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NEUROVASCULAR NEWS

The Brain Aneurysm Institute

Multidisciplinary Care of Patients with Hemorrhagic and Ischemic Stroke


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Synergistic Utilization of Endovascular and Surgical Techniques Reduces Risks of Treatment of Unruptured Intracranial Aneurysms

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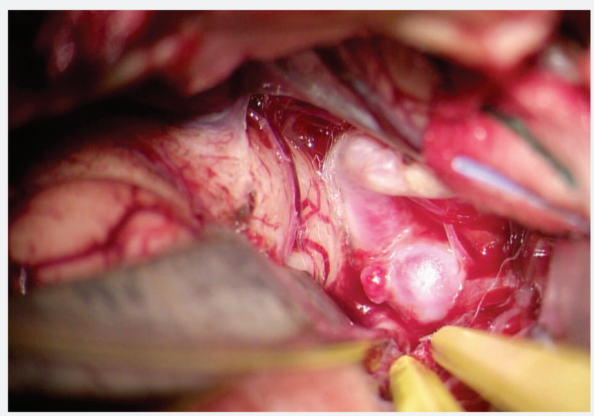
The decision to treat an unruptured intracranial aneurysm is primarily based on balancing the risks of treatment versus the natural history of the lesion for potential rupture. This decision must weigh lesion-specific factors as well as patient-specific factors both of which influence the treatment risk and the natural history risk of hemorrhage. A number of studies have been conducted to evaluate the overall risk of treating unruptured aneurysms using endovascular[1,2,6,7] or surgical techniques.[1,2,4,7] These reports have been both retrospective[1,4] and prospective.[7] However, there is little data available reporting the overall management morbidity for unruptured intracranial aneurysms in a combined practice, in which all proceduralists utilize both open and endovascular techniques.



Intraoperative image of an unruptured aneurysm with a bleb undergoing microsurgical clipping.

The critical question in determining whether to treat an unruptured aneurysm is simply; is the probability and severity of the procedure-related complication less than the complications associated with the natural history of aneurysmal rupture? At the Beth Israel Deaconess Medical Center Brain Aneurysm Institute, we sought to answer these questions by analyzing lesion and patient-specific factors related to outcome in complications in 656 unruptured aneurysms found in 558 patients, treated between

2014 and 2017. The type of procedure selected was based on the perceived lowest risk modality and was compared to historical complication rates. Over this same interval, we reviewed an estimated additional 850 patients where continued observation of the lesion was recommended without any intervention. These decisions were also based on aneurysm size, patient age, and patient comorbidities.

As each patient was considered for treatment, we determined whether or not treatment was appropriate and then specific type of treatment by discussing each patient at a multidisciplinary neurovascular conference attended by neurologists, neurosurgeons, and neuroradiologists. When open surgical techniques were utilized this typically involved direct microsurgical clipping of the aneurysm (251 patients, 38.2%). When utilizing endovascular techniques, endovascular coiling (70 patients, 10.6%), stent-assisted coiling (89 patients, 13.5%), or flow diversion techniques (248 patients, 37.7%) were used for treatment. After our multidisciplinary group had made a recommendation, the details of the suggested procedure were reviewed the patient and their family prior to proceeding with aneurysm treatment. More details of this data and further discussion has been recently published.[5]

As with other unruptured aneurysm studies, most of the patients treated in our cohort were female (77.5%). The median patient age was 59 years and the mean aneurysm size was 7.3 mm maximal diameter. Lesions were treated throughout the intracranial circulation and the distribution by location and by type of treatment is shown in Figure 1. Complications occurred in 66 procedures (10%). Of these, 38 (5.8% of total) were neurologic in nature. There was a total of seven (1%) of procedures that resulted in permanent poor neurologic outcome. Twenty-eight (4.3% of total procedures) non-neurologic complications occurred during or after procedures. While several of these non-neurological complications required intervention and longer hospital stays, none resulted in permanent morbidity.

