:0.095	0.925
ACT (sec.)	249±79	247±78	U:0.139	0.890
Closure devices				
- *Compression device*	57 (91.9%)	54 (93.1%)	x^2:0.062	0.804
- *Direct rolled gauze compression*	5 (8.1%)	3 (5.2%)	*FE*	0.527
Time to hemostasis (min.)	182±94	152±89	U:1.792	0.076

Using: U=Mann-Whitney test; t-Independent Sample t-test for mean±SD; x^2: Chi-square test or Fisher's Exact test for Number (%).

Table 3: Clinical outcome of all included patients

	Conventional radial approach (No: 62 patients)	Distal radial approach (No: 58 patients)	P-value
RAO			
- *24 hrs.*	4 (6.5%)	3 (5.2%)	0.763
- *30 days*	8 (12.9%)	5 (8.6%)	0.274
Hematoma	5 (8.1%)	4 (6.9%)	0.804
Forearm pain	3 (4.8%)	2 (3.4%)	0.701
Radial artery dissection	8 (12.9%)	7 (12.1%)	0.895
Radial artery spasm	8 (12.9%)	10 (17.2%)	0.511
Bleeding			
- *EASY I*	3 (4.8%)	4 (6.9%)	0.625
- *EASY II*	2 (3.2%)	1 (1.7%)	0.599
- *EASY III*	1 (1.6%)	0 (0.0%)	0.335
- *EASY IV or V*	0 (0.0%)	0 (0.0%)	---

Using: Fisher's Exact test for Number (%); p-value >0.05 is insignificant

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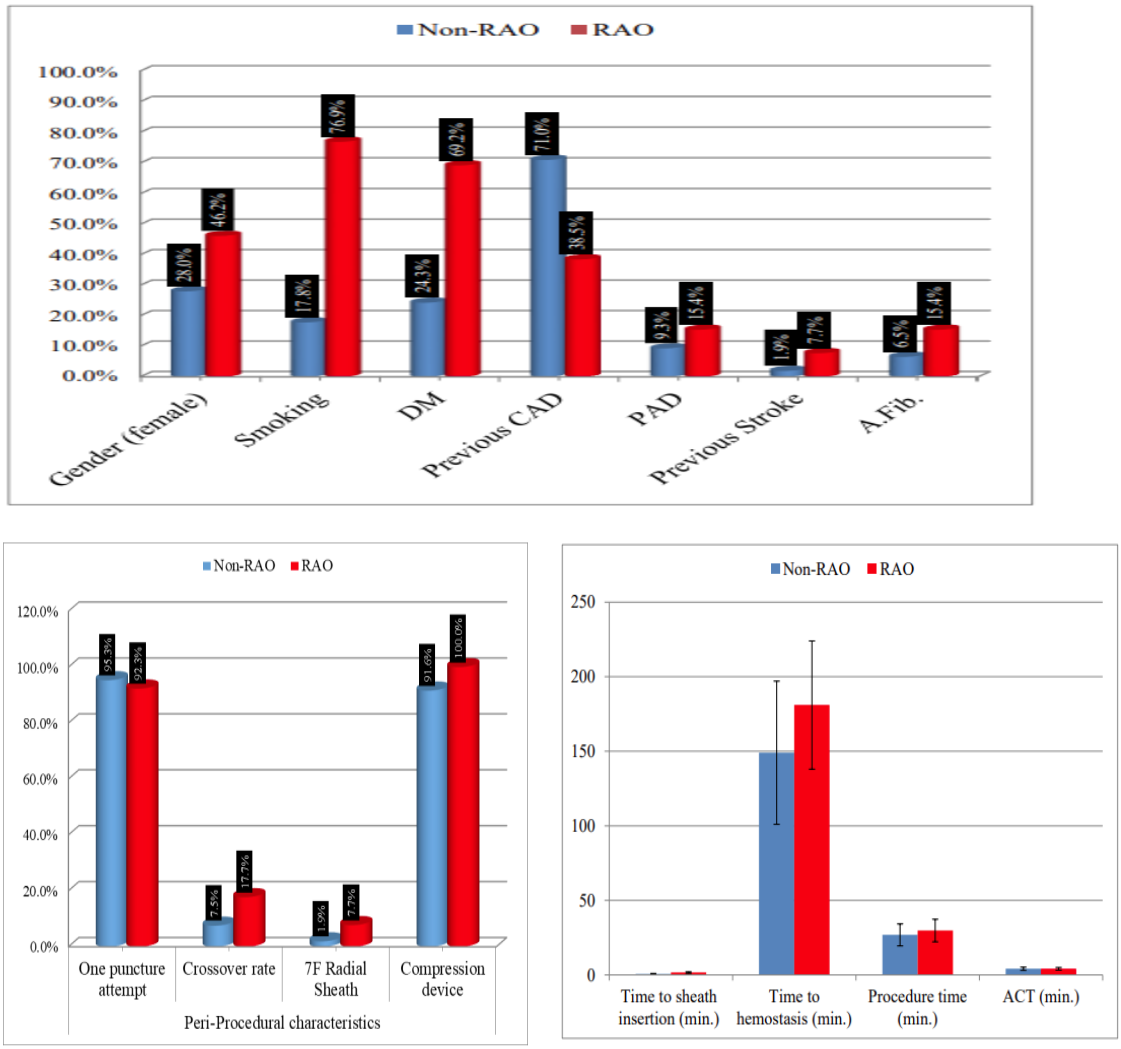

