HSPI The Open Access Publisher

JCCM JOURNAL OF CARDIOLOGY AND CARDIOVASCULAR MEDICINE
ISSN 2575-0143

Research Article

In Coronary Angiography, Transradial Versus Transfemoral Access: What Are Patients' Perspectives?

Zeynep Kumral*, Halil İbrahim Yıldırım, Yağmur Kurşun, Fatmanur Kodal and Mehmet Kış

Unye State Hospital, Ordu, Turkey

Summary

Objective: Current guidelines favour radial access (TRA) over femoral access (TFA) for percutaneous coronary interventions due to lower bleeding risks and quicker patient recovery.

This study compares patient satisfaction and complications between the two methods to identify the most suitable access route in coronary angiography (CAG).

Materials and methods: A total of 152 patients who underwent CAG between February and June 2024 at our clinic were included. The operator and patient made access site decisions. Patients were surveyed 24 hours post-procedure, and complications were tracked for one month. The primary endpoint was patient satisfaction, while complications were classified as minor and major bleeding, pseudoaneurysm, hematoma, and spasm.

Results: Of the 152 patients, 33% (n = 50) underwent TRA and 67% (n = 102) underwent TFA. Minor bleeding occurred in 16% (n = 24) and major bleeding in 0.02% (n = 3) patients. Pre-procedure anxiety, satisfaction with the access method, and awareness of TRA showed no significant differences between groups. However, post-procedure pain was higher in the TRA group (46% *vs.* 15%, $p < 0.001$), and systolic blood pressure was slightly elevated in the TRA group. Anxiety was more common in females, while elderly and obese patients showed no significant differences in bleeding or complications.

Conclusion: Despite TRA's benefits, no significant difference in satisfaction between TRA and TFA was observed. Patient preferences, radial artery spasms in females, and improved TFA techniques may influence outcomes. A shared decision-making process between operator and patient seems optimal for access site choice, with further investigation into patient satisfaction factors warranted.

More Information

***Address for correspondence:** Zeynep Kumral, MD, Unye State Hospital, Ordu, Turkey,
Email: zeynepkumral@gmail.com

https://orcid.org/0000-0003-2422-9363

Submitted: December 09, 2024
Approved: December 14, 2024
Published: December 16, 2024

How to cite this article: Kumral Z, Yıldırım HI, Kurşun Y, Kodal F, Kış M. In Coronary Angiography, Transradial Versus Transfemoral Access: What Are Patients' Perspectives? J Cardiol Cardiovasc Med. 2024; 9(3): 172-176. Available from: https://dx.doi.org/10.29328/journal.jccm.1001200

Keywords: Coronary angiography; Transradial access; Transfemoral access; Shared-decision

Abbreviations: ASA: Acetylsalicylic Acid; BMI: Body Mass Index; BP: Blood Pressure; CAG: Coronary Angiography; CCS: Chronic Coronary Syndrome; CKD: Chronic Kidney Disease; CVE: Cerebrovascular Event; DM: Diabetes Mellitus; GFR: Glomerular Filtration Rate; HT: Hypertension; KDIGO: Kidney Disease Improving Global Outcomes; LDL: Low-Density Lipoprotein; LVEF: Left Ventricular Ejection Fraction; PCI: Percutaneous Coronary Interventions; TC: Total Cholesterol; TG: Triglycerides; TFA: Transfemoral Access; TRA: Transradial Access

Introduction

For many years, the transfemoral approach (TFA) was the standard in percutaneous coronary interventions (PCI). However, the 2023 ESC Acute Coronary Syndrome and 2024 ESC Chronic Coronary Syndrome guidelines recommend the transradial approach (TRA) over the TFA with a Class IA recommendation [1,2]. The radial approach is linked with lower rates of major bleeding, reduced mortality, earlier mobilisation, shorter hospital stays, cost-effectiveness, and greater patient comfort [3,4].

