ORIGINAL ARTICLE

Comparison Between Transradial Versus Transfemoral Arterial Approach for Cerebral Angiography

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ABSTRACT
Background: *Catheterized cerebral angiography has long been recognized as a reliable and precise method for assessing the vascular system. The transfemoral and transradial approaches are two well-established methods for this procedure.* ***Objective:*** *The aim of the study is to compare between transradial and transfemoral approach for cerebral angiography.* ***Methods & Materials:*** *This quasi-experimental study was conducted over a one and half year period. A total of 50 patients participated, with 25 undergoing the transradial approach and 25 undergoing the transfemoral approach. Secondary outcomes included Cross-over, access site complications and duration of hospital stay.* ***Results:*** *The mean age was 36.7 ± 14.3 years in TRA and 34.0 ± 7.44 years in TFA (p= 0.403), with no significant difference in sex distribution (p = 0.571). Successful catheterization rates were high for most supra-aortic and branch vessels, except for the left subclavian artery (60.0% in TRA vs. 100.0% in TFA, p < 0.001) and the left vertebral artery (44.0% in TRA vs. 92.0% in TFA, p < 0.001), where TFA had a significant advantage. TRA was associated with a significantly shorter hospital stay (7.64 ± 0.99 hours vs. 19.64 ± 4.46 hours, p < 0.001). Pain was significantly higher in the TFA group (80.0%) compared to the TRA group (48.0%, p = 0.018).* ***Conclusions:*** *This study compared the Transradial and Transfemoral approaches for cerebral angiography, finding that both techniques achieved high success rates. The transradial approach was associated with fewer access site complications, shorter hospital stays, and improved patient recovery.*

Keywords: *Transradial approach, Transfemoral approach, Cerebral angiography, Access site complications, Fluoroscopic time*

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INTRODUCTION

Cerebral angiography is a diagnostic medical imaging technique employed to visualize the vascular structures within the brain [1]. The primary purpose of this diagnostic tool is to assess and identify a range of disorders in the cerebral blood arteries, such as aneurysms, arteriovenous malformations (AVMs), stenosis, and other vascular anomalies [2]. With the advancements in cerebrovascular imaging techniques, such as magnetic resonance (MR) angiography and three- dimensional CT angiography, have generated heightened attention towards cerebrovascular illness [3]. Nevertheless, cerebral catheter angiography continues to be widely regarded as the most reliable and accurate technique for evaluating the vascular system of individuals afflicted with cerebrovascular disorders. The selection of the right femoral artery as the primary vascular access for conducting cerebral angiography is commonly preferred due to the clinicians' experience with this approach and its convenient nature. The procedure exhibits a shallow learning curve and is capable of accommodating catheters with considerable diameters [4]. Transfemoral approach (TFA) exhibits several limitations. A considerable number of individuals experience hematomas or bruises in the inguinal region. Moreover, the occurrence of pseudoaneurysms or arteriovenous fistulae at the puncture site is infrequent but possible. Extended periods of postoperative compression and 24- hour bed rest are associated with potential complications in the groin area, including ecchymosis and hematoma [5]. The brachial or axillary artery may serve as alternative access routes; nevertheless, it is widely acknowledged that the incidence of puncture-related complications is higher for both of these arteries [6]. The transradial approach (TRA) has been used for angiography since 1989 [7]. Initially, the application of this technique was mostly explored within the domain of coronary angiography and intervention. Numerous studies have since documented the advantageous outcomes it offers to patients, including enhanced comfort and cost-effectiveness [8]. Anticipated advantages were also projected for the utilization of this methodology in cerebral angiography. The adoption of a radial-first technique has been driven by its association with reduced bleeding and vascular problems, as well as increased patient safety and satisfaction, compared to the standard transfemoral approach [9]. The puncture site of radial artery cerebrovascular angiography is located superficially, making it easily compressible following sheath extraction. Additionally, it is less prone to the formation of subcutaneous hematoma [10]. Absence of important nerve and vein in close proximity to radial artery, means less cause of injury to important structures. Additionally, patients don't have to remain bedridden for prolong time following a surgical procedure [11]. The advantages associated with the transradial technique for neuroendovascular treatments have sparked considerable interest, leading to its adoption. Retrospective data have documented promising outcomes through the trans-radial approach. However, the trans-radial approach owed a long learning curve, prolonged access time, more chance of vaso-spasm, cross-over rate, and sometimes occlusion of the radial artery [12].

