

# Feasibility and Utility of Transradial Cerebral Angiography: Experience during the Learning Period

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**Objective:** We wanted to present our experiences for performing transradial cerebral angiography during the learning period, and we also wanted to demonstrate this procedure's technical feasibility and utility in various clinical situations.

**Materials and Methods:** Thirty-two patients were enrolled in the study. All of them had unfavorable situations for performing transfemoral angiography, i.e., IV lines in the bilateral femoral vein, a phobia for groin puncture, decreased blood platelet counts, large hematoma or bruise, atherosclerosis in the bilateral femoral artery and the insistence of patients for choosing another procedure. After confirming the patency of the ulnar artery with a modified Allen's test and a pulse oximeter, the procedure was done using a 21-G micropuncture set and 5-F Simon II catheters. After angiography, hemostasis was achieved with 1–2 minutes of manual compression and the subsequent application of a hospital-made wrist brace for two hours. The technical feasibility and procedure-related immediate and delayed complications were evaluated.

**Results:** The procedure was successful in 30/32 patients (93.8%). Failure occurred in two patients; one patient had hypoplasia of the radial artery and one patient had vasospasm following multiple puncture trials for the radial artery. Transradial cerebral angiography was technically feasible without significant difficulties even though it was tried during the learning period. Pain in the forearm or arm developed in some patients during the procedures, but this was usually mild and transient. Procedure-related immediate complications included severe bruising in one patient and a small hematoma in one patient. Any clinically significant complication or delayed complication such as radial artery occlusion was not demonstrated in our series.

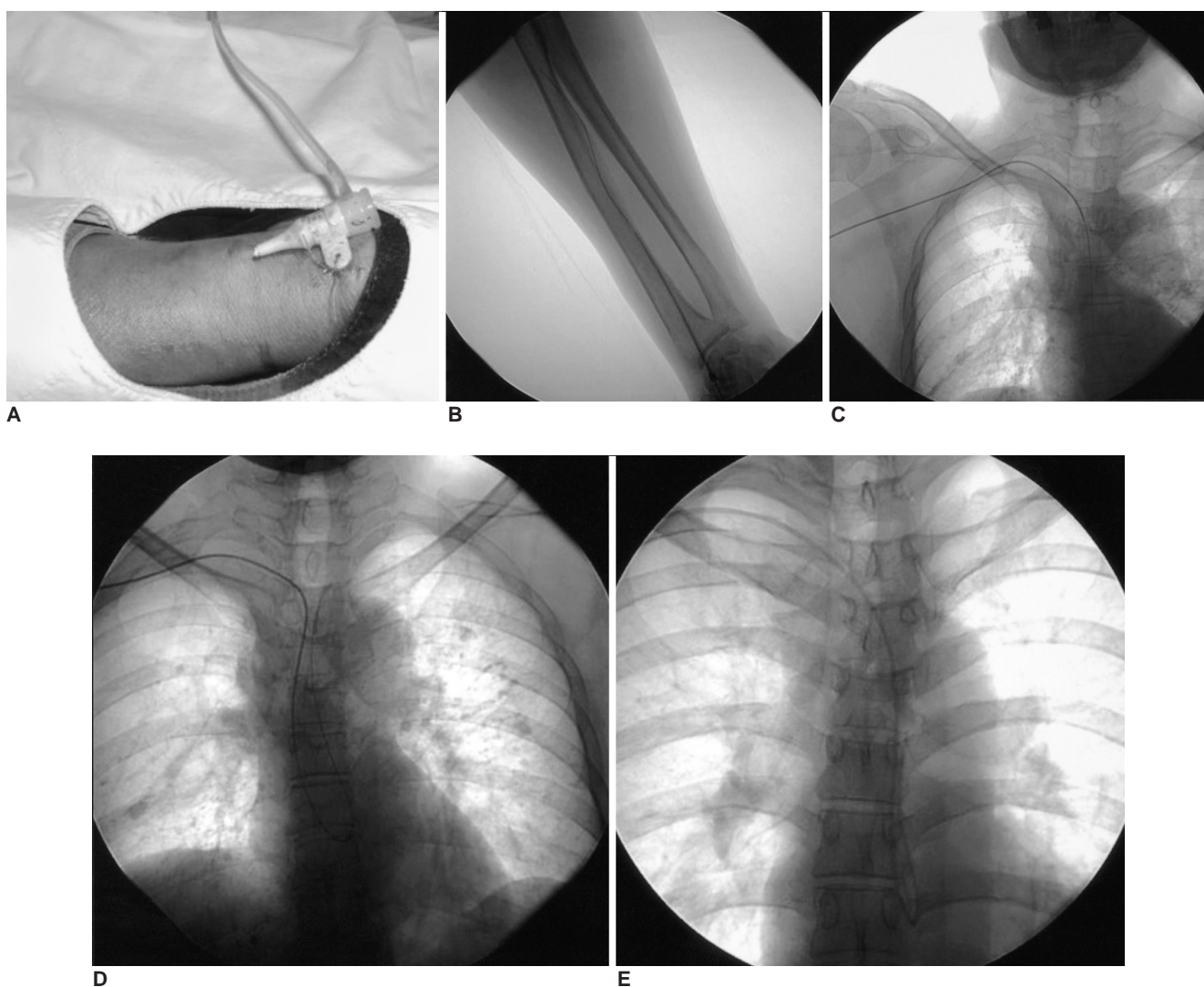
**Conclusion:** Transradial cerebral angiography is a useful alternative for the patients who have unfavorable clinical situations or contraindications for performing transfemoral cerebral angiography. For the experienced neurointerventionalists, it seems that additional training for performing transradial cerebral angiography is not needed.