However, the TRA has certain limitations, including difficult guide catheter intubation, less guide catheter support in anatomically challenging cases, a greater likelihood of transitioning to an alternative access route, and an increased risk of vascular occlusion at the access site [5]. Additionally, the learning curve and operator experience play a significant role. In routine practice, the selection of the access route is typically determined by the interventional cardiologist, taking into account clinical guidelines, personal expertise, and the patient's clinical characteristics (such as peripheral artery disease, obesity, collateral circulation, and arterial pulsation).

Moreover, in modern interventional cardiology, it is recommended to incorporate the patient's perspective and to enhance shared decision-making [5]. Previous studies comparing TRA and TFA approaches have primarily focused on comparing technical and clinical features, with patient satisfaction being evaluated in TRA-dedicated studies [6]. However, these studies were conducted in centres where most interventions were performed by experienced physicians, which may not reflect real-world data.

Therefore, our study aims to evaluate the access routes (TFA and TRA) from the patient's perspective, investigate patient satisfaction, and compare complications to identify the ideal route in daily clinical practice.

Methods

Patients

Between February 1 and June 30, 2024, a total of 152 patients who were admitted to our clinic with chronic coronary syndrome (CCS) and underwent coronary angiography (CAG) were included in the study. The decision on the access route was made jointly by the operator and the patient. The patients were categorized into two groups based on whether they underwent a radial or femoral approach. According to the standard protocol, the femoral approach used a 6/7 French sheath, while the radial approach used a 6 French sheath. After the CAG procedure, patients who underwent TFA were instructed to remain in bed for 4-6 hours, and femoral closure devices were not routinely used in the included patients. A radial artery compression device was routinely applied for patients who underwent the TRA. Bed rest was not required following the TRA procedure. The physician determined the length of hospital stay based on the procedure's duration, complications, and the patient's comorbidities.

Twenty-four hours after the CAG procedure, a questionnaire was administered by clinicians not involved in the intervention. The questionnaire is provided as supplementary information. In this survey, patients were asked to rate their anxiety and pain levels during the procedure. Patients were not routinely administered analgesics prior to or during the procedure. Similar studies have utilized the Numeric Pain Rating Scale (NPRS) to assess pain levels, and this scale was also employed to evaluate postoperative pain in this study. This 11-point numeric scale ranges from '0,' indicating one extreme of pain (e.g., "no pain"), to '10,' representing the other extreme (e.g., "pain as bad as you can imagine" or "worst pain imaginable") [7-9]. According to the scale, patients who scored 5 or higher were considered to have pain. In the evaluation of preoperative anxiety, the Amsterdam Preoperative Anxiety and Information Scale (APAIS), which has been validated for the Turkish patient population and commonly used in studies, was employed. The scale items were rated on a five-point Likert scale ranging from "not at all" (1) to "very much" (5) [10-12]. According to the scale, patients who scored 3 or higher were considered to have anxiety.

Additionally, their satisfaction with the access site, whether they would recommend the same access route to their relatives, and their awareness of the radial access route were also questioned. The patients were followed for complications over a one-month period. Complications were defined as minor bleeding (BARC 1-2), major bleeding (BARC 3-5), pseudoaneurysm, hematoma, and spasms [13].

The primary endpoint was the patients' satisfaction with the access route. The secondary endpoint was complications related to the access site.

The patients' demographic data, comorbidities, medications used at admission, left ventricular ejection fraction, pre-procedural blood pressure, heart rate, and discharge treatments were also evaluated. Subjects with a Blood Pressure (BP) of ≥ 140/90 mmHg (Stage 2 or greater) at presentation or those on regular antihypertensive medication were classified as hypertensive (HT). Patients exhibiting fasting blood glucose values of ≥ 126 mg/dL or HbA1c levels of ≥ 6.5% at presentation, or those on regular antidiabetic medication, were classified as having diabetes mellitus (DM). Patients with a glomerular filtration rate (GFR) of ≤ 60 mL/min/1.73 m^2 (Stage 3 or above) according to the Kidney Disease: Improving Global Outcomes (KDIGO) classification were considered to have chronic kidney disease (CKD). Patients with a total cholesterol (TC) level of ≥ 240 mg/dL, low-density lipoprotein (LDL) level of ≥ 160 mg/dL, or triglyceride (TG) level of ≥ 200 mg/dL, or those on regular lipid-lowering therapy, were classified as having hyperlipidemia (HL). Subjects with a history of ischemic or hemorrhagic stroke were evaluated as having experienced a cerebrovascular event (CVE).