METHODS & MATERIALS

This quasi-experimental study was carried out to identify and compare the post-procedural outcomes of the transradial versus transfemoral approach for cerebral angiography. The study was conducted at from December 2023 to May 2025 (18 months) the Department of Neurosurgery, Dhaka Medical College Hospital. The total sample was 50. Among them, 25 patients were selected for the transradial approach and 25 patients were selected for the transfemoral approach.

Inclusion Criteria

- Adult (≥18 years) patients of both sexes
- Procedure performed by experienced endo-vascular neurosurgeon
- Patient/Patient's legal guardian willing to give informed written consent for the study

Exclusion Criteria

- Contraindications of femoral approach: occlusive aortofemoral disease, traumatic aortic injury, groin injury, local lesion to the site, etc
- Contraindications of radial access: presence of radial line, upper extremity lymphedema, trauma, arteriovenous fistula, occluded radial artery, active Raynaud's disease, etc
- Reasonable pre-angiogram likelihood of performing an endovascular intervention during the procedure

Study Procedure

Before initiating the study, formal ethical approval was obtained from the Institutional Review Board (IRB) of Dhaka Medical College (DMC). Participants were divided into two groups: Group A (transradial approach) and Control Group B (transfemoral approach). Participants meeting the prerequisites and without contraindications were enrolled in either Group A or Group B using a purposive sampling method. Unsuccessful attempts with one approach were crossed over to the other group. Patients in both groups received standard pre-operative, intra-operative, and post-operative care in accordance with treatment protocols. Patient history, including clinical features, baseline parameters, past medical history, comorbidities, and findings from physical examinations and laboratory analyses, was collected as per standard protocols. Infective screening were performed following cath-lab protocols.

Data Collection

A semi-structured and pre-tested questionnaire was used to collect relevant information through history taking, focusing on clinical features. The success rate and total fluoro time were identified as the primary outcomes of the study. Secondary outcomes included cross-over, access site complications, and duration of the hospital stay. All collected information was securely stored in separate data record forms. After verifying the accuracy and completeness of the data, analysis was performed using SPSS version 26.0 (IBM, Inc, NY, USA).

Statistical Analysis

After data collection, the information was inputted into a database. The collected data were assessed for completeness, accuracy, and consistency prior to analysis. Data analysis was conducted using SPSS version 26.0. Continuous variables were summarized using means and standard deviations for normally distributed data or medians and ranges for non-normally distributed data. Categorical variables were summarized using frequency distributions. Differences between findings in the two groups were determined by calculating p-values using T-tests for continuous variables and Chi-square tests for categorical variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study included 50 patients who underwent cerebral angiography, with 25 assigned to the transradial group (Group A) and 25 to the transfemoral group (Group B).

Table I shows that the age distribution between the transradial (TRA) and transfemoral (TFA) groups was similar, with no statistically significant difference (p = 0.403). The mean age in the TRA group was 36.7 ± 14.3 years (range: 18–60 years), while in the TFA group, it was 34.0 ± 7.44 years (range: 19–52 years). The highest proportion of patients in the TRA group were in the 41–50 age range (28.0%), whereas the majority in the TFA group were in the 21–30 age range (36.0%).

