International Journal of Advances in Medicine
Dalai S et al. Int J Adv Med. 2022 Mar;9(3):371-375
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933
DOI: https://dx.doi.org/10.18203/2349-3933.ijam20220445

Review Article

Trans-radial cerebral angiography-safety, efficacy and patient comfort: review of literature

Sibasankar Dalai[1]*, Hemant K. Behera[2], Aravind V. Datla[3], Prithvi Jalamanchili[4]

[1]Department of Neurovascular Intervention, [2]Department of Cardiology, [3]Department of Medicine, [4]Department of Emergency Medicine, Medicover Hospitals, Visakhapatnam, Andhra Pradesh, India

Received: 28 December 2021
Revised: 29 January 2022
Accepted: 02 February 2022

***Correspondence:**
Dr. Sibasankar Dalai,
E-mail: inrresearch2021@gmail.com

ABSTRACT

A diagnostic cerebral angiography is a vital tool in the planning and management of various cerebrovascular conditions. Newer angiographic modalities, such as digital subtraction angiography offers dynamic imaging of the cerebral blood flow and is the preferred diagnostic modality of choice when a subsequent intervention is contemplated. Traditionally, the transfemoral route at the groin was used as the site for vascular access. However, landmark randomised controlled trials in the field of interventional cardiology have demonstrated the safety, efficacy and patient comfort attained by employing a trans-radial access for angiography and interventions. This has spawned numerous studies which were directed explicitly towards cerebral angiography and neuro-intervention. We present this review of literature to consolidate the current practices and to encourage the neuro-interventionalists to shift to a radial first approach.

Keywords: Cerebral angiography, Trans-radial, Transfemoral, Cardiology, Neuro-intervention, Randomised controlled trials

INTRODUCTION

A diagnostic cerebral angiography is an irreplaceable tool for neurovascular interventions in the management of various cerebrovascular conditions.[1,2] Newer angiographic modality, such as digital subtraction angiography (DSA), is touted as the "gold standard." Though the procedure involved in performing a DSA is more cumbersome, expensive and invasive than a computed angiography (CTA) or magnetic resonance angiography (MRA), the DSA offers dynamic imaging of the flow rather than the static images captured by the CTA or MRA.[3] Data obtained from the cerebral angiogram is real-time and allows for a rapid and better decision-making process. It is the most preferred diagnostic modality when a subsequent intervention is contemplated.[4-6] It can also be performed intraoperatively to assess the success of an open surgical approach prior to the closure.[7]

Performing an angiogram requires arterial access, traditionally the transfemoral route at the groin. For decades, the transfemoral access (TFA) at the groin was the preferrable vascular access site for the interventionalists. This was because of the perception that the TFA confers better work-flow ergonomics, ease of catheterizing the target vessel, the larger calibre of the femoral artery allowing the usage of a broader range of instrumentation, lower chances of vessel spasm necessitating a cross-over procedure and familiarity attained through prior experience.[8] However, the TFA is associated with some snags such as greater puncture site complications, lying supine with a straight leg for 2-8 hours, pain, all of which contribute to patient discomfort.

Based on various randomised controlled trials (RCT), interventional cardiology has pioneered the transition from the TFA to a radial first approach.[9-24] These trials demonstrated an overwhelming superiority in procedural

safety, patient comfort and preference for the procedural experience, nursing care choices, and reduced hospital costs.[25-27]

Despite these findings, the neurovascular interventionist has lagged behind the interventional cardiologist in adopting trans-radial access (TRA) for angiography and other methods of endovascular management. The reasons could be a perceived limitations of accessing a narrower artery, overcoming the learning curve associated with an alternative approach when the TFA has already been conquered, familiarity and convenience of femoral angiography within the context of neuro-interventional training, navigating the aortic arch from a different vector, and challenge in re-training the staff of the angiography suite.[28-30] Earlier literature which demonstrated age and the presence of higher comorbidities in the elderly as a predictor of failed TRA could also play a role.[31]