Approval for this study was obtained from our institutional ethics committee (2023/26-12, October 25, 2023). In our study, we utilized artificial intelligence for language editing. Informed consent forms were obtained from the patients participating in the study.

Data analysis

Data analysis was conducted using SPSS version 26 (SPSS Inc., Chicago, IL). The normality of continuous variables was assessed using histograms and the Kolmogorov–Smirnov test. Continuous data were presented as median (interquartile range) and mean ± standard deviation. As appropriate, group differences were analyzed using the Chi-square test, Mann–Whitney U test, and Student's t-test. Variables with a significance level of $p < 0.1$ in these tests were incorporated into univariate Cox proportional hazards models. Hazard Ratios (HR) and 95% Confidence Intervals (CI) were calculated from univariate and multivariate Cox models. Clinically significant variables identified in the univariate analysis were included in the multivariate analysis. Potential confounding factors that could influence the analysis were excluded from the evaluation. Before this, multicollinearity was checked to avoid including highly correlated or redundant variables.

Results

The demographic, clinical, and laboratory data of the patients included in the study are presented in Table 1. In the cohort of 152 patients, the average age was 63 ± 11 years, the average weight was 83 ± 5.8 kg, the pre-procedural average heart rate was 71 ± 12 bpm, and the median Left Ventricular Ejection Fraction (LVEF) was 57% (50 - 60). Of the patients, 38% (n = 58) were female, 67% (n = 102) had HT, 40% (n = 61) had DM, 10.4% (n = 13) had HL, and 0.2% (n = 3) had CKD. Additionally, 56% (n = 86) of the patients were smokers.

Table 1: Baseline Characteristics of the Patients.

	(n:152)
TRA, n (%)	50 (32)
Patients experiencing preoperative anxiety, n (%)	45 (29.6)
Patients experiencing moderate to severe perioperative pain, n (%)	19 (12.5)
Patients experiencing postoperative pain, n (%)	39 (25.6)
Satisfaction with CAG, n (%)	146 (96)
Patients recommending CAG from the site of the procedure, n (%),	147 (97)
Awareness of TRA, n (%)	102 (67)
ASA users, n (%)	61 (40)
Clopidogrel users, n (%)	21 (13.8)
OAC users, n (%)	7 (4.6)
Patients undergoing PCI, n (%)	44 (29)
Minor bleeding, n (%)	24 (15.7)
Major bleeding, n (%)	3 (2)
Pseudoaneurysm, n(%)	4 (2.6)
Hematoma, n (%)	10 (6.5)
Spazm, n (%)	3 (2)
Age, years	63 ± 11
SBP, mmHg	125 ± 15
DBP, mmHg	74 ± 10
BMI, kg/m^2	23 (17 - 24)
LVEF, %	57 (50 - 60)
Creatine, mg/dl	0.85 (0.67 - 1)
Hemoglobin, g/dl	12.5 (10.8 - 14.2)
PLT,10^3 /UL	254 (203 - 304)

Note: ASA: Acetylsalicylic Acid; BMI: Body Mass Index; CAG: Coronary Angiography; DBP: Diastolic Blood Pressure; OAC: Oral anticoagulants; LVEF: Left Ventricular Ejection Fraction; PCI: Percutaneous Coronary Interventions; PLT: Platelet Count; SBP: Sistolic Blood Pressure; TFA: Transfemoral Access; TRA: Transradial Access.

Radial access was used in 33% (n = 50) of patients, while femoral access was used in 67% (n = 102).

