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Cost Comparison: Evaluating Transfemoral and Transradial Access for Diagnostic Cerebral Angiography

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Abstract

BACKGROUND: Modern medicine necessitates the delivery of increasingly complex health care while minimizing cost. Transradial access (TRA) for neuroendovascular procedures is becoming more common as accumulating data demonstrate fewer complications, improved patient satisfaction, and high rates of treatment success compared with the transfemoral access (TFA) approach; however, disparities in cost between these approaches remain unclear. We compared supply and equipment costs between TRA and TFA for diagnostic cerebral angiography and evaluate the specific items that account for these differences.

METHODS: We reviewed all adult patients who underwent diagnostic cerebral angiography from July 1, 2019 to December 31, 2019. Data related to patient demographics, vascular access site, catheters used, cost of catheters, arterial access sheath use, cost of sheaths, closure devices used, and cost of closure devices were collected.

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Disclosures
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RESULTS: The transradial approach resulted in higher price of radial access sheath; however, the overall cost of closure devices was much lower in TRA group than in the TFA cohort. There was no significant difference in the cost of catheters. Overall, the total supply costs for TRA cerebral angiography were significantly lower than those of TFA cerebral angiography. The relative materials cost difference of using TRA was 20.9%.

CONCLUSION: This study is the first itemized materials cost analysis of TRA versus TFA cerebral angiography. TRA necessitates the use of a more expensive access sheath device; however, this cost is offset by the increased cost of devices used for femoral arteriotomy closure. Overall, the supply and equipment costs were significantly lower for TRA than TFA.

Keywords

angiography; clinical fiscal responsibility; cost analysis; transfemoral access; transradial access

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Prudent delivery of health care requires careful cost-benefit analysis of emerging techniques and standards of care. Transradial access (TRA) for diagnostic cerebral angiography is safe[1–3] and hasthe potential to reduce major access site complications and hemostasis time compared with transfemoral access (TFA)[4–6]; however, transradial approach-specific endovascular equipment is less common and anatomic trajectory difficulties could increase procedure time and cost. Analyzing how these factors influence expenses is a vital element of informed clinical decision-making and the development of health care guidelines.

Equipment use, especially of catheters, vascular sheaths, and closure devices, could significantly alter overall procedure costs for diagnostic cerebral angiography. The morphology of the arch can influence choice of catheter or cause the neurointerventionalist to try multiple catheters in 1 procedure especially from a transradial approach, thereby increasing costs. On the other hand, hemostatic devices are drastically different between TRA and TFA. Radial artery hemostasis can be achieved via an external inflatable wrist cuff,[7] compared with the transmural closure devices needed for femoral arteriotomy.[8] The extent to which one of these factors may predominate is unknown. The aim of this study was to compare (1) overall procedure supply cost and (2) itemized cost of catheters, sheaths, and closure devices. The electronic medical record itemized cost tool combined with operating room expense estimate was used to compare total price between groups. The clarity database is built into the itemized cost tool using automated Tableau software analysis as previously described.[9]

METHODS

Study Design and Data Collection

The data that support the findings of this study are available from the corresponding author upon reasonable request. This study was approved by the university institutional review board. A retrospective review was performed using an institutional database and the institution's electronic medical records system. Records were assessed from July 1, 2019 to December 31, 2019 to identify consecutive patients who underwent diagnostic cerebral angiograms. A total of 103 patients were identified as eligible for inclusion in this study; 51 patients were included in the transradial cohort and 52 patients were included in the

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transfemoral cohort. Data for the total cost of the procedure, cost of the catheters, cost of the closure device, cost of catheter sheaths, and the types of catheters used were extracted. In addition, demographic characteristics—including age, gender, and ethnicity and indications for the cerebral angiogram were collected.

Statistical Analysis

A power analysis demonstrated that a minimum of 50 patients would be needed in each arm to determine if there was a significant difference in cost between the 2 approaches. The deidentified data were analyzed by an institutional statistician. Descriptive statistics, including means, medians, ranges, and SDs, were calculated for each cohort. Differences in cohorts were assessed using an unpaired Student's *t*-test or Fisher's exact test where appropriate, with a significance level determined as a *P* value less than 0.05. Data are presented as mean±SD unless otherwise noted.

RESULTS

Patient Demographics

The proportion of female patients was 60.8% (31 of 51) in the TRA cohort and 67.3% (35 of 52) in the TFA cohort. Average age at time of procedure was 57.9±14.7 years and 60.0±15.1 years in the TRA and TFA cohorts, respectively. No demographic characteristic varied significantly between groups (Table 1).