PROCEDURE

The patient is placed supine on the angiographic table. The procedure is performed under local anesthesia and conscious sedation following strict aseptic protocol. Right radial access is more common obtained than the left. The wrist is prepped, draped, slight pronated and positioned against the patient's hip. The radial artery is catheterized using a 5-French Prelude sheath [Merit Medical, USA] with ultrasound guidance via double-wall puncture and the Seldinger technique. A vasolytic cocktail composed of 5 mg of nicardipine, 200 µg of nitroglycerin and 2000 units of heparin is continuously administered through the sheath.

A radial run is done to examine the local arterial anatomy. A 5F Simmons 2 Penumbra catheter [Penumbra, USA] in its formed configuration is used to select the target vessels. After completing the procedure, the sheath is removed and the radial artery is compressed.[32]

Causes of failure and technical difficulties that might necessitate a cross-over to the femoral access include severe vasospasm (prohibiting the advancement of the catheter despite adequate vasolytic medication), inadvertent entry into the venous system, radial artery loop, radial artery extravasation, radial artery tortuosity, Arteria Lusoria, left common carotid artery tortuosity, bovine aortic arch, spinal angiogram, large body habitus (prevents adequate visualisation of the major vessels) and failure to form the Simmons catheter.[8,32]

COMPLICATIONS

Some of the observed complications include excessive bleeding, large hematoma formation, pseudoaneurysm needing additional closure, arteriovenous fistula, arterial dissection, ischemic limb needing surgery, radial artery extravasation, abscess, retroperitoneal hemorrhage, stroke and/or death.[8,9,32]

DISCUSSION

Interventional cardiology produced level 1 evidence supporting the superiority of TRA over TFA access for coronary angiography through multiple, large, prospective, randomised trials showing lower vascular bleeding, renal complications, as well as mortality and higher patient satisfaction.[29]

The RIVAL study published in 2011 was a large multicentric, randomised, parallel-group trial conducted in 7021 patients across 158 hospitals in 32 countries. This was based on the idea that the radial artery is superficial and more conveniently compressible, resulting in significantly lesser bleeding than the TFA. The 30-day rate of myocardial infarction, stroke or death in the radial cohort was comparable with the femoral cohort. However, the incidence of large access-site hematomas and pseudoaneurysms needing closure were significantly lower in the TRA group ($p<0.0001$ and $p<0.006$, respectively). TRA was preferred by the patients over TFA for subsequent procedures. The TRA seemed to be beneficial compared to TFA in centres undertaking a higher number of radial procedures.[9] This is in line with other studies that established the link between better outcomes and PCI procedural volume.[33,34]

The RIFLE-STEACS study published in 2012 reported a significantly lower cardiac mortality and bleeding rates coupled with a shorter hospital stay in the TRA group than the TFA group. This result is consistent with data emerging from meta-analyses and pooled analyses demonstrating in STEMI patients a 46% to 48% reduction in risk of mortality associated with the trans-radial approach compared with TFA.[12,35,36] An explanation for this observation could be the lower rate of bleeding-induced hemodynamic compromise, need for blood transfusion, lifesaving drug discontinuation and early mobilization, as prolonged bed rest is a predictor for worse prognosis in coronary artery disease.