Table – I: Comparison of age between two groups (*n*=50)

Age group (years)	Transradial (n=25)	Transfemoral (n=25)	*p*-value
<20	4(16.0%)	1(4.0%)	0.403
21-30	6(24.0%)	9(36.0%)	
31-40	3(12.0%)	8(32.0%)	
41-50	7(28.0%)	6(24.0%)	
51-60	5(20.0%)	1(4.0%)	
Mean±SD	36.7±14.3	34.0±7.44	
Range (min-max)	(18-60)	(19-52)	

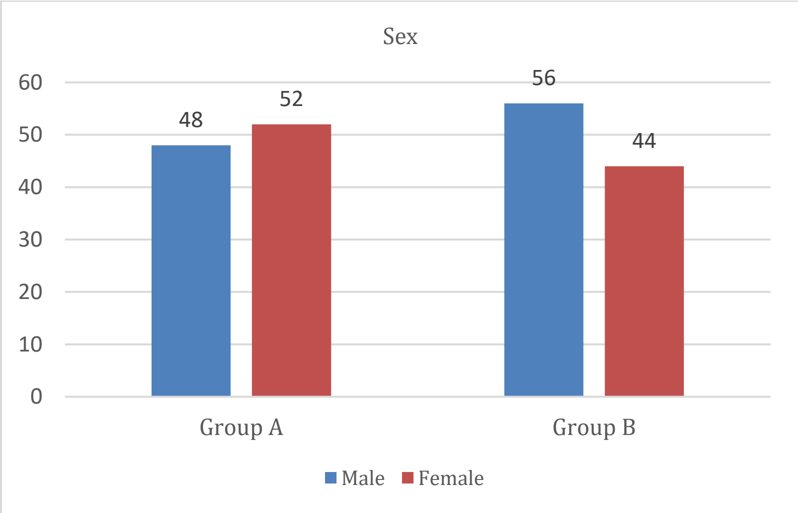

Figure – 1: Pie diagram showing the sex distribution of the study subjects

Figure 1 shows the sex distribution between the transradial (TRA) and transfemoral (TFA) groups, with no statistically significant difference (p = 0.571). In the TRA group, 48.0% were male and 52.0% were female, whereas in the TFA group, 56.0% were male and 44.0% were female.

Table II shows the distribution of co-morbidities between the transradial (TRA) and transfemoral (TFA) groups. Although the prevalence of diabetes mellitus (32.0% vs. 16.0%), hypertension (36.0% vs. 24.0%), and COPD (8.0% vs. 4.0%) was higher in the TRA group compared to the TFA group, the differences were not statistically significant (p = 0.185, p = 0.355, and p = 0.552, respectively). The most common indication in both groups was ruling out cerebral vasculopathy (44.0% in both TRA and TFA) followed by investigating the cause of intracranial hemorrhage (36.0% in TRA vs. 48.0% in TFA). The presence of an abnormality was slightly higher in the TRA group (16.0% vs. 8.0% in TFA), while follow-up of a previously treated abnormality was rare and observed only in the TRA group (4.0% vs. 0.0% in TFA). The differences between the groups were not statistically significant (p = 0.553).

Table – II: Distribution of study subjects by co-morbidities and indications of procedure between two groups (*n*=50)

Co-morbidities	Transradial (n=25)	Transfemoral (n=25)	*p*-value
Diabetes mellitus	8(32.0%)	4(16.0%)	0.185
Hypertension	9(36.0%)	6(24.0%)	0.355
COPD	2(8.0%)	1(4.0%)	0.552
Indications of procedure			
Presence of abnormality	4(16.0%)	2(8.0%)	0.553
Follow-up of previously treated abnormality	1(4.0%)	0(0.0%)	
Rule out the cause of intracranial hemorrhage	9(36.0%)	12(48.0%)	
Rule out cerebral vasculopathy	11(44.0%)	11(44.0%)	
Total	25(100.0%)	25(100.0%)	