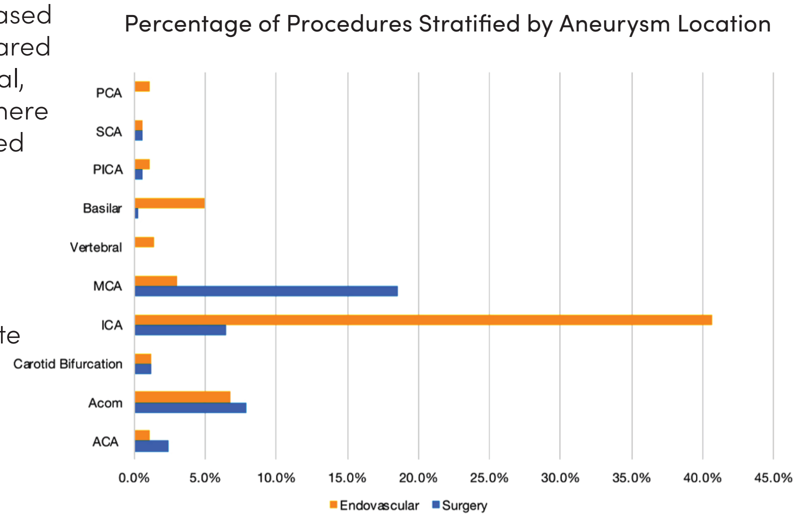


Figure 1: Proportion of types of procedures performed in our series stratified by aneurysm location. PCA=Posterior cerebral artery, SCA=Superior cerebellar artery, PICA=Posterior inferior cerebellar artery, Basilar artery, Vertebral artery, MCA=Middle cerebral artery, ICA=Internal carotid artery, ICA Bifurcation=Internal carotid artery bifurcation, Acom=Anterior communicating artery, ACA=Anterior cerebral artery.