The STEMI-RADIAL trial, published in 2014, revealed that major bleeding or vascular access site complications was significantly lower in the radial group compared to the femoral group (1.4% versus 7.2%; $p<0.0001$). The rate of net adverse clinical events was lower in the TRA group than the TFA group (4.6% versus 11%; $p=0.0028$). Intensive care stay and contrast utilization were significantly reduced in the radial group ($p=0.0038$ and $p=0.01$ and, respectively). However, mortality at 30 days and six months among both the groups showed no significant differences.[15]

In the 2015 randomized multicentric randomised trial by Valgimigli et al comprising 8404 patients about to undergo coronary angiography and percutaneous coronary intervention were delegated to the TRA and TFA groups. The TRA group had lower rates of major bleeding, major adverse cardiac events and all-cause mortality.[16]

Similar trials conducted in the preceding years reinforced the above findings, which demonstrated the superiority of TRA for coronary interventions.[9-24,33,34] This prompted numerous other studies which were directed explicitly towards cerebral angiography and neuro-intervention, albeit on a smaller scale.[8,29,32]

In the study by Osbun et al intraoperative cerebral angiography from a TRA was technically feasible for a variety of cerebrovascular pathologies without any access site complications or postoperative hand ischemia.[8] Moreover, they demonstrated its applicability in different patient positions and improved the work-flow ergonomics. In patients with involuntary movements or coughing during anesthesia emergence, there was no increased risk of bleeding or other associated complications, and the patients could move their arms freely.

Stone et al observed that for diagnostic cerebral angiography, TFA and TRA groups achieved their procedural goals with comparable efficacy (99% versus 97%), though patients strongly prefer the radial approach (64.8%; p<0.001).[29] This was comparable to the observations made by Snelling et al and Khanna et al.[28,37] Observed TFA specific complications (5.8%) were local access site pain, failure of the closure device, and fleeting right leg paresthesias. The TRA specific complications (2.5%) were local pain, arterial vasospasm and closure device failure. These findings support adopting a radial-first strategy for diagnostic cerebral angiography.

In a comparative analysis of patients aged >75 years, Sweid et al noticed that radiation exposure per vessel was significantly lower in the elderly TRA group than the elderly TFA group (p=0.001).[32] However, there were no significant differences between TRA and TFA groups for contrast dose, fluoroscopy time, procedure duration, cross-over rate, or access site complications. A second comparison (TRA in elderly versus TRA in the young) showed no significant differences for contrast dose, radiation exposure, procedure duration, access site complication or cross-over rate. However, a prolonged fluoroscopy time per vessel (p=0.050) was observed in the elderly TRA group, demonstrating the safety and feasibility of TRA even in the elderly population.

Nowadays, many interventionalists prefer a distal radial access at the anatomical snuffbox. In case of radial artery occlusion, the artery can be accessed at a proximal site near the flexor retinaculum for a later procedure. Furthermore, since the artery is punctured distal to its contributions to the deep palmar arch, the hand is protected from ischemia.[1,8,38]

After the completion of the procedure, the TRA site is more quickly and easily compressible owing to its superficial location. Placement of a simple radial band alleviates the need for invasive access closure device placement or the manual compression at the groin which is seen with TFA. Moreover, the radial band is less costly than the femoral closure device.

Radial artery vasospasm is acknowledged as a sudden inability to advance and manoeuvre the diagnostic catheter. Using a 16 cm or 25 cm sheaths (rather than 10 cm), placing the distal sheath in or near the brachial artery eliminates catheter motion against the bare intima of the smaller radial artery, reducing the likelihood of spasm.[39]

Incorporating the use of ultrasound guidance with colour flow Doppler function into routine protocol reduces the risk of inadvertent venous puncture. The current cross-over rate from TRA to TFA has ranged between 3% and 6% for diagnostic cerebral angiography.[28,29,37,40] In patients over the age of 60 years, the cross-over rate is estimated to be 7.8% for cerebral angiography through the TRA.[30] TRA has advantages over TFA in those with vascular disease, such as a lower rate of vascular complications and stroke in the elderly.[41] The mechanism is thought to be because the burden of aortic atherosclerotic is significantly higher in distal vessels,[42-44] and thus, the risk of dislodging aortic atheromas is lower via TRA. Since a sizeable portion of the elderly are on a "blood thinner", the radial artery's superficial and easily compressible nature reduces the risk of bleeding compared to the TFA.