Table III shows the distribution of successful catheterization of supra-aortic vessels between the transradial (TRA) and transfemoral (TFA) groups. The success rate for catheterizing the right common carotid artery (RCC) was 100% in both groups (p = 1.000), indicating no difference in procedural success for this vessel. Similarly, the left common carotid artery (LCC) was successfully catheterized in 92.0% of TRA cases and 96.0% of TFA cases (p = 0.552), showing no significant difference. For the right subclavian artery (RS), successful catheterization was achieved in 96.0% of TRA cases and 100.0% of TFA cases (p = 0.312), again demonstrating no statistically significant difference. However, successful catheterization of the left subclavian artery (LS) was significantly lower in the TRA group (60.0% vs. 100.0%, p < 0.001). Successful catheterization rate for the right internal carotid artery (RIC) was 100% in both groups (p = 1.000), indicating no difference in procedural success. Similarly, the left internal carotid artery (LIC) was successfully catheterized in 92.0% of TRA cases and 96.0% of TFA cases (p = 0.552), showing no statistically significant difference. However, successful catheterization of the right vertebral artery (RV) was significantly higher in the TRA group (88.0% vs. 52.0%, p = 0.005), suggesting an advantage of the radial approach in accessing this vessel. Conversely, successful catheterization of the left vertebral artery (LV) was significantly lower in the TRA group (44.0% vs. 92.0%, p < 0.001).

Table – III: Distribution of study subjects by Successful catheterization of supra-aortic and branch vessels between two groups (n=50)

Successful catheterization of supra-aortic vessels	Transradial (n=25)	Transfemoral (n=25)	*p*-value
RCC	25(100.0%)	25(100.0%)	1.000
LCC	23(92.0%)	24(96.0%)	0.552
RS	24(96.0%)	25(100.0%)	0.312
LS	15(60.0%)	25(100.0%)	<0.001*
Successful catheterization of branch vessels			
RIC	25(100.0%)	25(100.0%)	1.000
LIC	23(92.0%)	24(96.0%)	0.552
RV	22(88.0%)	13(52.0%)	0.005*
LV	11(44.0%)	23(92.0%)	<0.001*

Table IV shows the distribution of the study subjects based on the overall success rate of the procedure between the transradial (TRA) and transfemoral (TFA) groups. The success rate was 92.0% in the TRA group and 96.0% in the TFA group, with failure rates of 8.0% and 4.0%, respectively. However, this difference was not statistically significant (p = 0.552), indicating that both approaches achieved comparable procedural success. The crossover rate was higher in the TRA group (8.0%) compared to the TFA group (4.0%, p = 0.552).

Table – IV: Distribution of the study subjects by success rate and crossover rate between two groups (n=50)

Success	Transradial (n=25)	Transfemoral (n=25)	*p*-value
Yes	23(92.0%)	24(96.0%)	
No	2(8.0%)	1(4.0%)	0.552
Total	25(100.0%)	25(100.0%)	
Crossover rate			
Yes	2(8.0%)	1(4.0%)	
No	23(92.0%)	24(96.0%)	0.552
Total	25(100.0%)	25(100.0%)	

Table V shows the comparison of fluoroscopic time between the transradial (TRA) and transfemoral (TFA) groups. The mean fluoroscopic time was significantly higher in the TRA group (12.52 ± 1.14 minutes) compared to the TFA group (7.44 ± 1.05 minutes), with a statistically significant difference (p < 0.001). Hospital stay duration between the transradial (TRA) and transfemoral (TFA) groups. The mean hospital stay was significantly shorter in the TRA group (7.64 ± 0.99 hours) compared to the TFA group (19.64 ± 4.46 hours), with a statistically significant difference (p < 0.001).

Table – V: Comparison of fluoroscopic time and hospital stay between two groups (n=50)

fluoroscopic time (min)	Transradial (n=25)	Transfemoral (n=25)	*p*-value
Mean±SD	12.52±1.14	7.44±1.05	<0.001*
Range (min – max)	11.0 – 14.5	5.40 – 9.4	
Hospital stays (hours)			
Mean±SD	7.64±0.99	19.64±4.46	<0.001*
Range (min – max)	6.0 – 9.0	7.0 –26.0	

Table VI shows that pain (80.0% vs. 48.0%, p = 0.018) and hematoma (28.0% vs. 4.0%, p = 0.021) were significantly higher in the TFA group, while arterial spasm (20.0%, p=0.018) was significantly higher in TRA group.

