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DOI: 10.4103/bc.bc_38_20

# Dual-center study comparing transradial and transfemoral approaches for flow diversion treatment of intracranial aneurysms

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## Abstract:

**BACKGROUND:** The transfemoral approach (TFA) has been the traditional approach for neurointerventional cases. While the TFA allows for triaxial support in flow diverting stent cases, it is associated with access site complications. Recently, the transradial approach (TRA) has emerged as a safer alternative to the TFA. To the best of our knowledge, there have only been single-center studies comparing outcomes in flow diverter cases for these approaches. We demonstrate the safety and feasibility of the TRA for placement of flow diverting stents in the treatment of unruptured intracranial aneurysms at two high-volume centers.

**MATERIALS AND METHODS:** We performed a retrospective review of prospectively collected institutional databases at two high-volume neuroendovascular centers. Cases from 2016 to 2018 of unruptured intracranial aneurysms treated by flow diverting stenting accessed through either the TRA or the TFA were compared. Patient demographics, procedural and radiographic metrics including location and size of the aneurysm, size, and length of the flow diverter implant, and fluoroscopic time were recorded. Puncture site complications and length of hospital stay were also included in the data analysis.

**RESULTS:** There were three out of 29 TRA cases which were converted to the TFA. None of the TRA patients experienced site complications, whereas three TFA patients experienced site complications. While TRA and TFA patients did not differ significantly in their exposure to radiation, TRA patients experienced shorter hospital stays.

**CONCLUSIONS:** While long-term studies are still lacking regarding this approach, we demonstrate that the TRA is a safe and feasible approach for flow diverter stent placement.

## Keywords:

Cerebral aneurysm, flowdiverter, transradial approach

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Submission: 15-08-2020  
Revised: 30-12-2020  
Accepted: 26-01-2021  
Published: 29-05-2021

## Introduction

Deployment of flow diverting stents across the neck of an intracranial aneurysm, including those which are wide-necked, is a proven and effective treatment for aneurysms of the internal

carotid artery (ICA) [Figure 1]. Placement of flow diverting stents requires a fair amount of catheter support for the delivery microcatheter, generally provided by large bore guide catheters, and intermediate catheters (tri-axial endovascular navigation platforms). Traditionally, these stents are placed through a transfemoral approach (TFA).

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**How to cite this article:** Khandelwal P, Majmundar N, Rodriguez GJ, Patel P, Dodson V, Singla A, *et al.* Dual-center study comparing transradial and transfemoral approaches for flow diversion treatment of intracranial aneurysms. *Brain Circ* 2021;7:65-70.

However, the transradial approach (TRA) has recently emerged in the neuroendovascular field as a new “less invasive” alternative to the TFA.<sup>[1-4]</sup> The TRA has been shown to result in significantly lower access site-related complications, reduced associated cost, and increased patient preference.<sup>[5-8]</sup> Due to the smaller caliber of the radial artery and the higher potential for vasospasm when compared with the common femoral artery, large bore catheters may be difficult to navigate through the TRA. This creates a potential concern for appropriate support during the navigation and implantation of flow-diverting stents, especially due to the need for adequate catheter support. We present a retrospective two center, study comparing the TFA and the TRA in cases of flow diverting stent deployment.

### Objective

The objective of this study is to report a dual-institutional experience with the TRA for placement of flow-diverting stents in the anterior circulation for intracranial aneurysms as a feasible alternative to the TFA and provide a direct comparison with the traditional TFA.

### Materials and Methods

We performed a retrospective review of prospectively collected institutional databases at two high-volume neuroendovascular centers (Texas Tech University Health Science Center of El Paso and Rutgers University New Jersey Medical School). The authors included unruptured intracranial aneurysms in the anterior circulation, which were endovascularly treated with placement of a flow-diverting stent through a TRA from 2016 to 2018. The study was approved by the respective institution review boards. Once the interventionalists were comfortable with the TRA, a “radial first” approach was used in suitable patients. We compared these data with aneurysms treated with flow-diverting

stents of the anterior circulation through a TFA. Patient demographics, procedural and radiographic metrics including location and size of the aneurysm, size, and length of the flow diverter implant, and fluoroscopic time were recorded. Puncture site complications and length of in hospital stay were also included in the data analysis.