**T**he femoral artery has been the most common and popular puncture route for catheter-based cerebral angiography. It is easy to puncture and has an adequate size to insert a catheter or an introducer sheath with a large diameter. The incidence of puncture-related complication is also low if the patients' bleeding profiles are normal and post-angiographic compression is appropriately done. However, the transfemoral approach requires a long procedural time, at least 6–8 hours along with bed rest, and the patients have to be hospitalized for safety. The brachial or axillary artery can be an alternative access routes, but it is well known that the puncture related complication rate is higher for both these arteries (1, 2).

The transradial approach has been used for angiography since 1989 (3). It was first tried in the field of coronary angiography and intervention, and many studies have reported its benefits to patients for both comfort and cost-effectiveness (2–10). Similar benefits were also expected for using this approach for cerebral angiography, and several studies have tried to prove real benefits (11–16). Although neurointerventionalists already recognize the benefits of the transradial approach, most of them still favor the transfemoral approach. This is because the transfemoral approach is much more familiar, and most of them think a training period is required for performing transradial cerebral angiography. Actually, the psychological burden related to the initial learning period may act as

a critical factor to dampen neurointerventionalists' initial motivation and their willingness for further trials.

We think that presenting the experiences we gained during our learning period will be very helpful for other neurointerventionalists who want to try transradial cerebral angiography, and this may encourage its application in clinical practice. In this article, we show our experiences for transradial cerebral angiography during the learning period and we demonstrate the technical feasibility and utility of this procedure in various clinical situations.