Cost Analysis

First, we compared the total supply and implant costs between each cohort. The mean total cost of a diagnostic cerebral angiogram using a transradial approach was significantly lower than the cost using a transfemoral approach ($416.30±69.1 versus $525.90±253.8; P=0.004) (Table 2). The absolute cost supply cost difference of using the transradial approach was $110, or a relative reduction of 20.9%.

Next, we identified the costs of catheters, vascular access sheaths, and closure devices, as these supplies are both major cost factors as well as different between procedure types. There was no significant difference in the cost of catheters ($54.30±28.0 in TRA cohort versus $36.50±153.1 in TFA cohort; P=0.41) (Table 2). The cost of sheaths used was significantly higher in the TRA cohort compared with the TFA cohort ($55.20±7.3 versus $9.70±6.5; P<0.0001) (Table 2).The cost of closure devices was significantly lower in the TRA cohort than the TFA cohort ($38.80±18.8 versus $223.90±78.7; P<0.0001) (Table 2).

Finally, we sought to determine if the number of catheters or sheaths used during the procedure differed between TRA and TFA. There was no difference in the number of catheters or sheaths used between cohorts (1.18±0.39 catheters in TRA versus 1.15±0.36 catheters in TFA, and 1.02±0.14 sheaths in TRA versus 1.0±0.0 sheaths in TFA; P=0.75 and 0.32, respectively) (Table 3).

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DISCUSSION

Overall, our study has quantified the equipment-specific cost-effectiveness of transradial cerebral angiography compared with transfemoral cerebral angiography. There was a significant average materials cost reduction of >20% ($110) per procedure, mostly stemming from the cost of closure devices (Table 2). Consistent with our findings, a study analyzing total hospital cost found that TRA for elective neuroendovascular procedures was associated with lower average cost and decreased hospital stays.[10] The literature examining cost reductions in coronary angiography also parallels our findings.[5,11] Our findings of reduced direct costs coupled with recent studies indicating that TRA is safe and effective for diagnostic cerebral angiography[3,12,13] support the recent shift toward TRA. Accounting for the volume of cerebral angiography procedures done by neurointerventionalists (over 100 000 annually),[14] an average cost reduction of over $100 per procedure would save tens of millions of dollars in healthcare expenditures per year. This cost savings is expected to increase as the radial access sheath devices and catheters become less expensive with time.

The strength of our study is the electronic medical record tool allowing detailed, itemized interrogation of procedure costs. Using this tool, we were able to determine the influence of specific devices on overall procedure cost. We found that closure devices for femoral arteriotomy are significantly more expensive than those for the radial artery (Table 2). Closure devices are important for reducing major adverse events and improving patient comfort and satisfaction with transfemoral angiography[8,15]; thus, unless costs for transfemoral closure devices decrease, the increased relative cost of transfemoral angiography is likely to persist. We have also found that the itemized cost of access sheaths and catheters is higher for transradial diagnostic cerebral angiography although the cost difference in the cohort was statistically significant only for the sheaths (Table 2). The large cost difference between the closure devices (more expensive in TFA) offsets any cost increase associated with catheters and sheaths used in TRA. As transradial approaches become more common, the development and refinement of TRA-specific equipment could become more widespread and cost effective, further driving down the cost of this technique. Our unique, itemized cost reporting tool permits effective cost-reduction research through delineation of previously equivocal cost factors, such as catheters and closure devices.

Another important consideration is patient satisfaction with the procedure as well as safety. TRA closure devices allow for quicker discharge and return to normal functioning, which is highly valued by patients. Furthermore, TRA may also have decreased risks; a recent study demonstrated increased access site complications after TFA compared with TRA for flow diversion procedures.[16] Dilation of the radial artery with pharmacologic intervention has proven successful in limiting spasm around the sheath, further decreasing risk of harm. Overall, TRA is a safe and cost-effective option for diagnostic cerebral angiograms.

Our study has limitations to consider when interpreting the data. First, we are studying only diagnostic cerebral angiography. The equipment and procedural demands of other neurointerventions likely affect access location, device use, and costs that are beyond the scope of this article. Second, our study focuses on direct procedure-related costs and does not consider expenses due to complications or prolonged hospital stay. The risk of

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complications for the TFA are higher as mentioned previously. Postprocedure postanesthesia care unit time can vary greatly between TFA and TRA and shorter supine rest times have been demonstrated to reduce costs, which is seen with TRA.[17] Further, owing to large personnel and space costs, postprocedure postanesthesia care unit time differences can quickly outweigh materials costs. Lastly, TRA and TFA procedures typically have different standard protocols, such as the use of heparinized saline flush bags during TFA procedures or the preprocedure medication cocktails used for TRA procedures. These access-specific differences have costs that are not accounted for in our study. The design of our study is intended to focus on direct materials costs as related to devices used.