Table – VI: Distribution of the study subjects by access site complications between two groups (n=50)

Complications	Transradial (n=25)	Transfemoral (n=25)	*p*-value
Pain	12(48.0%)	20(80.0%)	0.018*
Hematoma	1(4.0%)	7(28.0%)	0.021*
Arterial spasm	5(20.0%)	0(0.0%)	0.018*

DISCUSSION

This study was a quasi-experimental, single-center study conducted at the Department of Neurosurgery, Dhaka Medical College Hospital, with the aim of comparing the transradial (TRA) and transfemoral (TFA) approaches for cerebral angiography. A total of 50 patients were included, with 25 assigned to the transradial group and 25 to the transfemoral group. Patient selection was based on predefined inclusion and exclusion criteria, ensuring a balanced comparison between the two groups. In the present study, the mean age of patients in the transradial (TRA) group was 36.7 ± 14.3 years, while in the transfemoral (TFA) group, it was 34.0 ± 7.44 years. The age distribution between the two groups showed no statistically significant difference (p = 0.403), indicating that age was not a determinant of procedural success or access site selection. The majority of patients in the TRA group were in the 41–50 age range (28.0%), whereas in the TFA group, most were in the 21–30 age range (36.0%). Compared to previous studies, the mean age in this study is notably lower. Liu et al reported a mean age of 67 ± 4 years for TRA and 68 ± 5 years for TFA, with no significant difference between the two groups (p = 0.77) [13]. Similarly, Bhat et al[12] found a mean age of 61.8 ± 6.6 years in the TRA group and 60.6 ± 10.0 years in the TFA group. In the TRA group, 48.0% of patients were male and 52.0% were female, whereas in the TFA group, 56.0% were male and 44.0% were female. Bhat et al reported a higher proportion of males in both groups, with 74% male and 26% female in the TRA group, and 67% male and 33% female in the TFA group [12]. Similarly, Liu et al found that 82% of TRA patients were male compared to 78.4% in the TFA group, again showing a higher proportion of male patients undergoing cerebral angiography [13]. In the present study, the prevalence of common comorbidities among patients undergoing cerebral angiography included diabetes mellitus (32.0% in TRA vs. 16.0% in TFA, p = 0.185), hypertension (36.0% in TRA vs. 24.0% in TFA, p = 0.355), and chronic obstructive pulmonary disease (COPD) (8.0% in TRA vs. 4.0% in TFA, p = 0.552). Liu et al reported that hypertension was present in 75.2% of patients overall (78.4% in TFA vs. 72.0% in TRA, p = 0.45), while diabetes mellitus was observed in 25.7% (27.5% in TFA vs. 24.0% in TRA, p = 0.69) [13]. Similarly, Atallah et al found that hypertension was more common in the TFA group (60.2%) compared to the TRA group (57.2%, p = 0.38), and diabetes mellitus was nearly identical between the groups (13.1% in TFA vs. 13.6% in TRA, p = 0.79) [14]. In the present study, the most common indication for cerebral angiography was to rule out cerebral vasculopathy (44.0% in both TRA and TFA groups), followed by investigation of intracranial hemorrhage (36.0% in TRA vs. 48.0% in TFA). Presence of an abnormality was observed in 16.0% of TRA cases and 8.0% of TFA cases, while follow-up of previously