**Fig. 1.** Due to groin phobia, this 44-year-old male patient underwent transradial cerebral angiography.

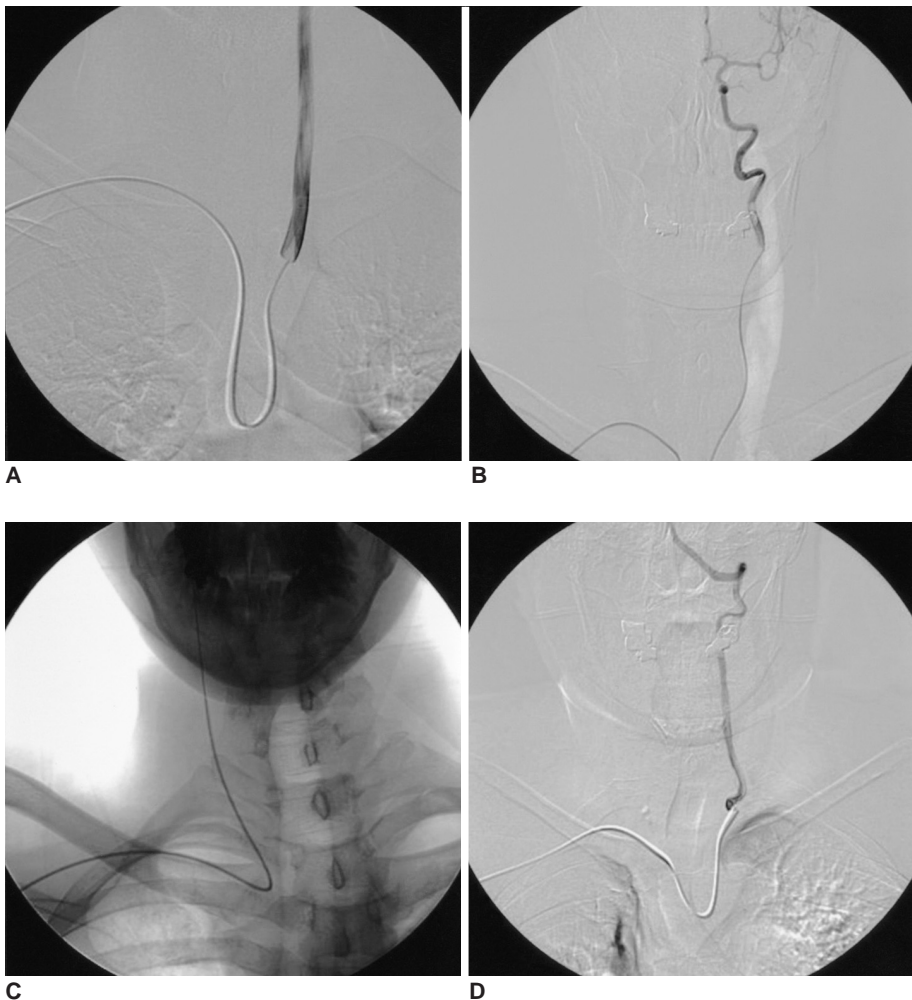
- A. A 5-F introducer sheath was inserted into the radial artery.
- B. A 0.035-inch guide wire was passed through the radial and brachial arteries.
- C. A guide wire and a 5-F Simon II catheter were introduced into the ascending aorta.
- D. The guide wire was turned back at the aortic valve.
- E. A J-curve was made at the distal portion of the Simon II catheter.

## MATERIALS AND METHODS

We performed transradial cerebral angiography in 32 patients (M:F = 19:13, age range: 22–68 years, mean age of 46 years). All of them displayed factors that made it unfavorable for them to undergo cerebral angiography via the transfemoral approach. Six patients had intravenous (IV) lines in the bilateral femoral vein with overlying dressing. Five patients had a phobia for performing a groin puncture. Five patients had abnormally decreased blood platelet counts. Four patients had large hematomas or bruises in the bilateral inguinal area that were due to IV line leakage or previous transfemoral angiography. Six patients had severe atherosclerosis in their bilateral femoral artery. Two patients, who had undergone aneurysm clipping, strongly wanted to undergo outpatient department based follow-up angiography without hospital admission. Four patients were in a mentally confused state, and it would have been difficult for them to stay quiet for a long period of bed rest without moving their lower extrem-

ities after transfemoral angiography.