CONCLUSIONS

Transradial diagnostic cerebral angiography has significantly lower materials cost compared with the transfemoral approach. The cost of closure devices in particular was much lower for TRA. In patients equally suitable for both access locations, TRA may be considered as a more cost-effective option.

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The authors received no funding to conduct this research.

Nonstandard Abbreviations and Acronyms

TRA transradial access

TFA transfemoral access

REFERENCES

1. Goldman DT, Bageac D, Mills A, Yim B, Yaeger K, Majidi S, Kellner CP, de Leacy RA. Transradial approach for neuroendovascular procedures: a single-center review of safety and feasibility. Am J Neuroradiol. 2021;42:313–318. https://pubmed.ncbi.nlm.nih.gov/33446499/ [PubMed: 33446499]
2. Joshi KC, Beer-Furlan A, Crowley RW, Chen M, Munich SA. Transradial approach for neurointerventions: a systematic review of the literature. J Neurointerv Surg. 2020;12:886–892. https://pubmed.ncbi.nlm.nih.gov/32152185/ [PubMed: 32152185]
3. Zussman BM, Tonetti DA, Stone J, Brown M, Desai SM, Gross BA, Jadhav A, Jovin TG, Jankowitz BT. A prospective study of the transradial approach for diagnostic cerebral arteriography. J Neurointerv Surg. 2019;11:1045–1049. https://pubmed.ncbi.nlm.nih.gov/30842303/ [PubMed: 30842303]
4. Jolly SS, Yusuf S, Cairns J, Niemelä K, Xavier D, Widimsky P, Budaj A, Niemelä M, Valentin V, Lewis BS, 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;377:1409–1420. https://pubmed.ncbi.nlm.nih.gov/21470671/ [PubMed: 21470671]
5. 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;5:454–462. https://pubmed.ncbi.nlm.nih.gov/22740010/ [PubMed: 22740010]
6. Kiemeneij F, Laarman GJ, Odekerken D, Slagboom T, Van Der Wieken R. A randomized comparison of percutaneous transluminal coronary angioplasty by the radial, brachial and femoral approaches: the access study. J Am Coll Cardiol. 1997;29:1269–1275. https://pubmed.ncbi.nlm.nih.gov/9137223/ [PubMed: 9137223]

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7. Chen SH, Peterson EC. Radial access for neurointervention: room set-up and technique for diagnostic angiography. J Neurointerv Surg. 2021;13:96. https://pubmed.ncbi.nlm.nih.gov/32732255/ [PubMed: 32732255]
8. Noori VJ, Eldrup-Jørgensen J. A systematic review of vascular closure devices for femoral artery puncture sites. J Vasc Surg. 2018;68:887–899. https://pubmed.ncbi.nlm.nih.gov/30146036/ [PubMed: 30146036]
9. Pontarelli EM, Grinberg GG, Isaacs RS, Morris JP, Ajayi O, Yenumula PR. Regional cost analysis for laparoscopic cholecystectomy. Surg Endosc. 2019;33:2339–2344. https://pubmed.ncbi.nlm.nih.gov/30488194/ [PubMed: 30488194]
10. Catapano JS, Ducruet AF, Koester SW, Cole TS, Baranoski JF, Rutledge C, Majmundar N, Srinivasan VM, Wilkinson DA, Lawton MT, et al. Propensity-adjusted cost analysis of radial versus femoral access for neuroendovascular procedures. J Neurointerv Surg. 2021;13:752–754. http://jnis.bmj.com/ [PubMed: 33106321]
11. Plehn G, Örnek A, Gkiouras G, Vormbrock J, Maagh P, Butz T, Meissner A. Transradial versus transfemoral approach in coronary angiography: a matched pair analysis of cath lab equipment costs. J Vasc Access. 2015;16:413–417. https://pubmed.ncbi.nlm.nih.gov/26044893/ [PubMed: 26044893]
12. Bhatia K, Guest W, Lee H, Klostranec J, Kortman H, Orru E, Qureshi A, Kostynskyy A, Agid R, Farb R, et al. Radial vs. femoral artery access for procedural success in diagnostic cerebral angiography: a randomized clinical trial. Clin Neuroradiol. 2020;31:1083–1091. https://pubmed.ncbi.nlm.nih.gov/33373017/ [PubMed: 33373017]
13. Stone JG, Zussman BM, Tonetti DA, Brown M, Desai SM, Gross BA, Jadhav A, Jovin TG, Jankowitz B. Transradial versus transfemoral approaches for diagnostic cerebral angiography: a prospective, singlecenter, non-inferiority comparative effectiveness study. J Neurointerv Surg. 2020;12:993–998. http://jnis.bmj.com/ [PubMed: 31974282]
14. Shams T, Zaidat O, Yavagal D, Jovin AXT, Janardhan V. Society of vascular and interventionalneurology (SVIN) stroke interventionallaboratory consensus (SILC) criteria: a 7m management approach todeveloping a stroke interventional laboratory in the era of stroke thrombectomy for large vessel occlusions. Interv Neurol. 2016;5:1–28. https://pubmed.ncbi.nlm.nih.gov/27610118/ [PubMed: 27610118]
15. Kim N, Lee JH, Jang SY, Bae MH, Yang DH, Park HS, Cho Y, Yoon JY, Jeong MH, Park JS, et al. Radial versus femoral access with or without vascular closure device in patients with acute myocardial infarction. Am J Cardiol. 2019;123:742–749. https://pubmed.ncbi.nlm.nih.gov/30563616/ [PubMed: 30563616]
16. Li Y, Chen SH, Spiotta AM, Jabbour P, Levitt MR, Kan P, Griessenauer CJ, Arthur AS, Osbun JW, Park MS, et al. Lower complication rates associated with transradial versus transfemoral flow diverting stent placement. J Neurointerv Surg. 2021;13:91–95. https://pubmed.ncbi.nlm.nih.gov/32487766/ [PubMed: 32487766]
17. Zuckerman SL, Bhatia R, Tsujiara C, Baker CB, Szafran A, Cushing D, Aiken J, Tracy M, Mocco J, Ecker RD. Prospective series of two hours supine rest after 4fr sheath-based diagnostic cerebral angiography: outcomes, productivity and cost. Interv Neuroradiol. 2015;21:114–119. https://pubmed.ncbi.nlm.nih.gov/25934785/ [PubMed: 25934785]