treated abnormalities was noted in 4.0% of TRA cases and none in TFA. In the present study, the successful catheterization rates of the right common carotid artery (RCC) were 100.0% in both TRA and TFA groups (p = 1.000), left common carotid artery (LCC) was 92.0% in TRA and 96.0% in TFA (p = 0.552), right subclavian artery (RS) was 96.0% in TRA and 100.0% in TFA (p = 0.312), while left subclavian artery (LS) was significantly lower in TRA (60.0%) compared to TFA (100.0%, p < 0.001). Beihai and Yuhua reported similar trends, with RCC catheterization success rates of 100.0% in TRA and 96.7% in TFA (p = 0.001), LCC at 99.1% in TRA and 100.0% in TFA (p = 0.117), RS at 100.0% in TRA and 95.7% in TFA (p < 0.001), and LS at 97.5% in TRA and 98.9% in TFA (p = 0.170) [15]. Similarly, Liu et al found that TRA achieved 100.0% success for RCC and RS, while LS success was lower (97.4%) compared to TFA (98.3%) (p = 0.707) [13]. In the present study, the successful catheterization rates for branch vessels were 100.0% for the right internal carotid artery (RIC) in both TRA and TFA groups (p = 1.000), 92.0% for the left internal carotid artery (LIC) in TRA versus 96.0% in TFA (p = 0.552), 88.0% for the right vertebral artery (RV) in TRA versus 52.0% in TFA (p = 0.005), and 44.0% for the left vertebral artery (LV) in TRA versus 92.0% in TFA (p < 0.001). Comparing with previous studies, Beihai and Yuhua reported that TRA had a 96.7% success rate for RIC versus 91.9% in TFA (p = 0.207), while LIC success was 90.2% in TRA versus 96.9% in TFA (p = 0.083) [15]. For vertebral arteries, TRA had a significantly lower success rate in LV (58.9%) compared to TFA (92.0%, p < 0.001), whereas RV access was comparable between TRA (95.8%) and TFA (89.7%, p = 0.164). However, the TRA success rate was lower in the left vertebral artery (LV) (58.9% vs. 92.0%, p < 0.001), indicating anatomical challenges with TRA for certain vessels. Similarly, Liu et al found that TRA achieved a success rate of 93.4%, while TFA had a success rate of 96.9% (p = 0.049), showing a minor but statistically significant advantage for TFA. In the present study, the total fluoroscopic time was significantly longer in the transradial access (TRA) group (12.52 ± 1.14 minutes) compared to the transfemoral access (TFA) group (7.44 ± 1.05 minutes, p < 0.001), indicating that TRA required greater fluoroscopic exposure [16]. In the present study, access site complications were significantly lower in the transradial access (TRA) group compared to the transfemoral access (TFA) group. Pain was reported in 48.0% of TRA cases versus 80.0% in TFA cases (p = 0.018), and hematoma occurred significantly more in the TFA group (28.0% vs. 4.0%, p = 0.021). Additionally, arterial spasm was observed exclusively in the TRA group (20.0%, p = 0.018), a known limitation due to the smaller radial artery diameter. These findings are consistent with Bhat et al, who reported a significantly higher incidence of hematoma in the TFA group (14.5%) compared to no cases in the TRA group (p = 0.005) [12]. Bleeding complications were also significantly higher in TFA (7.0%) than TRA (3.0%, p = 0.039), reinforcing the lower risk of major vascular complications with the radial approach.