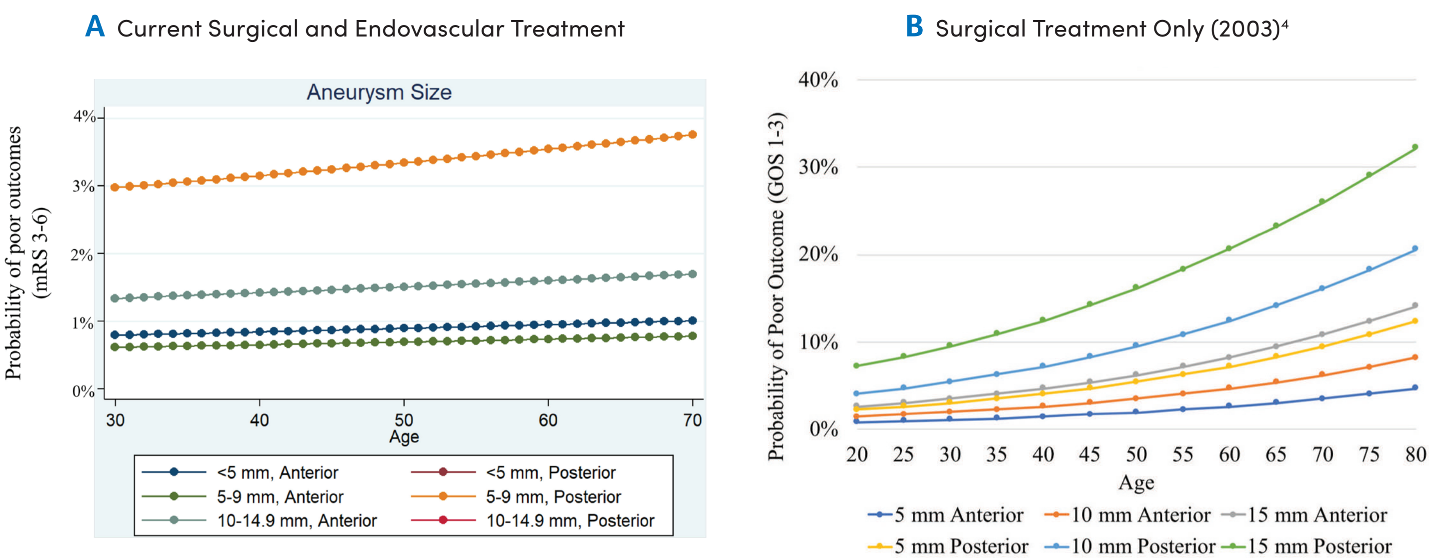


Figure 2: Comparison of risk outcome (in mRS) of our current series of 658 lesions treated with surgical or endovascular techniques in a comprehensive fashion (A) and of surgical results (in GOS, 604 lesions) published in an earlier study[4] (B). In panel A, the risk of poor outcomes in aneurysms in the posterior circulation smaller than 5 mm and from 10-14.9 mm is not plotted because no poor outcomes were observed in these groups. The apparent explanation is that the number of poor outcomes observed in these groups was too small to be plotted.

The treatment outcomes for unruptured intracranial aneurysms were generally favorable and the patient selection for treatment took into account medical comorbidities as well as aneurysm specific factors and other patient-related risk factors. By utilizing both endovascular and open surgical techniques, the risks of the current figures are dramatically lower compared to open surgical techniques performed 15 years ago (Figure 2). The probability of poor outcomes is shown for our current cohort of patients (Figure 2A) utilizing surgical and endovascular treatments. The outcome was evaluated using the modified Rankin scale; a scale that evaluates neurological function in terms of dependence or disability following a stroke. The results shown are stratified by age and size of aneurysm as well as its location. In the anterior circulation, referring to aneurysms in the carotid arteries, middle cerebral arteries, and anterior cerebral arteries. The posterior circulation refers to aneurysms in the vertebrobasilar arterial system. A similar plot is also shown for results published in 2003 utilizing surgical techniques only (Figure 2B). The graph shows outcomes based on the Glasgow outcome scale (Poor outcome GOS 1-3); a scale of outcomes following any type of brain injury and stratified by aneurysm size and location in the anterior or posterior circulation. While direct statistical comparisons cannot be made because of the different outcome scales used, one can see that risks of treatment in the current era utilizing surgical and endovascular techniques fall in the low single digits of percentage compared to the higher chance of poor outcome reported in the past.

UCAS[3] Probability of Aneurysm Rupture

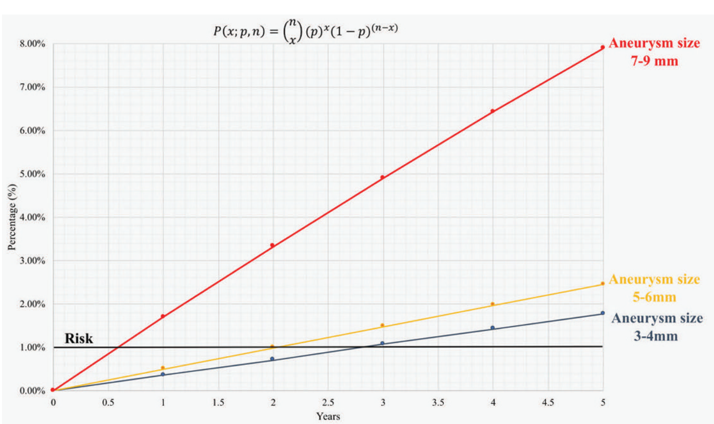


Figure 3: UCAS study[3] data plotted predicted probabilities of aneurysmal rupture over time stratified by aneurysm size. A "Risk" line of 1% is plotted to demonstrate the projected length of time a patient would need to live to justify treatment (where the risk of treatment is lower than the risk of hemorrhage).

The implications of these results give new light to the discussion of treating unruptured intracranial aneurysms. Indeed, if lower complication rates can be achieved, then the balance between the natural history rupture risk and the treatment-related risks is altered. Figure 3 shows the probability of rupture for unruptured intracranial aneurysms as reported for a large number of patients in a Japanese cohort.[3] The graph shown in this figure is based on cumulative binomial probability plots from rupture rates reported in this study based on the size of the aneurysm. We have drawn a 1% risk of treatment line on the graph to demonstrate the interval of time needed such that rupture rate risk would exceed treatment-related risks for differently sized aneurysms. This can be seen to have impact even for smaller aneurysms. Using this reasoning, treatment may be justified even for smaller lesions if a patient has a long-projected life expectancy.