### Procedural technique

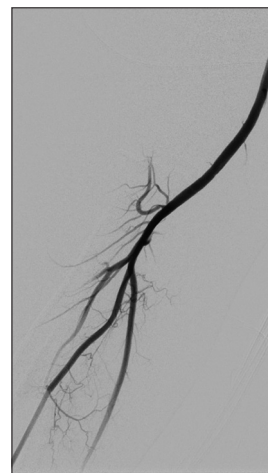
All procedures were performed under general anesthesia. Patients were treated with dual antiplatelet therapy for at least 5 days prior to the procedure (clopidogrel 75 mg daily and aspirin 325 mg daily). Resistance to the antiplatelet effect of clopidogrel and platelet reactivity using the point of care verify-now platelet reactive units (PRU) was measured prior to treatment to ensure the level was therapeutic (<208 PRU). If patients were noted to be hyporesponsive to clopidogrel (>208 PRU value), the dual antiplatelet regimen was switched to ticagrelor 90 mg twice per day and aspirin 81 mg daily.

### Transradial approach

The right radial artery was chosen in all cases except one. We did not routinely perform Barbeau or Allen testing as neither has been shown to be of clinical significance in recent studies.<sup>[9,10]</sup> The radial artery was accessed under ultrasound guidance with a short 21G radial needle using a modified Seldinger technique. A 6 or 7-Fr short transradial introducer sheath (Glidesheath Slender, Terumo, Somerset, New Jersey) was inserted over the microwire. A radial “cocktail” containing 200 mcg of nitroglycerin and 2.5 mg of verapamil was diluted in 8 ml of blood aspirated from the sheath, and the total amount of mixed blood and vasodilators (10 ml) was slowly infused in the artery over 2 min. An angiographic run in the AP plane was performed after infusing the cocktail in order to assess for radial artery vasospasm and any aberrant anatomy [Figure 2]. In



**Figure 1:** Working projection angiography of a left ophthalmic artery aneurysm treated with a flow-diverting stent

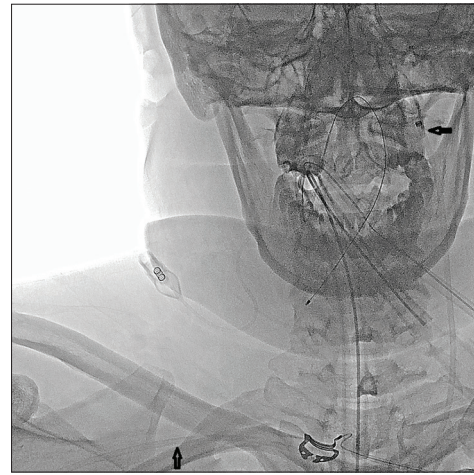


**Figure 2:** Digital subtraction angiography in the AP projection demonstrating a large caliber radial artery suitable for an 8 French guide catheter allowing for triaxial support for flow diverter deployment

case of persistent vasospasm, the administration of the nitroglycerin and verapamil was repeated. After the radial cocktail was administered, a 70 units/kg bolus of intravenous heparin was given to achieve an activating clotting time between 250 and 300 s. Two types of triaxial support systems were used. If the arterial diameter was >2 mm but smaller than 2.4 mm, a 6-Fr system was used. The 6-Fr system included a combination of a 6-Fr guide catheter (Envoy guide DA XP catheter Codman Neuro, Raynham, Massachusetts, USA), a Phenom Plus .045" intermediate catheter or a Navien 0.58 intermediate catheter, and a 0.27" Phenom microcatheter (Medtronic, Minneapolis, Minnesota, USA) navigated over a 0.014 inch Synchro 2 microwire (Stryker Kalamazoo, California, USA). This system was used in approximately 45% of cases. Approximately 55% of the cases (especially when the artery was larger than 2.4 mm in diameter) employed a triaxial construct combining the AXS Infinity LS long sheath (Infinity; Stryker Neurovascular), the SYPHONTRAK™ Support Catheter 0.060" (InNeuroCo, Sunrise, Florida, USA) and a Phenom 0.27" microcatheter. The larger system (8F) provides adequate support in tortuous arteries, especially for stents of larger size. If coiling is planned alongside FD placement, then 8F guide catheter can easily accommodate large intermediate catheter (inner diameter of .72 inch) which in turn can accommodate two microcatheter for coiling and FD placement, respectively. We excluded patients with a radial artery diameter <2 mm from TRA. In either case, the target vessel was initially catheterized with the guide catheter over a Simmons-2 catheter. The flow diverter was deployed using standard stent deployment techniques. Removal of the radial sheath was performed immediately after the case was finished, and radial artery hemostasis was achieved using a radial artery compression device (TR Band, Terumo, Somerset, New Jersey, USA).