During the one-month follow-up period, minor bleeding occurred in 16% (n = 24) of patients, while major bleeding was reported in 0.02% (n = 3). Additionally, 48% (n = 61) of the patients were using acetylsalicylic acid (ASA), and 13.8% (n = 21) were on clopidogrel. In 29% (n = 44) of the patients, PCI followed CAG.

When assessing patients who received radial versus femoral access, no statistically significant differences were observed between the groups concerning gender (female) (18 (36%) *vs.* 40 (39%), p = 0.7), body mass index (BMI) (24 (17-29) *vs.* 21 (17-27), p = 0.98), or antiplatelet use: ASA (15 (30%) *vs.* 46 (45%), p = 0.07), clopidogrel (3 (6%) *vs.* 18 (18%), p = 0.05). Similarly, when complications were evaluated, no differences were found in terms of minor bleeding (p = 0.37), major bleeding (p = 0.98), pseudoaneurysm (p = 0.73), or hematoma (p = 0.36).

Upon reviewing the survey results, 30% of patients reported experiencing anxiety prior to the procedure. However, no statistically significant difference was observed between the two groups (16 (32%) *vs.* 29 (28%), p = 0.65). When comparing moderate to severe pain experienced during the procedure, no difference was found between the groups (9 (18%) *vs.* 10 (9.8%), p = 0.15). Both groups had similar satisfaction with the CAG procedure based on the chosen access route (p = 0.98). However, post-procedural pain was reported more commonly in the TRA group (23 (46%) *vs.* 16 (15%), p < 0.001). SBP was also found to be higher in this group (126 ± 13 *vs.* 124 ± 16, p = 0.03) (Table 2).

Pre-procedural anxiety was more common in female patients (27 (46%) *vs.* 18 (19%), p < 0.001), but there was no substantial difference between male and female patients in terms of post-procedural pain (19 (32%) *vs.* 20 (21%), p = 0.11) (Table 3).

There was no statistically significant difference in access site selection in elderly patients (≥ 65 years) (21 (42%) *vs.* 52 (50%), p = 0.29). Similarly, when comparing radial and femoral access in elderly patients, no significant difference was observed in minor (p = 0.12) or major bleeding (p = 0.51).

In obese patients (BMI ≥ 30), no differences were found in terms of minor (p = 0.75) or major bleeding (p = 0.28), or pseudoaneurysm (p = 0.21), though obesity was more common in female patients (p = 0.03).

Table 2: Comparison of Patients Who Underwent TRA and TFA Procedures.

	Patients Undergoing TRA n:50	Patients Undergoing TFA n:102	p - value
Gender, Female, n (%)	18 (36)	40 (39)	0.70
Hypertension, n (%)	31 (62)	71 (70)	0.34
Diabetes, n (%)	19 (38)	42 (41)	0.70
Age, years	61.7 ± 12	64 ± 10	0.28
SBP, mmHg	126 ± 13	124 ± 16	0.033
DPB, mmHg	75 ± 11	73 ± 10	0.22
Heart Rate, v/dk	71 ± 10	71 ± 12	0.26
PLT, 10^3 /UL	255 ± 77	271 ± 101	0.24
BMİ, kg/m^2	24 (17 - 29)	21 (17 - 27)	0.98
LVEF, %	60 (50 - 60)	55 (45 - 60)	0.079
Creatine, mg/dl	0.85 (0.74 - 1)	0.86 (0.66 - 1)	0.72
Hemoglobin, g/dl	12.5 (11.4 - 14.4)	12.6 (10.3 - 14)	0.51
ASA users, n (%)	15 (30)	46 (45)	0.074
Clopidogrel users, n (%)	3 (6)	18 (18)	0.05
Patients experiencing preoperative anxiety, n (%)	16 (32)	29 (28.4)	0.65
Patients experiencing moderate to severe perioperative pain, n (%)	9 (18)	10 (9.8)	0.15
Patients experiencing postoperative pain, n (%)	23 (46)	16 (15.6)	<0.001
Satisfaction with CAG, n (%)	48 (96)	98 (96)	0.98
Patients recommending CAG from the site of the procedure, n (%),	48 (96)	99 (97)	0.73
Awareness of TRA, n (%)	38 (74)	64 (62)	0.10
Patients undergoing PCI, n (%)	19 (38)	25 (24.5)	0.8
Minor bleeding, n (%)	6 (12)	18 (17.6)	0.37
Major bleeding, n (%)	1 (2)	2 (1.9)	0.98
Pseudoaneurysm, n(%)	1 (2)	3 (2.9)	0.73
Hematoma, n (%)	2 (4)	8 (7.8)	0.36