References

1. Kim YD, Bang JS, Lee SU, Jeong WJ, Kwon OK, Ban SP, et al: Long-term outcomes of treatment for unruptured intracranial aneurysms in South Korea: clipping versus coiling. J Neurointerv Surg, 2018
2. Mazur MD, Taussky P, Park MS, Couldwell WT: Contemporary endovascular and open aneurysm treatment in the era of flow diversion. J Neurol Neurosurg Psychiatry 89:277-286, 2018
3. Morita A, Kirino T, Hashi K, Aoki N, Fukuhara S, Hashimoto N, et al: The natural course of unruptured cerebral aneurysms in a Japanese cohort. N Engl J Med 366:2474-2482, 2012
4. Ogilvy CS, Carter BS: Stratification of outcome for surgically treated unruptured intracranial aneurysms. Neurosurgery 52:82-87; discussion 87-88, 2003
5. Ogilvy CS, Jordan NJ, Ascanio LC, Enriquez-Marulanda AA, Salem MM, Moore JM, et al: Surgical and endovascular comprehensive treatment outcomes of unruptured intracranial aneurysms: Reduction of treatment bias. World Neurosurg, 2019
6. Shimizu K, Imamura H, Mineharu Y, Adachi H, Sakai C, Sakai N: Endovascular Treatment of Unruptured Paraclinoid Aneurysms: Single-Center Experience with 400 Cases and Literature Review. AJNR Am J Neuroradiol 37:679-685, 2016
7. Wiebers DO, Whisnant JP, Huston J, 3rd, Meissner I, Brown RD, Jr., Piepgras DG, et al: Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet 362:103-110, 2003

Middle Meningeal Artery Embolization for Chronic Subdural Hematomas

Ajith J. Thomas, MD, Georgios A. Maragkos, MD, Justin Moore, MD, and Christopher S. Ogilvy, MD

Chronic subdural hematoma (CSDH) is estimated to affect 13.5 out of 100,000 individuals per year and up to 58 out of 100,000 individuals aged 65 and older, with a mortality rate of about 5%.[1] As the population ages, the incidence of CSDH is expected to double and become the most common cranial neurosurgical condition among adults by the year 2030. This is not a benign disease that can be treated effectively with surgery. In a cohort of Medicare beneficiaries that underwent surgery, reoperation rate was 7.5%, and the cumulative 90-day mortality rate was 17.6%.[2] Although the etiology of acute SDH is venous in nature, with stretching and tearing of the bridging veins, CSDH has recently been proposed to be of arterial origin. The growth and recurrence of CSDH is thought to comprise of several steps: initial injury to the dura followed by inflammation and secretion of angiogenic factors, which causes the formation of fragile capillaries. These are prone to hemorrhaging repeatedly, causing the development of a membrane. The repetition of this cycle leads to growth and recurrence of the CSDH over time. In the absence of brain atrophy, the subdural hematoma is usually resorbed and CSDH formation is avoided. The current standard of treatment for CSDH consists of burr hole or craniotomy for irrigation and evacuation, often leaving a subdural drain.

Embolization of the Middle Meningeal Artery (MMA) is a new modality of treatment, effective in treating this condition without cranial surgery. It is thought to eliminate the blood supply to the CSDH membrane, thus interrupting the process of rehemorrhage and promoting the blood resorption over time. The main benefits of MMA embolization, which is done by accessing the femoral artery or the radial artery, are its minimally invasive nature and highly efficacious outcomes. Extracranial embolization can be performed endovascularly under conscious sedation with local anesthesia, offering a potentially effective alternative treatment for high-risk surgical patients, such as those who require antiplatelets or anticoagulation or those with thrombocytopenia or significant co-morbidities. There is a risk of stroke in elderly patients with tortuous or diseased vessels and loss of vision from ophthalmic collaterals from the MMA. However, these risks can be mitigated by attention to detail and obtaining a non-invasive preoperative vessel study such as a computed tomography angiogram (CTA) of the neck.