Figure 1: Characteristics of all included participants with RAO at 30 days follow-up

Table 5: Univariate regression analysis for radial artery occlusion

Factors	Univariate analysis			
	Odds ratio	95% CI		P-value
		Lower	Upper	
Age (years)	0.526	0.142	1.211	0.013*
Gender (female)	3.194	2.205	6.344	0.015*
Smoking	3.721	2.723	7.832	0.011*
DM	3.349	2.450	7.049	0.012*
Hypertension	0.392	0.104	0.972	0.821
Dyslipidemia	1.682	1.105	2.748	0.162
Previous CAD	2.313	1.481	4.188	0.038*

Previous CABG	1.198	0.880	1.848	0.440
Peripheral arterial disease	1.874	1.206	3.216	0.045*
Previous stroke	1.366	0.974	2.207	0.340
Atrial fibrillation	0.435	0.128	1.080	0.677
Valvular diseases	1.574	1.037	2.473	0.251
S. Creatinine	0.650	0.195	1.482	0.552
Blood platelet count (10xmm^3)	1.362	0.972	2.147	0.374
Oral anticoagulant	0.873	0.639	1.609	0.506
LVEF%	1.697	1.141	2.894	0.098
Diagnostic CA only	1.300	0.924	1.987	0.390
PCI	0.474	0.128	1.090	0.656
Introducer sheath used				
- *6F*	1.104	0.876	1.846	0.447
- *7F*	2.441	1.557	4.564	0.030*
Time to sheath insertion (min.)	2.398	1.516	4.411	0.034*
Multiple punctures	1.479	0.995	2.281	0.118
Crossover rate	2.702	1.706	5.177	0.027*
Procedure time (min.)	2.961	1.872	5.709	0.024*
Contrast vol.(ml.)	1.226	0.919	1.932	0.424
ACT (sec.)	2.570	1.646	4.915	0.029*
Closure devices				
- *Compression device*	0.317	0.084	0.788	0.883
- *Bandage*	0.993	0.827	1.739	0.474
Time to hemostasis (min.)	2.096	1.341	3.696	0.041*

OR: Odds ratio, CI: Confidence interval

Table 6: Multivariate regression analysis to predictors of RAO.

Factors	**Multivariate analysis**			
	Odds ratio	**95% CI**		**P-value**
		Lower	**Upper**	
Smoking	2.712	1.756	5.446	0.027*
DM	2.587	1.655	5.071	0.029*
Procedure time (min.)	2.665	1.685	5.138	0.028*
Time to hemostasis (min.)	4.134	3.025	8.702	0.006*

