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TECHNICAL NOTE

The Radial Artery Access Site for Interventional Neuroradiology Procedures

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The radial artery access site offers many advantages in neuroangiography. Right vertebral artery access is readily obtained from a right radial artery approach. As with cardiology procedures, neuroradiology procedures may necessitate the use of lytic therapy or platelet inhibitors. Sheath removal can be done without reversal of anticoagulation or concerns about major bleeding complications. We report our experience in using the radial artery access site for interventional neuroradiology cases. Practical considerations and technical details are offered.

Radial artery access for coronary intervention has become a routine procedure.[1,2] The radial artery offers numerous advantages over other access sites for coronary procedures. The primary advantage is a low incidence of access site bleeding complications, because the radial artery is readily compressed.[3] Angiography can be performed from the radial artery even in the setting of warfarin (Coumadin) administration, lytic therapy, or antiplatelet therapy, without the need for closure devices or prolonged, supine bedrest.[4] The radial artery is markedly different from the axillary and brachial arteries. The radial artery, in the setting of a patent palmar arch, is not an end artery, thus occlusion or injury of the radial artery will not typically result in tissue injury. The radial artery is readily compressed, hematoma formation is rare, and radial artery occlusion rates, even after the use of 6F sheaths, are low.[1,3] Although radial artery access is common in cardiology, its use in neuroradiology and interventional neuroradiology remains rare.[4-7]

Description of Technique

Before considering radial artery access, it is imperative to confirm that the palmar arch is patent by performing an Allen test.[8] With the patient's hand slightly flexed, the ulnar and radial arteries are simultaneously compressed as the hand is vigorously opened and closed. Blanching of the hand occurs as the blood drains. A positive Allen test is observed when there is adequate collateral circulation to the hand from the ulnar artery and a palmar blush occurs within 5–10 seconds after releasing the ulnar artery. A negative Allen test is a contraindication to radial artery catheterization. The most physiologic test is that of pulse oximetry with radial artery occlusion. For this test, a pulse oximeter is placed on the thumb and a baseline waveform is obtained. It is important to note both the shape of the waveform as well as the percentage value of oxygenation. After evaluation of the baseline pulse oximetry, the ipsilateral radial artery is occluded with manual pressure. The pulse oximetry is evaluated to confirm continued adequate waveform. The percentage of oxygenation should not diminish over time during the test occlusion of the radial artery. If either the waveform becomes damped or the percentage oxygenation drops more than 2%–3%, the radial artery should not be used for access. If the pulse oximetry evaluation shows adequate palmar arch collateral supply, then a visual Allen test can be performed as described above, though this test may be more subjective than the pulse oximetry test. Last, an audible Doppler evaluation of the palmar arch may be performed, if available. The palmar arch is identified along the proximal aspect of the palm with a handheld Doppler unit. The radial and ulnar arteries are then compressed until the Doppler signal intensity is no longer heard. At this time, ulnar artery compression is released and Doppler interrogation of the palmar arch is maintained. If adequate ulnar artery collaterals are present, the audible Doppler waveform will reappear.

A modified armboard is used to support the upper extremity. Although the radial artery is often palpated most readily near the radial styloid, puncture is best performed approximately 2–3 cm cephalad to the radial styloid. This allows entry to a larger, less tortuous portion of the radial artery compared with that seen more distally. In most cases, the right radial artery is used, although the left radial artery may also be used. The subcutaneous tissue is anesthetized. Dedicated radial artery access entry sets, including a 21-gauge needle, a 0.018-inch microguidewire, and a sheath (either 4, 5, or 6F) with a dilator tapered to 0.018 inches, are available (Cook Inc, Bloomington, Ind). Although a single wall entry would be ideal, it is usually not possible to achieve, and double-wall puncture is often required. The 21-gauge needle is advanced with light palpation above and below the access site. Overly vigorous pressure applied proximal to the puncture site may obscure the artery and render access difficult or impossible. After needle access, the wire is placed and a skin nick is made adjacent to the needle. The needle is then removed and the sheath is placed. Most patients can tolerate up to a 6F sheath without undue risk of radial artery injury. After sheath placement, antispasm prophylaxis is performed by instillation of 3 mg of verapamil into the radial artery sheath.[9] We do not recommend the use of continuous flush into the sheath, but routinely administer a 500-U heparin bolus into the side-port of the sheath.