MMA embolization targets the root cause of CSDH compared to standard surgical techniques. Thus, MMA embolization appears to have a lower recurrence rate compared to surgery and may be effective for recurrent CSDH after conventional treatment. Conventional surgical intervention has reported recurrence rates that vary from 5-30%.[3] Our meta-analysis and systematic review analyzed studies up untill October 2018 (excluding case reports) and found an MMA embolization recurrence rate of 3.6%.[4]

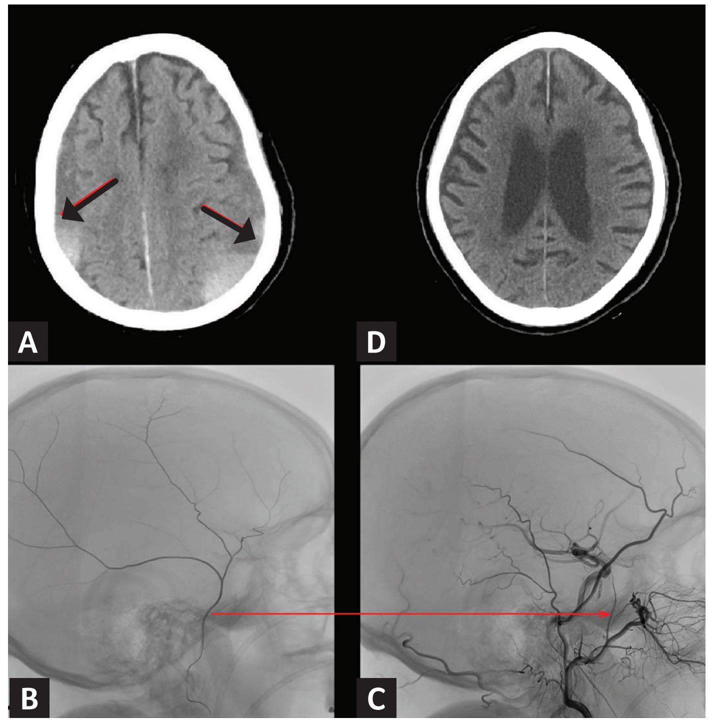


Figure 1: Preoperative axial CT (A) reveals a chronic subdural hematoma in an 89-year-old patient, who was treated with MMA embolization. Panel (B) demonstrates the patient's right MMA on lateral view. Panel (C) shows the same view after the embolization with particles and coils, where the MMA is completely missing (arrow). Panel (D) shows a follow-up axial CT after 2 months, where no residual hematoma can be observed.

Patient Selection

Regarding the question of optimal patient selection, it has been suggested that an ideal treatment group would be a minimally symptomatic cohort with mass effect but without motor deficit (more than subtle pyramidal weakness) or radiographic progression of disease (significant mass effect should be a contraindication at this point). Currently, we consider the following three groups of patients for MMA embolization: 1) patients who failed surgery at any point and need additional intervention; 2) patients on antiplatelet therapy or anticoagulation, or persistently thrombocytopenic patients who need intervention; and

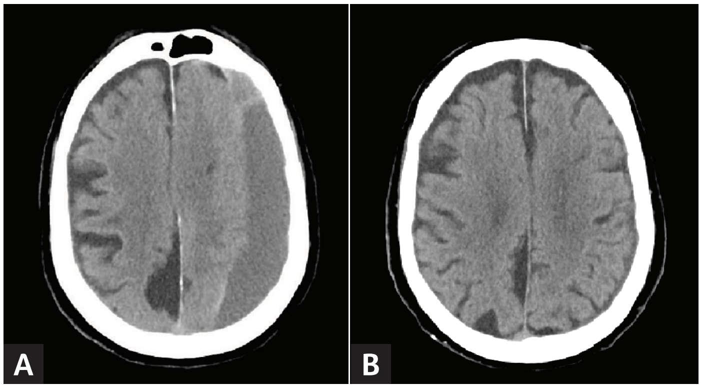


Figure 2: MMA embolization in a 94-year-old gentleman. Preoperative axial CT revealed a large chronic subdural hematoma. The patient underwent MMA embolization with no further surgical intervention. Panel (B) demonstrates a follow-up axial CT 3 months later, where no residual hematoma is observed.