### Transfemoral approach

We are radial first centers. Reasons for choosing TFA included smaller radial artery diameter (artery to sheath ratio <.8), unfavorable arch, or early provider experience with flow diverter stenting. The common femoral artery was accessed with a micropuncture kit under ultrasound guidance and an 8-Fr sheath was placed using the Seldinger technique. A Neuron Max (Penumbra, Alameda, California, USA) or infinity long guide sheath (AXS Infinity, Stryker Neurovascular, Fremont, California, USA) was then navigated to the cervical ICA on the side of the target aneurysm [Figure 3]. A 5-Fr Phenom Plus .045-inch (Medtronic, Minneapolis, Minnesota, USA) or a Syphontrak (InNeuroCo, Sunrise, Florida, USA) catheter was used as the intermediate catheter. An 0.027-inch microcatheter (Phenom, Medtronic Neurovascular) was used for deployment of the flow-diverting stent. After



**Figure 3:** Unsubtracted AP image of a large bore catheter in the distal left cervical internal carotid artery. This large bore catheter was navigated through the right transradial approach into the left cervical internal carotid artery for deployment of a flow diverting stent

deployment, femoral artery hemostasis was obtained using standard closure devices.

### Statistical analysis

Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS) Version 25.0 statistic software package (IBM, Armonk, New York, USA). Data are presented as mean and SD for continuous variables and as frequency (percentages) for categorical variables. A value of  $P \leq 0.05$  was considered statistically significant.

### Results

A total of 29 subjects underwent placement of flow-diverting stents in the anterior circulation through TRA from 2016 to 2018 (8 subjects at Texas Tech University Health Science Center at El Paso and 21 subjects at Rutgers New Jersey Medical School). The average age of the patients was 55 years old and 83% of the patients were female. Angiographic, anatomic, and demographic characteristics are described in Table 1. The right radial artery was the access site for all cases except one. Left radial access was used in one case due to the patient's aberrant origin of the right subclavian artery. No infectious or hemorrhagic site complications were recorded in any patient. More than two-thirds of the aneurysms were located in the supraclinoid segment of the intracranial ICA, and in more than half of the patients, the flow-diverting stent was implanted in the right ICA. The average aneurysm size was 6.1 mm, and almost all aneurysms were wide necked and pure side wall aneurysms. A triaxial system was used in all the cases performed through the TRA or TFA, and the average flow diverting stent size and length were 4.0 and 17 mm, respectively. In three cases, the TRA was not suitable for



flow-diverting stent placement; therefore, placement of the stent was done through the TFA. All cases in which the TRA was converted to the TFA were in middle-aged females with radial artery diameter ranging from 2.0 to 2.5 mm. In each case, we were able to advance the catheter into the aortic arch; however, we were not able to advance the catheter into the desired supraortic vessel, due to severe radial artery vasospasm. The guide catheter was safely withdrawn in all the cases, and TFA was used for the remainder of the procedure. None of these cases had any significant deficit from the vasospasm.

A total of 57 subjects who underwent to flow-diverting stent placement through TFA in the anterior circulation were recorded between 2016 and 2018 (19 subjects at Texas Tech University Health Science Center at El Paso and 38 subjects from Rutgers New Jersey Medical School). The average age was 52, and more than 80% were female. The average aneurysm size was 8 mm. Half of the target aneurysms were located in the right ICA. A triaxial system was used in all the cases performed through TFA, and the average flow-diverting stent size and length were 3.9 and 18 mm, respectively. Details of the location, access side, and clinical and radiographic characteristics for the TFA are listed in Table 2. A total of three subjects (5.2%) suffered from hemorrhagic complications at the access site including a single case of a large retroperitoneal hematoma.

When comparing the TRA to the TFA approach for placement of a flow-diverting stent in the anterior circulation, the stent was successfully deployed in all the cases regardless of the access site. The average size and length of the implant were comparable in both groups, and the amount of radiation exposure was not significantly different between groups [Table 3]. Finally, the average length of hospital stay for the TRA group was 1 day compared to 3 days in the TFA group.

## Discussion

The benefits of TRA for patients have been well reported in interventional cardiology procedures, but only recently have there been a series of publications demonstrating the safety and efficacy of TRA for neurointerventional procedures.<sup>[3-6,11-14]</sup> In Japan and Europe, the TRA is utilized in over 80% of interventional cardiology procedures, while the TRA is utilized in approximately 40% of these procedures in the US.<sup>[4,15]</sup> Moreover, the interventional cardiology literature demonstrated a reduced risk of complications, increased patient satisfaction, and diminished costs associated with the TRA when compared with the TFA.<sup>[5,6,16-19]</sup> The advantages of the TRA can be attributed to the superficial location of the artery, easier hemostasis, reduced risk of life-threatening hemorrhagic complications, and lack of major postoperative limitations.<sup>[2-4,11,12]</sup>