All procedures were performed for diagnostic purposes; 15 patients were evaluated for the cause of subarachnoid hemorrhage or nonhypertensive intracerebral hemorrhage, 11 patients were followed up after aneurysm clipping and six patients were evaluated for patency of their intracranial arteries. We performed all the transradial approaches at the right side. If the right side was not available, we did not proceed with the transradial approach because performing this procedure via the left arm was very inconvenient to do in our angiography unit. At first, the patency of the right ulnar artery and palmar arch was examined with using the modified Allen's test and a pulse oximeter. After compressing both the ulnar and radial arteries of the right hand, the patient repeatedly clenched their hand into a fist until the hand blanched. If the palm reddened less than ten seconds after release of pressure over the ulnar artery, the patency of the ulnar artery was considered normal (modified Allen's test). The arterial waveform and arterial O<sub>2</sub> saturation (SaO<sub>2</sub>) were also checked via a pulse oximeter applied to the thumb. After the ulnar artery was



**Fig. 2.** When handling the catheter, the brain supplying arteries can be easily selected.

- A.** Left common carotid artery,
- B.** Left internal carotid artery,
- C.** Right common and internal carotid artery,
- D.** Left vertebral artery.

proven to be patent on both tests, a small amount of 1% lidocaine was infiltrated into the subcutaneous tissue on the radial artery around the styloid process of the radius. Using 21-G micropuncture system (Cook, Bloomington, IN), the radial artery was punctured cephalic to the styloid process. A 5-F Introducer sheath (Terumo, Tokyo, Japan) was inserted through the punctured radial artery. To prevent vasospasm, 3 mg of verapamil was injected through the side-port of the introducer sheath. Instead of continuous saline flushing, we filled the side-port of the introducer sheath with heparin solution. Heparin, 2,000 – 3,000 IU, was injected through the IV route into the patients. Under fluoroscopy monitoring, a 0.035" guide wire (Terumo, Tokyo, Japan) was gently advanced from the radial artery to the brachial artery, and then 5-F Simon II catheter (Cook, Bloomington, IN) was introduced over the wire. Wire was subsequently advanced to the ascending aorta and turned back at the aortic valve. A 5-F catheter was placed over the wire to make a J shape. After making the J shape with the catheter, the wire was withdrawn to the curve point of the catheter. The catheter tip was controlled to select the orifice of the target artery (the innominate artery, left common carotid artery or the left subclavian artery), and then it was raised to the distal portion of that artery over the wire for more distal selection (the internal carotid artery or vertebral artery). After finishing the angiography, the introducer sheath was removed and manual compression was very gently done for 1–2 minutes. Subsequently, a hospital-made wrist-brace was applied for two hours. Bleeding at the puncture site, color change of the hand and pulsation of the radial artery were checked for the following three hours. The

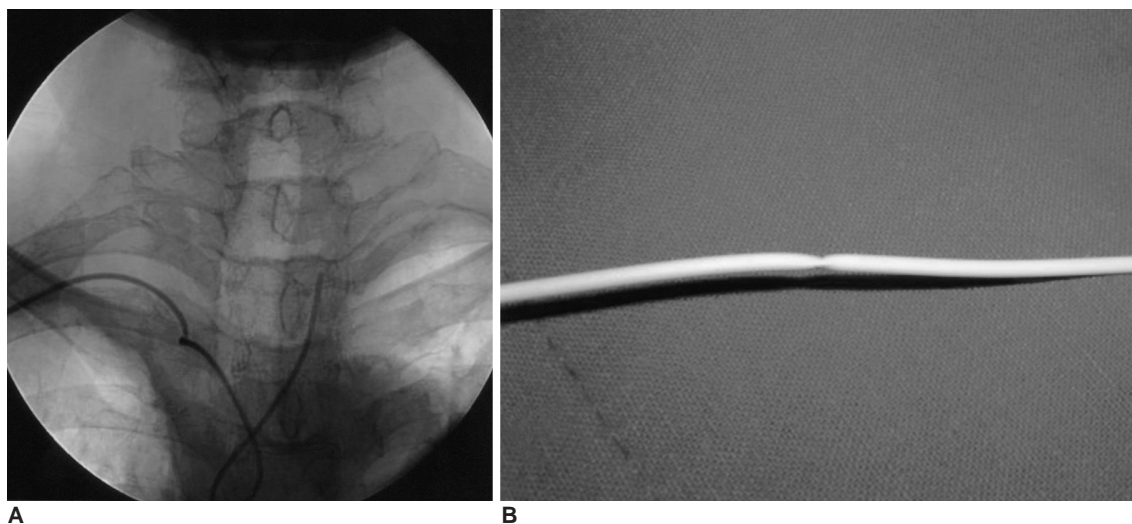
technical details and feasibility were evaluated, and the immediate and 6-month delayed procedure-related complications were examined.