Note: ASA: Acetylsalicylic Acid; BMI: Body Mass Index; CAG: Coronary Angiography; DBP: Diastolic Blood Pressure; LVEF: Left Ventricular Ejection Fraction; PCI: Percutaneous Coronary Interventions; PLT: Platelet Count; SBP: Systolic Blood Pressure; TRA: Transradial Access.

Table 3: Comparison of Patients Female and Male Patients.

	Female Patients n:58	Male Patients n:94	*p* - value
Patients experiencing preoperative anxiety, n (%)	27 (46)	18 (19)	< 0.001
Patients experiencing postoperative pain, n (%)	19 (32)	20 (21)	0.11
Awareness of TRA, n (%)	43 (74)	59 (62)	0.14
Note: TRA: Transradial Access			

Discussion

Current data and guidelines advocate for the "radial-first" approach; however, no substantial difference was observed between the TRA and TFA groups related to minor and major bleeding or other complications in our work. Due to the 30-day follow-up period in our study, mortality outcomes could not be evaluated.

In studies comparing radial and femoral access routes in patients with acute and chronic coronary syndromes, the observed reduction in mortality has been primarily linked to the decreased risk of bleeding [6,14,15]. Over the years, the preference for radial access has significantly increased, supported by various studies [16]. However, considerable inter-hospital variability remains. In the ACUITY trial, encompassing more than 10,000 patients from 600 centres across 10 countries, radial access was utilized in just 6.2% of cases [17]. This diversity can be attributed to TRA being technically demanding and necessitating a longer learning curve for operators [18,19]. Nevertheless, it is believed that TRA performed by experienced operators offers significant benefits, outweighing the disadvantages, and should be considered the primary access route [20]. The absence of significant differences in our study may be explained by the fact that our clinic is a training institution, with procedures performed by a mixed team of relatively less experienced and highly experienced physicians.

Regarding patient satisfaction, no significant difference was found between the two groups in our study. In the RIVAL trial, patients were randomly allocated to either TRA or TFA; the majority of patients in the TRA group expressed a preference for TRA post-procedure, whereas the preference between TRA and TFA was nearly evenly divided among patients in the TFA group [21]. In the PREVAS study, most preferred TFA when patients were directly asked, as more than 60% of procedures were performed via TFA. However, patients who had experienced TRA and TFA tended to choose TRA [5]. Our findings align with the PREVAS study, suggesting that personal experience may influence patient satisfaction, especially among those who have only experienced one access route.

Another surprising result in our study was the statistically significant increase in post-procedural pain in the TRA group. The elevated systolic blood pressure in the group undergoing TRA can be explained by the higher preoperative and postoperative pain observed in the radial arm, which may be attributed to spasms and procedure-related anxiety. This may be explained by the increased use of closure devices in TFA, which improves the femoral experience with proper compression. Furthermore, factors such as smaller radial arteries in women, a higher propensity for spasms, and anxiety related to TRA may contribute to higher post-procedural pain in this group [22]. The learning curve for radial access and the experience of the operator team may also have influenced these results.

No significant differences were found in access route preference or minor and major bleeding complications in elderly patients. The higher incidence of access-site crossover and site-related complications in elderly patients could account for these findings [23].

Limitations

The primary limitation of our study is that a single operator did not perform the CAG procedures; rather, it was conducted by a mixed team comprising both experienced and inexperienced members. Our study was conducted at a single centre with a small patient population. Furthermore, although the primary physician did not administer the surveys, their completion before discharge may have led to biased patient responses. Additionally, the routine non-use of closure devices in TFA procedures, the inability to reach a consensus for each patient due to comorbidities, and the short follow-up duration limited our ability to assess mortality and long-term outcomes.