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CLINICAL PERSPECTIVE

- The cost of materials (sheaths, catheters, and closure devices) is lower on average for transradial access versus transfemoral access for diagnostic cerebral angiography.
- Closure devices influence total materials cost more than sheaths or catheters.

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Table 1.

Demographic Characteristics of Transradial and Transfemoral Cohorts

Arterial access approach	Transradial (n=51)	Transfemoral (n=52)	*P* value
Male sex (%)	20 (39.2%)	17 (32.7%)	0.54
Mean age (SD) (y)	57.9 (14.7)	60.0 (15.1)	0.49
Race or ethnicity (%)			
White	40 (78.4%)	39 (76.5%)	
Black	5 (9.8%)	8 (15.7%)	
Hispanic	5 (9.8%)	3 (5.9%)	
Asian	1 (2.0%)	0 (0.0%)	
Other *	0 (0.0%)	2 (3.9%)	

* Other includes American Indian or Alaska Native, Native Hawaiian or Other, Pacific Islander, Multiracial.

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Table 2.

Supply and Implant Costs of Transradial Versus Transfemoral Diagnostic Cerebral Angiography

Arterial access approach	Transradial (n=51)	Transfemoral (n=52)	*P* value
Total cost (dollars)			
Mean (SD)	416.3 (69.1)	525.9 (253.8)	0.004
Median (min, max)	406 (292, 602)	480 (230, 2207)	
Cost of catheters (dollars)			
Mean (SD)	54.3 (28.0)	36.5 (153.1)	0.41
Median (min, max)	48.6 (39, 180)	11 (11, 1115.3)	
Cost of sheath (dollars)			
Mean (SD)	55.2 (7.3)	9.7 (6.5)	<0.0001
Median (min, max)	55 (8.5, 63.5)	8.5 (8.5, 55)	
Cost of closure device (dollars)			
Mean (SD)	38.8 (18.8)	223.9 (78.7)	<0.0001
Median (min, max)	25 (25, 84)	210 (0, 635)	

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Table 3.

Quantity of Catheters, Sheaths, and Closure Devices Used During Transradial Versus Transfemoral Diagnostic Cerebral Angiography

Arterial access approach	Transradial (n=51)	Transfemoral (n=52)	*P* value
Catheters (n)			
Mean (SD)	1.18 (0.39)	1.15 (0.36)	0.75
Sheath (n)			
Mean (SD)	1.02 (0.14)	1.0 (0.0)	0.32
Closure device (n)			
Mean (SD)	1.36 (0.48)	1.06 (0.37)	0.0007