## RESULTS

The ulnar artery and palmar arch were revealed to be patent in all patients on the pulse oximeter evaluation. Their arterial waveform and the SaO<sub>2</sub> of the digital artery in the thumb were normal during compression of the radial artery around the wrist. The procedure was successful in 30/32 patients (93.8%) without serious difficulties. It failed in two patients - one with hypoplasia of the radial artery



**Fig. 4.** During guide wire insertion through the radial artery, it entered the radial recurrent artery, causing sharp pain in the forearm.



**Fig. 3. A.** During catheter handling to select the right common carotid artery, the catheter kinked because of excessive torque. The innominate artery was very tortuous in this patient.  
**B.** The catheter was withdrawn. Focal kinking is demonstrated in the catheter.

and one experienced vasospasm of the radial artery following multiple puncture trials. A 5-F Simmons type II catheter was used for all the procedures, except for one patient, to select the left vertebral artery. For that patient, successful selection was achieved with using 5-F headhunter catheter (Cook, Bloomington, IN). Handling the catheter to select arteries was not difficult and there were no significant technique-related problems (Figs. 1, 2). However, severe folding of the catheter occurred in one patient because of the excessive torque that was used to the select common carotid artery (Fig. 3). We changed this for a new catheter and we were able to finish the angiography with performing more careful handling of the catheter. Pain in the forearm or arm developed in some patients during the procedures, but it was usually mild and transient. In one patient, the pain was very severe, which was due to the wire entering a small arterial branch during advancing the wire (Fig. 4). The immediate procedure-related complications included severe bruising in one patient and a small hematoma in one patient. Procedure-related hand ischemia was not demonstrated in our series. On the 6-month follow-up, chronic or delayed complications such as radial artery occlusion were not demonstrated in any patient.

### DISCUSSION

The transradial approach in coronary angiography was introduced for the first time in 1998 (3). It was considered to reduce the puncture site complication rate and to increase the comfort of the patients (4, 5). The transradial approach is now the first choice for performing coronary angioplasty in a number of centers worldwide because of its low puncture site complication rate, as compared with the transfemoral approach, for the patients undergoing anticoagulation therapy (6–8). However, when it is used only for diagnostic purposes, there is no definite benefit to perform the transradial approach except for reducing bed rest time (17). The transfemoral approach is also safe, relatively painless, easy to learn and, most of all, physicians are more familiar with it than the transradial approach. Therefore, transradial angiography for diagnostic purposes is usually reserved for the patients with contraindications for the transfemoral approach (8, 17).

The transradial approach in neuroangiography and neurointervention was introduced in 2000 (11). It was expected to have similar clinical gains as those of transradial approach in coronary angiography. There have also been reports about carotid and vertebral artery stenting following descriptions about transradial cerebral angiography via the transradial approach (14, 15). Some authors

have asserted that the transradial approach could be a gold standard for cerebral angiography (13), although the transfemoral approach is usually favored in almost all centers because of its familiarity and convenience. We also favor the transfemoral approach for cerebral angiography. However, we sometimes encounter difficult clinical situations that necessitate forgoing the transfemoral approach, and we need other access routes for cerebral angiography. Our study included patients with cannulation in the bilateral femoral veins, bleeding tendencies, groin phobia, large hematomas in their groins and severe atherosclerosis in the bilateral femoral arteries. Even though these situations were not absolute contraindications for the transfemoral approach, we had to consider another approach route to obtain a successful result and for the convenience in performing the procedures. Femoral vein cannulation itself was not an obstacle for a femoral artery puncture, but we had to consider the risk of contamination. Hildick-Smith et al. have reported on transradial coronary angiography in the patients for whom the transfemoral approach was contraindicated (17). Their series included patients with peripheral vascular disease, peripheral vascular grafts, peripheral angioplasty, amputation, abdominal aortic aneurysm, thoracic aortic aneurysm, aortic dissection, coarctation, coagulation abnormality, recent thrombolysis, thrombocytopenia, morbid obesity and groin phobia (17).