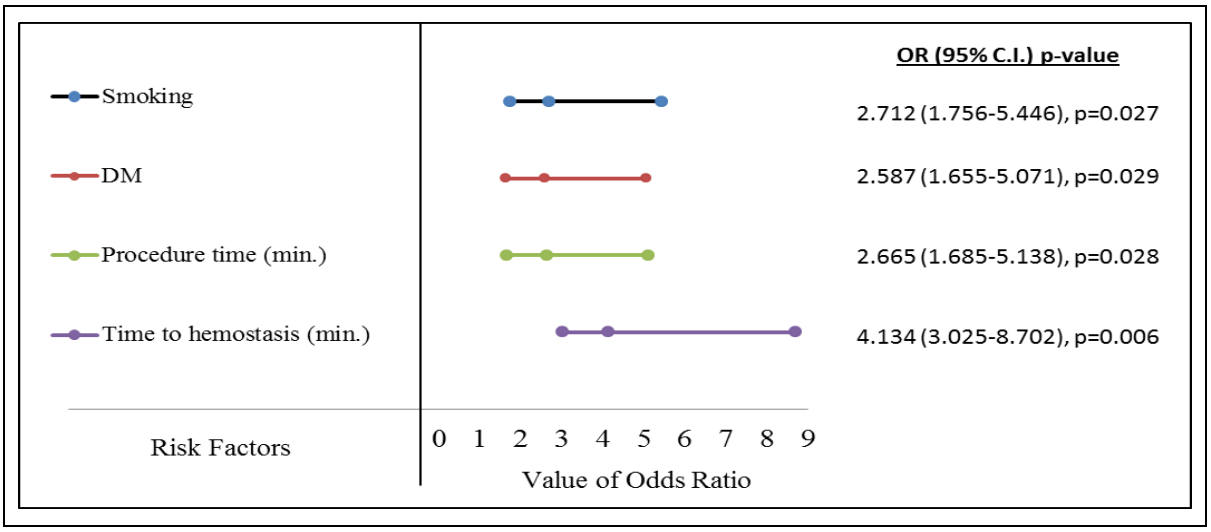

Figure 2: Odds ratio for predictors of RAO

DISCUSSION

Many factors contribute to RAO, as endothelial damage, vasospasm, and reduced or even complete stoppage of perfusion in RA may be happened during procedure [(12)]. Prolonged radial artery hypoperfusion along the procedure followed by the time needed for complete hemostasis by closure devices, leads to thrombosis. In addition, maintaining hemostasis as short as feasible has also been found to help RAO prevention. [(13)] This research included 120 subjects with radial diagnostic CA or elective PCI via CRA or DRA. The age ranged from 53-84 years with mean±SD (68.5±10.4 years old).

This prospective study demonstrated no significant difference among all patients in terms of socio-demographic and clinical characteristics (P >0.05) (Table 1). Time to sheath insertion and Procedure time were long among patients who had Distal radial approach with statistically significant difference (P <0.01) (table 2). In terms of clinical outcome among all included participants, incidence of RAO at 24 hours and 30 days follow up was higher among patients had CRA than those had DRA without significant difference (P >0.05) (table 3). This comes in agreement with Guering E, et al (2021) where he found that when compared to CRA, DRA decreased RAO incidence in proximal segment of radial artery 24 hours and 30 days following the operation [(14)].

This research showed that RAO incidence was significantly high in younger patients, smoker, DM and those with previous CAD. Also, time to sheath insertion and time to hemostasis were long in patients with RAO with statistically significant difference (P <0.05) (Figure 1). This high prevalence at a younger age may be attributed to high sympathetic reactivity, which puts people at a higher risk of vascular spasm than older people who have more atherosclerotic variations inside the arterial wall with lower sympathetic tone. In addition, ischemic pre-conditioning at elderly lead to increased arterial diameter. Active smoking is linked to vascular spasm too, which can contribute to RAO.

This study was in concordance with Adel et al (2022) where he enrolled 657 subjects having CRA, and 650 subjects having DRA. RAO incidence was high among patients had CRA (P =0.29). DRA had a greater crossover rate (3.5% vs 7.4%; P <0.001) with low average hemostasis duration (3 vs 2.55 hours; P <0.001). DRA caused higher radial artery spasm (P =0.015). Ultimately, no differences in bleeding episodes or vascular complications among

group were presented [15]. Also, our data agreed with Andrea et al (2022) who concluded that DRA led to less RAO incidence in contrast with CRA [16].

This research demonstrated that smoking, DM, long Procedure time and increased hemostasis time with diminished blood supply in wrist throughout hemostasis were strong predictors for radial artery occlusion (table 5, table 6, and figure 2). This agreed with Schlosser et al (2022) who had 2004 subjects with TRA. Radial artery patency was evaluated by doppler ultrasonography, female gender and smoking were the most powerful predictors of RAO at 30-day follow-up. [17]

CONCLUSION

After both traditional TRA and DRA, forearm RAO rate was exceptionally low, with no statistically significant difference among groups. When compared to proximal radial access, the use of DRA avoids RAO in the proximal part of radial artery at 24 h and 30 days post cardiac catheterization. So, DRA emerges as a valid alternative, safer and simpler vascular access.