3) patients with minimal symptoms, such as only headache or pronator drift, who need intervention. Significant mass effect on CT scan with midline shift is considered an exclusion criterion for now.

Technique Details

We generally perform the procedure through a transfemoral approach. Regarding the method of embolization, we prefer particulate embolization because of penetration to the distal vasculature, in contrast to liquid embolics which provide only a proximal "stump" embolization. We use a combination technique of distal penetration with polyvinyl alcohol (PVA) particles (150-250 microns) followed by coil-embolization for permanent proximal trunk occlusion of the MMA.

Prospective Studies

MMA embolization is an exciting new therapy for CSDH. Though preliminary studies have been extremely promising, randomized controlled trials are needed to understand the efficacy of embolization compared to standard surgical treatment or natural history of the disease.

References

1. Almenawer SA, Farrokhyar F, Hong C, et al. Chronic subdural hematoma management: a systematic review and meta-analysis of 34,829 patients. Ann Surg. 2014;259:449-457.
2. Knopman J, Link TW, Navi BB, Murthy SB, Merkler AE, Kamel H. Rates of Repeated Operation for Isolated Subdural Hematoma Among Older Adults. JAMA Netw Open. 2018;1:e183737.
3. Waqas M, Vakharia K, Weimer PV, Hashmi E, Davies JM, Siddiqui AH. Safety and Effectiveness of Embolization for Chronic Subdural Hematoma: Systematic Review and Case Series. World Neurosurg. 2019.
4. Srivatsan A, Mohanty A, Nascimento FA, et al. Middle Meningeal Artery Embolization for Chronic Subdural Hematoma: Meta-Analysis and Systematic Review. World Neurosurg. 2019;122:613-619.

Radial Access for Neuro-Endovascular Procedures

TM Robinson, MD, Kimberly Kicielinski, MD, Justin M. Moore, MD, PhD, Christopher S. Ogilvy, MD, and Ajith Thomas, MD

Femoral access for cerebral angiography and neuro interventional procedures has been the dominant access site for the last 3 decades. It allowed repetition of puncture and easy access to the vessels that needed to be interrogated. Over the last two decades there has been a shift from transfemoral puncture to transradial access in the field of interventional cardiology.[2] With regards to transradial access, there is data demonstrating reduction in access site complications, decreased length of stay, reduced hospital costs, and improved patient satisfaction.[3] The transition to transradial has been more pronounced in Europe and Japan with 80% of cardiology procedures being performed via the radial artery.[1] Adoption of the transradial route for cerebral angiography has been slower, but has been increasing in recent years, partially due to the increased exposure via social media.[4]

We have increasingly adopted the transradial approach for cerebral angiography.All patients undergoing cerebral angiography via the transradial approach undergo pre-procedure assessment of the collateral palmar circulation via Barbeau testing.[5] For this test, a pulse oximeter is placed on the middle finger and the radial artery is compressed. Patients with no return of pulse tracing following 2 minutes of radial artery compression are not candidates for transradial cerebral angiography. Approximately 4% patients fail Barbeau testing. While in the pre-procedure holding area, topical lidocaine/nitroglycerin ointment is applied as well. The patient is then transferred to the neuro angiography suite and the areas of potential arterial puncture are draped in a sterile fashion. Following infiltration of lidocaine at the puncture site, the radial artery is accessed and a radial sheath is placed (Figure 1). An antispasmodic "cocktail" is given which consists of verapamil, nitroglycerine, and heparin via the arterial sheath. At the conclusion of the procedure, a radial arm band is placed over the arterial puncture site (Figure 2). This band is inflated, and the sheath is removed. A small amount of air is removed until there is a small amount of bleeding from the puncture site. Then a small amount of air is re inflated until bleeding ceases. The patient then returns to the post procedure holding area and air is removed from the radial arm band every 15 minutes until the armband is removed. This is approximately 60-90 minutes from the end of the procedure.