CONCLUSION

TRA is a safe, effective and patient-friendly method for performing a cerebral angiogram, which is a vital tool for procedural planning and aids in the decision making of the interventionalist. Numerous large-scale RCTs have established the benefits of TRA over the more traditional TFA. With a wider adaptation of TRA for diagnostic and interventional purposes, the healthcare-related costs, as well as the physical toll of the procedure on the patients will lessen.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Hoffman H, Bunch KM, Mikhailova T, Cote JR, Kumar AA, Masoud HE, et al. Comparison of the Safety, Efficacy, and Procedural Characteristics Associated with Proximal and Distal Radial Access for Diagnostic Cerebral Angiography. J Stroke Cerebrovasc Dis. 2021;31(1):106204.
2. Muehlschlegel S, Kursun O, Topcuoglu MA, Fok J, Singhal AB. Differentiating reversible cerebral vasoconstriction syndrome with subarachnoid hemorrhage from other causes of subarachnoid hemorrhage. JAMA Neurol. 2013;70(10):1254-60.
3. Herzig R, Burval S, Krupka B, Vlachová I, Urbánek K, Mares J. Comparison of ultrasonography, CT angiography, and digital subtraction angiography in

severe carotid stenoses. Eur J Neurol. 2004;11(11):774-81.
4. Dalai S, Datla AV. Management of significant atherosclerotic carotid artery disease: review of literature. Int Surg J. 2021;8:3758-66.
5. Ricotta JJ, Aburahma A, Ascher E. Updated Society for Vascular Surgery guidelines for management of extracranial carotid disease [published correction appears in. J Vasc Surg. 2012;894:1-31.
6. Schindler A, Schinner R, Altaf N, Hosseini AA, Simpson RJ, Esposito BL, et al. Prediction of Stroke Risk by Detection of Hemorrhage in Carotid Plaques: Meta-Analysis of Individual Patient Data. JACC Cardiovasc Imaging. 2020;13(2):395-406.
7. Ares WJ, Kenmuir CL, Panczykowski DM, Weiner GM, Jadhav AP, Jovin TG, et al. A Critical Analysis of the Utility of Intraoperative Angiography. World Neurosurg. 2018;110:84-9.
8. Osbun JW, Patel B, Levitt MR, Yahanda AT, Shah A, Dlouhy KM, et al. Transradial intraoperative cerebral angiography: a multicenter case series and technical report. J Neurointerv Surg. 2020;12(2):170-5.
9. 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):1409-20.
10. Lee MS, Wolfe M, Stone GW. Transradial versus transfemoral percutaneous coronary intervention in acute coronary syndromes: re-evaluation of the current body of evidence. JACC Cardiovasc Interv. 2013;6(11):1149-52.
11. Rao SV, Stone GW. Arterial access and arteriotomy site closure devices. Nat Rev Cardiol. 2016;13(11):641-50.
12. Romagnoli E, Biondi-Zoccai G, Sciahbasi A, Politi L, Rigattieri S, Pendenza G, et al. Radial versus femoral randomized investigation in ST-segment elevation acute coronary syndrome: the RIFLE-STEACS (Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome) study. J Am Coll Cardiol. 2012;60(24):2481-9.