Conclusion

In conclusion, although TRA is recommended as the default access route, operator experience, patients' personal preferences, and comorbidities can influence daily practice choices. A shared decision-making process regarding vascular access between the operator and the patient is the ideal approach. Considering the patients' previous experiences, explaining the challenges associated with both access routes to the patients, and informing the patient about the operator's experience with TRA in centres with mixed operators can positively influence the procedural experience. Further studies are needed to evaluate other factors that may influence the choice of access route and patient satisfaction.

Acknowledgment

This study was supported by TÜBİTAK.

References

1. Byrne R, Rossello X, Coughlan J, Barbato E, Berry C, Chieffo A, et al. 2023 ESC Guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3720-3826. Available from: https://doi.org/10.1093/eurheartj/ehad191

2. Vrints C, Andreotti F, Koskinas KC, Rossello X, Adamo M, Ainslie J, et al. 2024 ESC Guidelines for the management of chronic coronary syndromes. Eur Heart J. 2024;45(36):3415-3537. Available from: https://doi.org/10.1093/eurheartj/ehae177

3. Jolly SS, Yusuf S, Cairns J, Niemela 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. Available from: https://doi.org/10.1016/s0140-6736(11)60404-2

4. Gargiulo G, Giacoppo D, Jolly SS, Cairns J, Le May M, Bernat I, et al. Effects on mortality and major bleeding of radial versus femoral artery access for coronary angiography or percutaneous coronary intervention: Meta-analysis of individual patient data from 7 multicenter randomized clinical trials. Circulation. 2022;146(18):1403-1411. Available from: https://doi.org/10.1161/circulationaha.122.061527

5. Kok MM, von Birgelen C. Involving the patient's perspective and preferences concerning coronary angiography and percutaneous coronary intervention. EuroIntervention. 2020;15(14):e1330-1338. Available from: https://doi.org/10.4244/eijv15i14a221

6. Chiarito M, Cao D, Nicolas J, Roumeliotis A, Power D, Chandiramani R, et al. Radial versus femoral access for coronary interventions: An updated systematic review and meta-analysis of randomized trials. Catheter Cardiovasc Interv. 2021;97(7):1387-1396. Available from: https://doi.org/10.1002/ccd.29486

7. Correll D. Chapter 22 - The measurement of pain: Objectifying the subjective. In: Pain management (2nd ed.). Elsevier. 2011;191-201. Available from: http://dx.doi.org/10.1016/B978-0-7216-0334-6.50022-4

8. Tasneem S, Ilyas N. Levels of pain in patients undergoing coronary invasive procedures in trans-radial versus trans-femoral approaches: a cross-sectional study. Malaysian J Nurs. 2018;10(1):26-34. Available from: http://dx.doi.org/10.31674/mjn.2018.v10i01.004

9. Heravi MY, Mohsen S, Amini Z, Salimi P, Falahi Z, Gazerani A. Pain estimation after coronary angiography based on vital signs by using artificial neural networks. Anaesth Pain Intensive Care. 2021;25(1):45-50. Available from: https://www.apicareonline.com/index.php/apic/article/view/1433

10. Moerman N, van Dam FS, Muller MJ, Oosting H. The Amsterdam Preoperative Anxiety and Information Scale (APAIS). Anesth Analg. 1996;82(3):445-451. Available from: https://doi.org/10.1097/00000539-199603000-00002

11. Çetinkaya F, Kavuran E, Sevgi K, Aslan U. Validity and reliability of the Amsterdam Preoperative Anxiety and Information Scale in the Turkish population. Turk J Med Sci. 2019;49(1):178-183. Available from: https://doi.org/10.3906/sag-1806-84

12. Nawi MA, Mulud ZA, Mohamad N. Empowerment and Preoperative Anxiety among Patients Undergoing Cardiac Surgery: A Cross Sectional Study. Mal J Med Health Sci. 2023;19(SUPP18):28-35. Available from: https://medic.upm.edu.my/upload/dokumen/202312292116235_0634.pdf