Transradial access for cerebral angiography has been described in several retrospective series and shown to be safe and effective.[3,6-10] No major complications were seen in one report of a series of 148 patients. (i.e. hand ischemia, radial artery occlusion, access site hematoma, neurological injury)[3] Radial artery spasm, a minor complication with a prevalence of 6-10% is typically treated with antispasmodic agents and is self-resolving. A major complication, radial artery occlusion is seen in less than 1% of patients with modern patent hemostasis techniques. Improved safety has been demonstrated for TRA, which applies for most patient groups. Particularly obese patients, patients taking anticoagulation and elderly patients benefit more, as traditional TFA has been shown to carry increased risk in these subgroups. It is also assumed that pregnant patients would benefit from this approach as the access site is away from the groin and the gravid uterus. There are also patients in whom femoral access is not possible due to atherosclerotic disease or distal aortic disease who require an alternate approach.

Most patients experience little to no discomfort at the access site in the arm following the procedure.[3] Data from the cardiology literature demonstrate a TRA preference rate of 71-90% in patients who have undergone both TFA and TRA.[11-13] The reason for TRA preference is likely due to decreased rates of overall discomfort and ease of ambulation.[13] Patients are able to sit up immediately following the procedure and are able to ambulate, with assistance, to the restroom with the hemostatic band in place. Patients often require a shorter observation period and are discharged after 90 minutes compared to 2-6 hours following the procedure with TFA.

The cardiac literature supporting radial artery approach is impressive and 90% of interventional cardiology procedures are performed via the radial artery.[2] There have been numerous reports demonstrating safety for TRA in neuro vascular procedures.[3,6-10] At the BIDMC Brain Aneurysm Institute, trans-radial access is used on a regular basis for both diagnostic angiography and interventions on neurovascular lesions with good success.

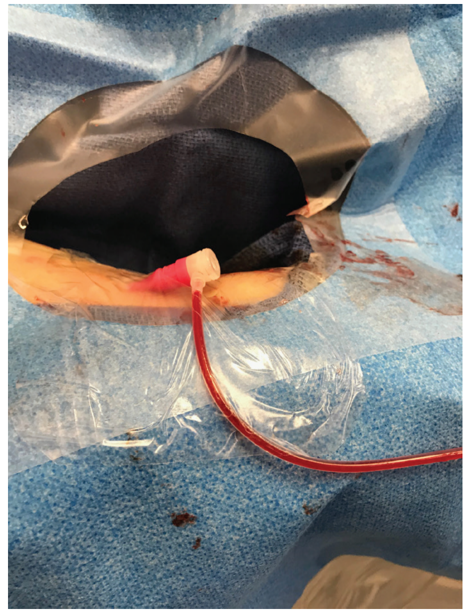


Figure 1: 4 French vascular sheath placed in distal radial artery.

Figure 2: Radial arm band inflated after removal of sheath to provide hemostasis.