RECOMMENDATIONS

Encouraging the interventional cardiologists for more practicing about utilizing DRA due to its advantages like safety with less vascular complications and short time to hemostasis.

REFERENCES

1. Sciahbasi A, Pristipino C, Ambrosio G, et al. Arterial access-site–related outcomes of patients undergoing invasive coronary procedures for acute coronary syndromes (from the ComPaRison of Early Invasive and Conservative Treatment in Patients with Non-ST-ElevatiOn Acute Coronary Syndromes [PRESTO-ACS] Vascular Substudy). Am J Cardiol. 2009; 103 (6): 796–800.
2. Cooper CJ, El-Shiekh RA, Cohen DJ, et al. Effect of transradial access on quality of life and cost of cardiac catheterization: a randomized comparison. Am Heart J. 1999; 138(3):430–436.
3. Agostoni P, Biondi-Zoccai GG, De Benedictis ML, et al. Radial versus femoral approach for percutaneous coronary diagnostic and interventional procedures: systematic overview and meta-analysis of randomized trials. J Am Coll Cardiol. 2004; 44 (2): 349-356.
4. Roffi M, Patrono C, Collet J-P, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the ESC. Eur Heart J. 2016, 37:267-315.
5. Bernat I, Aminiam A, Pancholy S, et al. Best practice for the prevention of radial artery occlusion after transradial diagnostic angiography and intervention. An international consensus paper. J Am Coll Cardiol Intv. 2019; 12:2235–46.
6. Corcos T. Distal radial access for coronary angiography and percutaneous coronary interventions: a state-of-the-art review. Catheter Cardiovasc Interv. 2019; 93:639–44.
7. Avdikos G, Karatasakis A, Tsoumeleas A, et al. Radial artery occlusion after transradial coronary catheterization. Cardiovasc Diagn Ther. 2017; 7(3):305.

8. Tsigkas G, Papageorgiou A, Moulias A, et al. Distal or traditional transradial access site for coronary procedures: a single-center, randomized study. J Am Coll Cardiol Intv. 2022; 15: 22–32.
9. Aoi S, Htun WW, Freeo S, et al. Distal transradial artery access in the anatomical snuffbox for coronary angiography as an alternative access site for faster hemostasis. Catheter Cardiovasc Interv. 2019; 94:651-657.
10. Pancholy S, Coppola J, Patel T, et al. Prevention of radial artery occlusion patent hemostasis evaluation trial (PROPHET study): a randomized comparison of traditional versus patency documented hemostasis after transradial catheterization. Catheter Cardiovasc Interv. 2008; 72:335–340.
11. Bertrand O, De Larochelliere R, RodesCabau J, et al. A randomized study comparing same-day home discharge and abciximab bolus only to overnight hospitalization and abciximab bolus and infusion after transradial coronary stent implantation. Circulation. 2006; 114:2636–2643.
12. Mamas MA, Fraser DG, Ratib K, et al. Minimizing radial injury: prevention is better than cure. Euro Intervention. 2014; 10:824-832.
13. Aminian A, Saito S, Takahashi A, et al. Impact of sheath size and hemostasis time on radial artery patency after transradial coronary angiography and intervention in Japanese and non-Japanese patients; a substudy from RAP and BEAT (radial artery patency and bleeding, efficacy, adverse evenT) randomized multicenter trial. Catheter Cardiovasc Interv. 2018; 92:844-851.
14. Guering E, Agustín R, Joaquín J, et al. Distal Radial Artery Approach to Prevent Radial Artery Occlusion Trial. J Am Coll Cardiol Intv. 2021; 14:378–85.
15. Adel A, Gregory A.S, Marcus W, et al. Distal Versus Conventional Radial Access for Coronary Angiography and Intervention the DISCO RADIAL Trial. Journal of the American College of Cardiology. 2022; 15; 1192-1201.
16. Andrea P, Antonio M, Jorge S.S, et al. Radial artery occlusion after conventional and distal radial access: Impact of preserved flow and time-to-hemostasis. Cardiovasc Interv. Catheter Cardiovasc Interv. 2022; 99:827–835.
17. Schlosser J, Herrmann L, Böhme T, et al. Incidence and predictors of radial artery occlusion following transradial coronary angiography: the proRadial trial. Clin Res Cardiol. 2022; 9:1-11.