**Table 1: Characteristics of transradial access flow diversion cases**

Characteristics	n (%)
Age, years (average)	55
Female:male	4.8:1
Target vessel	
Right ICA	15 (52)
Left ICA	14 (48)
Aneurysm location	
Anterior choroidal artery	0
Ophthalmic segment	11
Posterior communicating segment	10
Superior hypophyseal	3
Cavernous ICA	2
Distal cervical/petrous ICA	3
TRA side	
Right wrist	28 (97)
Average aneurysm size (mm)	6.1
Site complications	0

ICA: Internal carotid artery, TRA: Transradial access

**Table 2: Characteristics of transfemoral access flow diversion cases**

Characteristics	n (%)
Age, years (average)	52
Female:male	3.8:1
Target vessel	
Right ICA	27 (46)
Left ICA	32 (53)
Aneurysm location	
Anterior choroidal/ICA terminus	4
Ophthalmic segment	24
Posterior communicating segment	10
Superior hypophyseal	4
Cavernous ICA	8
Distal cervical/petrous ICA	6
Miscellaneous	3
Average aneurysm size (mm)	8
Serious site complications (subjects)	3

ICA: Internal carotid artery

**Table 3: Comparison of technical aspects between transradial access and transfemoral access of flow diversion treatment for treatment of anterior circulation cerebral aneurysm**

Characteristics	Transradial	Transfemoral
Average PED size (mm)	4.0	3.9
Average PED length (mm)	17.1	18.0
Triaxial platform (%)	100	100
Successful final PED deployment (%)	100	100
Average radiation exposure (min)	39.7	41.7
Rate to conversion (%)	10 (three patients)	0

ped: Pipeline embolization device

While the TRA has proven to be safe and effective for interventional cardiology cases, its role in neurointerventional procedures was initially limited to diagnostic procedures.<sup>[1]</sup> The traditional TFA had

been the “workhorse” access site for diagnostic and neuroendovascular procedures until recently. With the advent of new catheters, operator experience, and better understood techniques, the TRA has started to become more commonplace in neurointerventional cases. Furthermore, the TRA has been shown to be a safe technique not only for diagnostic procedures but also for complex interventions.<sup>[3,11,12]</sup>

Deployment of flow-diverting stents initially appeared to be a challenging feat to accomplish through the TRA. While the TRA does offer a reduction in hemorrhagic access site complications, especially in patients on dual antiplatelet therapy, it remained unclear whether the TRA would provide adequate support for the safe deployment of a stent. Flow diverters require large guide catheter support and often an additional intermediate catheter to provide additional support for the microcatheter, through which the device is deployed. Navigating the cavernous and supraclinoid carotid, at times a tortuous route, requires substantial support for precise placement of the flow diverter stent.

In this retrospective two-center study, we demonstrate that a triaxial system can safely be employed in flow diverter deployment through the TRA without any increased risks when compared to TFA. The major limitation of the TRA is the size of the radial artery. If the artery-to-sheath ratio is  $> 1$  or close to 1, then a 6-Fr catheter (0.70” ID) or 6-Fr long sheath (0.88” ID) may be used. In some cases, operators may encounter severe vasospasm of the radial artery, even in cases with an adequately sized artery. In these cases, we recommend that additional doses of spasmolytic medications be used and adequate sedation of the patient be provided by the anesthesiologist. In extreme cases of vasospasm or unfavorable vascular anatomy (three cases in our series), we recommend transition to the TFA.

In this series, TRA was not used if the radial artery caliber was smaller than 2 mm. There were three cases which were converted to TFA, as explained above. Of importance, preoperative CT angiogram of the head and neck can provide important information regarding the anatomy of the supra-aortic vessels during the transition from the TFA to the TRA. In most cases, a bovine left ICA is more easily catheterized from the right TRA than from the traditional TFA. The CTA neck also provides information regarding vascular anomalies such as aberrant origin of the right subclavian artery or stenosis in the right subclavian artery. In those cases, the right TRA is not optimal for navigation to the supra-aortic vessels, and left-sided TRA or TFA can be used instead.

### Limitations

This is a retrospective study performed at two centers. In addition, long-term follow-up of these patients is not

available for review. Due to its retrospective nature, we cannot provide any data regarding long-term radial artery complications, which include occlusion rates of the radial artery.

### Conclusion

As familiarity with the TRA increases, this approach will become more commonplace for neurointerventional cases. Here, we have provided data regarding the feasibility of the TRA for flow-diverting stent deployment at two centers. While long-term studies are still lacking regarding this approach, we demonstrate that the radial first approach is safe and feasible for flow-diverter deployment.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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