References

1. Anjum I, Khan M, Aadil M, et al. (June 03, 2017) Transradial vs. Transfemoral Approach in Cardiac Catheterization: A Literature Review. Cureus 9(6): e1309. doi:10.7759/cureus.1309
2. C aputo RP, Tremmel JA, Rao S, et al. Transradial arterial access for coronary and peripheral procedures: executive summary by the Transradial Committee of the SCAI. Catheter Cardiovasc Interv 2011;78:823-39.
3. Snelling BM, Sur S, Shah SS, et al Transradial cerebral angiography: techniques and outcomes Journal of NeuroInterventional Surgery 2018;10:874-881.
4. https://www.merit.com/distal-transradial-access-is-taking-social-media-by-storm
5. Barbeau GR, Arsenault F, Dugas L, et al. Evaluation of the ulnopalmar arterial arches with pulse oximetry and plethysmography: comparison with the Allen's test in 1010 patients. Am Heart J 2004;147:489-93.
6. Levy EI, Boulos AS, Fessler RD, et al. Transradial cerebral angiography: an alternative route. Neurosurgery 2002;51:335-42.
7. Jo KW, Park SM, Kim SD, et al. Is transradial cerebral angiography feasible and safe? A single center's experience. J Korean Neurosurg Soc 2010;47:332-7.
8. Chen SH, Snelling BM, Shah SS, *et al* Transradial approach for flow diversion treatment of cerebral aneurysms: a multicenter study *Journal of NeuroInterventional Surgery* Published Online First: 22 January 2019. doi: 10.1136/neurintsurg-2018-014620
9. Snelling BM, Sur S, Shah SS, et al Transradial access: lessons learned from cardiology *Journal of NeuroInterventional Surgery* 2018;10:487-492.
10. Brian M Snelling, Samir Sur, Sumedh S Shah, Justin Caplan, Priyank Khandelwal, Dileep R Yavagal, Robert M Starke, Eric C Peterson, Transradial Approach for Complex Anterior and Posterior Circulation Interventions: Technical Nuances and Feasibility of Using Current Devices, *Operative Neurosurgery*, copy352
11. Kok MM, Weernink MGM, von Birgelen C, et al. Patient preference for radial versus femoral vascular access for elective coronary procedures: The PREVAS study. Catheter Cardiovasc Interv 2017. doi: 10.1002/ccd.27039 [Epub ahead of print].
12. Jolly SS, Yusuf S, Cairns J, 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;377:1409-20.
13. Cooper CJ, El-Shiekh RA, Cohen DJ, et al. Effect of transradial access on quality of life and cost of cardiac catheterization: A randomized comparison. Am Heart J 1999;138:430-6.

News and Events

The BIDMC Brain Aneurysm Institute is pleased and proud to announce the recruitment of our senior Endovascular and Operative Neurovascular fellow, **Dr. Kimberly Kicielinski,** as Assistant Professor to the Medical University of South Carolina Medical Center. Dr. Kicielinski will be one of only 4 women in the United States who is trained and actively practicing 'open' neurovascular surgery and endovascular techniques (MUSC) for neurovascular disease in the brain, neck and spine. Dr. Kicielinski is a graduate of the Neurosurgical residency at the University of Alabama. She has been instrumental in establishing BIDMC as a comprehensive stroke center and will use her talents at MUSC which is a center that has become known nationally and internationally as a leader in Neurovascular disease.

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News and Events

BIDMC Brain Aneurysm Institute welcomes **Justin Moore, MD,** B.Med Sci, LLB (JD), PhD (Oxford), Grad Dip Sur Anatomy, FRACS (Neurosurgery), Assistant Professor of Neurosurgery, Harvard Medical School, as Neurosurgery Faculty at Beth Israel Deaconess Medical Center, Boston, MA

Dr. Moore subspecializes in cerebrovascular and neuro-oncological diseases. He is a dual trained neurosurgeon who uses both endovascular and open surgical techniques for the treatment of cerebrovascular diseases such as strokes and aneurysms. He has extensive research experience in both basic laboratory work and clinical research. His basic science work was completed at Oxford University in the UK, and involved the study and manipulation of poorly understood genes within the brain with utilization of animal models. Clinically, Dr. Moore has published extensively in his field of expertise, with a particular interest in strokes, aneurysms and neuro-oncology. This work has been presented at multiple national and international conferences. Currently Dr. Moore is collaborating with colleagues to develop novel treatments for translation in to patients with Stroke and Neuro-oncology disease. Dr. Moore takes an active interest in teaching and mentoring and currently mentors students, residents, research, and clinical fellows at Harvard, Stanford and Boston University.