13. Sciahbasi A, Calabrò P, Sarandrea A, Rigattieri S, Tomassini F, Sardella G, et al. Randomized comparison of operator radiation exposure comparing transradial and transfemoral approach for percutaneous coronary procedures: rationale and design of the minimizing adverse haemorrhagic events by TRansradial access site and systemic implementation of angioX - RAdiation Dose study (RAD-MATRIX). Cardiovasc Revasc Med. 2014;15(4):209-13.
14. Valgimigli M, Frigoli E, Leonardi S, Vranckx P, Rothenbühler M, Tebaldi M, et al. Radial versus femoral access and bivalirudin versus unfractionated heparin in invasively managed patients with acute coronary syndrome (MATRIX): final 1-year results of a multicentre, randomised controlled trial. Lancet. 2018;392(10150):835-48.
15. Bernat I, Horak D, Stasek J, Mates M, Pesek J, Ostadal P, et al. ST-segment elevation myocardial infarction treated by radial or femoral approach in a multicenter randomized clinical trial: the STEMI-RADIAL trial. J Am Coll Cardiol. 2014;63(10):964-72.
16. 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(9986):2465-76.
17. Chase AJ, Fretz EB, Warburton WP, Klinke WP, Carere RG, Pi D, et al. Association of the arterial access site at angioplasty with transfusion and mortality: the M.O.R.T.A.L study (Mortality benefit Of Reduced Transfusion after percutaneous coronary intervention via the Arm or Leg). Heart. 2008;94(8):1019-25.
18. 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(1):132-40.
19. Snelling BM, Sur S, Shah SS, Marlow MM, Cohen MG, Peterson EC. Transradial access: lessons learned from cardiology. J Neurointerv Surg. 2018;10(5):487-92.
20. Won H, Lee WS, Kim SW, Cho BR, Youn YJ, Lim YH, et al. Safety and efficacy of transradial coronary angiography and intervention in patients older than 80 years: from the Korean Transradial Intervention Prospective Registry. J Geriatr Cardiol. 2017;14(2):81-6.
21. Mitchell MD, Hong JA, Lee BY, Umscheid CA, Bartsch SM, Don CW. Systematic review and cost-benefit analysis of radial artery access for coronary angiography and intervention. Circ Cardiovasc Qual Outcomes. 2012;5(4):454-62.
22. Roussanov O, Wilson SJ, Henley K, Estacio G, Hill J, Dogan B, et al. Cost-effectiveness of the radial versus femoral artery approach to diagnostic cardiac catheterization. J Invasive Cardiol. 2007;19(8):349-53.
23. Satti SR, Vance AZ, Golwala SN, Eden T. Patient Preference for Transradial Access over Transfemoral Access for Cerebrovascular Procedures. J Vasc Interv Neurol. 2017;9(4):1-5.
24. Wang YB, Fu XH, Wang XC, Gu XS, Zhao YJ, Hao GZ, et al. Randomized comparison of radial versus femoral approach for patients with STEMI undergoing early PCI following intravenous thrombolysis. J Invasive Cardiol. 2012;24(8):412-6.
25. Amin AP, Patterson M, House JA, Giersiefen H, Spertus JA, Baklanov DV, et al. Costs Associated With Access Site and Same-Day Discharge Among Medicare Beneficiaries Undergoing Percutaneous Coronary Intervention: An Evaluation of the Current