We followed the techniques described in the previously published articles (5, 11–13), and we modified them to be suitable to our angiography unit. Even though this was a pilot trial and we were without previous experience, transradial neuroangiography was technically feasible in most patients and hemostasis at the puncture site of the radial artery was easily achieved with just short-time manual compression and subsequent applying a hospital-made brace. The failures in two patients were due to radial artery spasm that was caused by multiple puncture trials and hypoplasia of the radial artery. We think sonographic evaluation of the radial artery is helpful for deciding on further trials if the first two or three puncture trials are not successful (18). Hildick-Smith et al. have reported that the success rate of a transradial approach to the coronary artery was from 88% for beginners to 94% for experienced specialists (17). Some authors have reported higher success rates that reached 96–98% (19–21). Even though we were beginners in a learning period, the success rate was 93.8% in our series.

The Simon II catheter was the choice of catheter for transradial neuroangiography. With a Simon curve made at the aortic valve and with appropriate catheter manipulation, we could easily catheterize the innominate artery, left

common carotid artery and left subclavian artery. Catheterizing the more distal arterial branches, i.e., the right common carotid artery, right vertebral artery, right internal carotid artery, left internal carotid artery and left vertebral artery, was also feasible without difficulties. In one patient, however, a headhunter catheter was needed to catheterize the left vertebral artery. Although we used 5-F catheters, 4-F catheters are preferred for the transradial approach in a number of other institutes. We also used 4-F catheters in our early series (not included in this study). However, we experienced that the 4-F catheters were more easily kinked than the 5-F catheters in the tortuous arteries, and controlling the torque of the 5-F catheter tip was easier than for the 4-F catheters. Some authors have reported that they used 5-F as well as 4-F catheters for transradial cerebral angiography (13, 16). However, they did not mention their criteria for catheter selection. The Simon catheter has unique curvature in the tip, which may cause damage to the vessel wall when it is advanced through the vessel, especially in the vertebral artery with a relatively narrow lumen. To avoid vessel wall damage in the vertebral artery, we placed the catheter tip to the orifice or the most proximal portion of the vertebral artery.

Some authors have mentioned that they advanced a catheter from the radial artery to the subclavian artery without fluoroscopic monitoring (13). However, we think fluoroscopic monitoring is very important for the comfort and safety of the patient. The wire or catheter may enter small muscular branches of the radial or brachial artery, and further advancement through those branches may cause severe pain or vascular injury.

As has been proven in many previous studies, the rate of puncture-related complication is very low in the transradial approach. Except for a small hematoma and some bruising, we did not experience any immediate and delayed complications at the puncture site. Hemostasis at the puncture site was easy, not painful and it was needed for just a short time. As was demonstrated in two patients of our series, the transradial approach seems to be appropriate for patients with mental confusion. Long-time bed rest without moving the lower extremities is usually impossible in those patients, which increases the puncture-related complication rate of the transfemoral approach. Severe atherosclerotic change of bilateral femoral arteries is also an indication for the transradial approach. If the femoral pulse is not palpable, the transradial approach should be considered along with the suspicion of severe atherosclerosis. Even though the procedures were performed during learning period, transradial cerebral angiography was successfully performed in almost all patients, and there were no techni-

cal difficulties or serious complications.

In conclusion, the transradial approach is a useful alternative for the patients who have unfavorable clinical situations for performing transfemoral cerebral angiography. We think that for experienced neurointerventionalists, additional training for transradial cerebral angiography is not needed.

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