Access through the upper-extremity vessels is facilitated by the use of a straight guidewire. We primarily use the 0.035-inch Bentson guidewire (Cook Inc). Angled guidewires tend to become lodged in small branch vessels and should thus be avoided while gaining access to the subclavian artery. Because most neuroangiography suites do not allow ready imaging of the upper extremity, this portion of the procedure is usually done without fluoroscopic guidance. The system should be advanced gently to the level of the shoulder.

Guiding catheter placement in the right vertebral artery is straightforward. We either place an angled Envoy guiding

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catheter (Cordis, Miami Lakes, Fla) or place a 5F diagnostic catheter and exchange for the guiding catheter. For access into the right carotid system, 2 different approaches may be used. A backwards-facing catheter such as a Simmons curve can be used. In that case, the Simmons catheter is advanced over a Bentson guidewire into the aortic arch. The catheter can be formed at the aortic root or by passing a wire into the descending aorta, advancing the Simmons catheter partially into the arch, and then removing the wire as the catheter is advanced farther until it is formed appropriately. Once formed, the Simmons catheter is retracted into the common carotid artery. If access into the internal or external carotid artery is required, the catheter is then advanced over a wire into these vessels. Once in place, the Simmons catheter can be exchanged for a guiding catheter over an exchange length wire. An alternative approach for access into the right carotid system is the use of a sharply angled catheter, because the origin of the common carotid artery is often highly acute with respect to the brachiocephalic artery. An angled guidewire is useful in these situations to facilitate advancement of the catheter into the common carotid artery.

Although left carotid and left vertebral artery interventions can be performed from a right radial artery access site, in most cases this approach is relatively unfavorable. In particular, when the brachiocephalic and left common carotid arteries have separate origins, the passage of a guiding catheter from one vessel to the other through the aortic arch is difficult, though access for diagnostic work is straightforward when using a Simmons-type catheter. One instance in which the right radial access site may be preferred over the femoral access site is in cases where the left carotid artery arises directly from the brachiocephalic artery in a horizontal course. The approach to the left carotid system in this situation is a straight line from the radial access site. The use of the right radial approach for placement of a left carotid stent in the setting of such aortic arch anatomy has been reported.[10]

The same difficulty with left common carotid access can be seen with interventions in the left vertebral artery from the right radial approach. It is possible to access the left radial artery for left vertebral interventions, though the angle of origin of the left vertebral artery may be quite acute relative to the subclavian artery.

At the termination of the angiogram, the sheath is removed and a wrist brace (RadStat, Merit Medical, South Jordan, Utah) is placed. If there is resistance to removal of the sheath, then a second infusion of verapamil is given. Anticoagulation does not need to be reversed because the wrist brace is kept in place for 2–3 hours, depending on the amount of heparin administered during the procedure. If continued oozing or bleeding is noted at the time of initial brace removal, then an additional hour of bracing can be used. Patients are allowed to sit up immediately after the procedure, if their medical condition allows. Close observation is maintained regarding adequacy of distal tissue perfusion.

Over a 36-month period, we performed 726 endovascular neurointerventional procedures. Of these 726 procedures, 26 patients underwent neurointerventional procedures from a radial artery access approach (Table 1). Radial artery access was pursued under 2 circumstances. When the procedure was technically difficult or impossible from a routine femoral artery approach, access was converted to the radial artery. Otherwise, radial artery access was used in those cases in which guiding catheter placement in the right subclavian or vertebral arteries was anticipated before intervention. Twenty-five of the 26 cases used the right radial artery for access. In a single case, the left radial artery was entered to allow access to the left costocervical and thyrocervical trunks. The target territory was successfully catheterized from the radial access site in all cases in this series. Twenty of 26 cases were vertebrobasilar interventions and 5 were carotid territory interventions. A single case involved intervention in left subclavian artery branches. Six French sheaths were used in 62% of cases and 5F sheaths were used in 31%. A 4F system was used in 2 cases (7%). In the case of left radial artery access for tumor embolization, a 4F sheath and 4F vertebral catheters were used in the left subclavian artery. One of 10 basilar tip aneurysms was treated with both right radial and common femoral artery access routes. The right radial artery was entered with a 4F sheath, and a 4F vertebral catheter was placed in the right vertebral artery. Through this system, a remodeling balloon was placed across the aneurysm neck. The common femoral artery route was used for guiding catheter and microcatheter access into the left vertebral artery for coil deposition.