Percutaneous Coronary Intervention Care Pathways in the United States. JACC Cardiovasc Interv. 2017;10(4):342-51.
26. Bakker EJ, Maeremans J, Zivelonghi C, Faurie B, Avran A, Walsh S, et al. Fully Transradial Versus Transfemoral Approach for Percutaneous Intervention of Coronary Chronic Total Occlusions Applying the Hybrid Algorithm: Insights From RECHARGE Registry. Circ Cardiovasc Interv. 2017;10(9):e005255.
27. Jin C, Li W, Qiao SB, Yang JG, Wang Y, He PY, et al. Costs and Benefits Associated With Transradial Versus Transfemoral Percutaneous Coronary Intervention in China. J Am Heart Assoc. 2016;5(4):e002684.
28. Snelling BM, Sur S, Shah SS, Khandelwal P, Caplan J, Haniff R, et al. Transradial cerebral angiography: techniques and outcomes. J Neurointerv Surg. 2018;10(9):874-81.
29. Stone JG, Zussman BM, Tonetti DA. Transradial versus transfemoral approaches for diagnostic cerebral angiography: a prospective, single-center, non-inferiority comparative effectiveness study. J Neuro Intervent Surg. 2020;12:993-8.
30. Park JH, Kim DY, Kim JW, Park YS, Seung WB. Efficacy of transradial cerebral angiography in the elderly. J Korean Neurosurg Soc. 2013;53(4):213-7.
31. Dehghani P, Mohammad A, Bajaj R, Hong T, Suen CM, Sharieff W, et al. Mechanism and predictors of failed transradial approach for percutaneous coronary interventions. JACC Cardiovasc Interv. 2009;2(11):1057-64.
32. Sweid A, Das S, Weinberg JH, E L Naamani K, Kim J, Curtis D, et al. Transradial approach for diagnostic cerebral angiograms in the elderly: a comparative observational study. J Neurointerv Surg. 2020;12(12):1235-41.
33. Post PN, Kuijpers M, Ebels T, Zijlstra F. The relation between volume and outcome of coronary interventions: a systematic review and meta-analysis. Eur Heart J. 2010;31(16):1985-92.
34. Rao SV, Cohen MG, Kandzari DE, Bertrand OF, Gilchrist IC. The transradial approach to percutaneous coronary intervention: historical perspective, current concepts, and future directions. J Am Coll Cardiol. 2010;55(20):2187-95.
35. Vorobcsuk A, Kónyi A, Aradi D. Transradial versus transfemoral percutaneous coronary intervention in acute myocardial infarction Systematic overview and meta-analysis. Am Heart J. 2009;158(5):814-21.
36. Mamas MA, Ratib K, Routledge H, Fath-Ordoubadi F, Neyses L, Louvard Y, et al. Influence of access site selection on PCI-related adverse events in patients with STEMI: meta-analysis of randomised controlled trials. Heart. 2012;98(4):303-11.
37. Khanna O, Sweid A, Mouchtouris N, Shivashankar K, Xu V, Velagapudi L, et al. Radial Artery Catheterization for Neuroendovascular Procedures. Stroke. 2019;50(9):2587-90.
38. Brunet MC, Chen SH, Sur S, McCarthy DJ, Snelling B, Yavagal DR, et al. Distal transradial access in the anatomical snuffbox for diagnostic cerebral angiography. J Neurointerv Surg. 2019;11(7):710-3.
39. Caussin C, Gharbi M, Durier C, Ghostine S, Pesenti-Rossi D, Rahal S, et al. Reduction in spasm with a long hydrophylic transradial sheath. Catheter Cardiovasc Interv. 2010;76(5):668-672. doi:10.1002/ccd.22552.
40. Liu Y, Wen X, Bai J, Ji X, Zhi K, Qu L. A Single-Center, Randomized, Controlled Comparison of the Transradial vs Transfemoral Approach for Cerebral Angiography: A Learning Curve Analysis. J Endovasc Ther. 2019;26(5):717-24.
41. Alnasser SM, Bagai A, Jolly SS, Cantor WJ, Dehghani P, Rao SV, et al. Transradial approach for coronary angiography and intervention in the elderly: A meta-analysis of 777,841 patients. Int J Cardiol. 2017;228:45-51.
42. Sen S, Wu K, McNamara R, Lima J, Piantadosi S, Oppenheimer SM. Distribution, severity and risk factors for aortic atherosclerosis in cerebral ischemia. Cerebrovasc Dis. 2000;10(2):102-9.
43. Günenç Beşer C, Karcaaltıncaba M, Çelik HH, Başar R. The prevalence and distribution of the atherosclerotic plaques in the abdominal aorta and its branches. Folia Morphol (Warsz). 2016;75(3):364-75.
44. Kronzon I, Tunick PA. Aortic atherosclerotic disease and stroke. Circulation. 2006;114(1):63-75.

Cite this article as: Dalai S, Behera HK, Datla AV, Jalamanchili P. Transradial cerebral angiography-safety, efficacy and patient comfort: review of literature. Int J Adv Med 2022;9:371-5.