13. Mehran R, Rao SV, Bhatt DL, Gibson M, Caxieta A, Eikelboom J, et al. Standardized bleeding definitions for cardiovascular clinical trials: A consensus report from the Bleeding Academic Research Consortium. Circulation. 2011;123:2736-2747. Available from: https://doi.org/10.1161/CIRCULATIONAHA.110.009449

14. Di Santo P, Simard T, Wells G, Jung R, Ramirez P, Poland F, Marbach J, et al. Transradial Versus Transfemoral Access for Percutaneous Coronary Intervention in ST-Segment–Elevation Myocardial Infarction: A Systematic Review and Meta-Analysis. Circulation: Cardiovascular Interventions. 2021;14(3). Available from: https://doi.org/10.1161/circinterventions.120.009994

15. Jahic A, Mujanovic E, Bajric M, Mirsic D, Hasukic I. Comparative Analysis of Transradial and Transfemoral Arterial Approach When Performing Diagnostic Coronary Angiography. Med Arch. 2023;77(2):112-117. Available from: https://doi.org/10.5455/medarh.2023.77.112-117

16. Monteiro A, Cappuzzo M, Aguirre O, Vakharia K, Levy R, Waqas M, et al. Transradial versus Transfemoral Approach for Neuroendovascular Procedures: A Survey of Patient Preferences and Perspectives. World Neurosurg. 2022;163:e623-e627. Available from: https://doi.org/10.1016/j.wneu.2022.04.043

17. Hamon M, Rasmussen LH, Manoukian SV, Cequier A, Lincoff M, Rupprecht HJ, et al. Choice of arterial access site and outcomes in patients with acute coronary syndromes managed with an early invasive strategy: The ACUITY trial. EuroIntervention. 2009;5:115-120. Available from: https://doi.org/10.4244/eijv5i1a18

18. Valgimigli M, Gagnor A, Calabró P, Frigoli E, Leonardi S, Zaro T, et al. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: A randomised multicentre trial. Lancet. 2015;385:2465-2476. Available from: https://doi.org/10.1016/s0140-6736(15)60292-6

19. Changal K, Syed MA, Atari E, Nazir S, Saleem S, Gul S, Salman FNU, Inayat A, Eltahawy E. Transradial versus transfemoral access for cardiac catheterization: A nationwide pilot study of training preferences and expertise in The United States. BMC Cardiovasc Disord. 2021;21(1):250. Available from: https://doi.org/10.1186/s12872-021-02068-5

20. Bertrand OF, Rao SV, Pancholy S, Jolly SS, Rodes-Cabau J, Larose E, et al. Transradial approach for coronary angiography and interventions: Results of the first international transradial practice survey. J Am Coll Cardiol Intv. 2010;3:1022-1031. Available from: https://doi.org/10.1016/j.jcin.2010.07.013

21. Jolly SS, Amlani S, Hamon M, Yusuf S, Mehta SR. Radial versus femoral access for coronary angiography or intervention and the impact on major bleeding and ischemic events: A systematic review and meta-analysis of randomized trials. Am Heart J. 2009;157:132-140. Available from: https://doi.org/10.1016/j.ahj.2008.08.023

22. Stehli J, Duffy SJ, Koh Y, Martin C, Brenna A, Dinh DT, et al. Sex Differences in Radial Access for Percutaneous Coronary Intervention in Acute Coronary Syndrome Are Independent of Body Size. Heart Lung Circ. 2021;30(1):108-114. Available from: https://doi.org/10.1016/j.hlc.2020.06.023

23. Cantor WJ, Mehta S, Yuan F, Dzavik V, Worthley M, Niemela K, et al. Radial versus femoral access for elderly patients with acute coronary syndrome undergoing coronary angiography and intervention: Insights from the RIVAL trial. Am Heart J. 2015;170(5):880-6. Available from: https://doi.org/10.1016/j.ahj.2015.08.011