CONCLUSION

The findings of this study highlight the benefits and challenges of both the transradial and transfemoral approaches for cerebral angiography. While both methods showed comparable procedural success, the transradial approach offered advantages in terms of reduced access site complications, shorter hospital stays, and faster recovery. However, it was associated with a higher rate of arterial spasm and longer fluoroscopic time. The transfemoral approach, while slightly more efficient for accessing certain vessels, carried a higher risk of hematoma and longer post- procedure recovery. These results support the increasing adoption of the transradial approach as a preferred method for cerebral angiography, particularly for patients requiring early mobilization and lower vascular complication risks.

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REFERENCE

1. *Sattenberg, R.J., Atchaneeyasakul, K., Meckler, J., Saver, J.L., Gobin, Y.P. and Liebeskind, D.S. Cerebral Angiography, in Stroke. Elsevier. 2022; pp. 699-713.e2.*
2. *Sattenberg, R.J., Meckler, J., Saver, J.L., Gobin, Y.P. and Liebeskind, D.S. 2016. Cerebral Angiography, in Stroke. Elsevier. 2016; pp. 790–805.*
3. *Haussen, D.C. and Nogueira, R.G. Conventional Cerebral Arteriography, in Primer on Cerebrovascular Diseases. Elsevier. 2017; pp. 707–712.*
4. *Snelling, B.M., Sur, S., Shah, S.S., Khandelwal, P., Caplan, J., Haniff, R., Starke, R.M., Yavagal, D.R. and Peterson, E.C. Transradial cerebral angiography: techniques and outcomes, Journal of NeuroInterventional Surgery. 2018; 10(9), pp. 874–881.*
5. *Liu, M.D. and Y.T., G. Comparison of transradial and transfemoral cerebral angiography, Brain Hemorrhages. 2020; 1(1), pp. 95–98.*
6. *Hildick-Smith, D.J.R., Khan, Z.I., Shapiro, L.M. and Petch, M.C. Occasional- operator percutaneous brachial coronary angiography: First, do no arm, Catheterization and Cardiovascular Interventions. 2002; 57(2), pp. 161–165.*
7. *Campeau, L. Percutaneous radial artery approach for coronary angiography', Catheterization and Cardiovascular Diagnosis.1989; 16(1), pp. 3–7.*
8. *Laarman, G., Muthusamy, T.S., Swart, H., Westendorp, I., Kiemeneij, F., Slagboom, T. and van der Wieken, R. Direct coronary stent implantation: Safety, feasibility, and predictors of success of the strategy of direct coronary stent implantation, Catheterization and Cardiovascular Interventions. 2001; 52(4), pp. 443–448.*
9. *Mason, P.J., Shah, B., Tamis-Holland, J.E., Bittl, J.A., Cohen, M.G., Safirstein, J., et al. An Update on Radial Artery Access and Best Practices for Transradial Coronary Angiography and Intervention in Acute Coronary Syndrome: A Scientific Statement From the American Heart Association, Circulation: Cardiovascular Interventions. 2018;11(9), p. e000035.*
10. *Balaji, N.R. and Shah, P.B. Radial artery catheterization. Circulation. 2011; 124(16), pp. 1-6.*

11. Jo, K.W., Park, S.M., Kim, S.D., Kim, S.R., Baik, M.W. and Kim, Y.W. Is transradial cerebral angiography feasible and safe? A single center's experience. Journal of Korean Neurosurgical Society. 2010; 47(5), p.332.
12. Bhat, F.A., Changal, K.H., Raina, H., Tramboo, N.A. and Rather, H.A. Transradial versus transfemoral approach for coronary angiography and angioplasty–a prospective, randomized comparison. BMC cardiovascular disorders.2017; 17, pp.1-7.
13. Liu, Y., Wen, X., Bai, J., Ji, X., Zhi, K. and Qu, L. A single-center, randomized, controlled comparison of the transradial vs transfemoral approach for cerebral angiography: a learning curve analysis. Journal of Endovascular Therapy.2019; 26(5), pp.717-724.
14. Atallah, E., El Naamani, K., Momin, A.A., Abbas, R., Jain, P., Hunt, A., et al. Transradial versus transfemoral access routes for diagnostic cerebral angiography: a large single-center comparative cost-analysis study. Journal of Neurosurgery. 2024; 140(5), pp.1328-1334.
15. Beihai, G., and Yuhua, W. Comparison of transfemoral cerebral angiography and transradial cerebral angiography following a shift in practice during four years at a single center in China. Medical science monitor: international medical journal of experimental and clinical research.2020; 26, pp. e921631.
16. Dodd, W.S., Small, C.N., Goutnik, M., Laurent, D., Crossman, J., Motwani, K., et al. Cost comparison: evaluating transfemoral and transradial access for diagnostic cerebral angiography. Stroke: Vascular and Interventional Neurology. 2023; 3(1), p.e000428.