Interventional neuroradiology cases performed with radial artery access

Guiding Catheter Location	Procedure	No. of Cases
Right vertebral artery	Basilar tip aneurysm coiling	10
	PCA aneurysm coiling	2
	Intracranial stenting	1
	AVM embolization	1
	SCA aneurysm coiling	1
	Distal vertebral artery sacrifice	1
	Thrombolysis	2
Right subclavian artery	Vertebral artery origin stenting	2
Left subclavian artery	Tumor embolization	1
Right internal carotid artery	Thrombolysis	2
	AcomA aneurysm coiling	1
	Intracranial stenting	1
	ICA test balloon occlusion	1
Total procedures		26

Note:—PCA indicates posterior cerebral artery; AVM, arteriovenous malformation; SCA, superior cerebellar artery; AcomA, anterior communicating artery; ICA, internal carotid artery.

No significant complications related to the radial artery access site were encountered in our series. No hematomas occurred at the radial access site and no hand injuries were reported. Although the radial artery was palpable in all cases after removal of the occlusion device, we did not assess the long-term patency of radial arteries accessed for interventional procedures. We did not specifically record the cases in which radial artery access was not pursued because of a negative Allen test. However, we estimate that this occurred in approximately 3–5 neurovascular interventional cases during the same period.

Representative Case

A 69-year-old man with vertebrobasilar ischemic symptoms was evaluated with MR imaging and MR angiography. The left vertebral artery was occluded, and the patient was referred for angiography and endovascular treatment of a suspected right

vertebral artery stenosis. The right radial artery was accessed and a 6F sheath was placed. A 6F guiding catheter was then advanced over a 0.035-inch wire into the right subclavian artery. Single-plane anteroposterior digital subtraction angiography was then performed over the proximal right vertebral artery during injection of the guiding catheter and a high-grade vertebral artery origin stenosis was confirmed. A 3.75-mm balloon-expandable stent was then placed across the stenosis at the right vertebral artery ostium. After deploying the stent and removing the balloon, a repeat angiogram through the guiding catheter was performed. After removal of the catheter and sheath, pressure was applied for 10 minutes over the puncture site, and hemostasis was achieved. There were no complications and the patient was asymptomatic at 1-year follow-up.

Discussion

The upper extremity access approach offers great advantages in neurointerventional procedures. The primary advantage is that of ready access to the vertebral artery origin, especially the right vertebral artery that may often be difficult to access from the femoral artery. In the past, however, upper extremity access sites have included the axillary and brachial arteries, which are end arteries without robust collateral networks in case of untoward occlusion. Furthermore, compression of these arteries may be difficult and hematoma formation common, with substantial risk for nerve injury or compartment syndrome. Thus, these access sites have represented sites of "last resort" in most practices.

In contradistinction to axillary and brachial artery access sites, the radial artery represents a safe, practical alternative with minimal risk of adverse effects. Unlike the axillary and brachial arteries, the radial artery in most patients contributes to a rich collateral arcade that minimizes or eliminates risk of ischemic complications. This small risk can be further minimized by performing careful evaluation of the patency of the palmar arch by pulse oximetry, Doppler ultrasound, and visual Allen tests. Risk of hematoma formation is minimal, because the radial artery is readily compressed. Hemostasis is readily obtained even in the setting of systemic anticoagulation or multiagent antiplatelet therapy. Indeed, we do not reverse heparinization before sheath removal and simply apply compression banding for 2–3 hours.

Although the radial artery is of relatively small size compared with the femoral artery, sheaths up to 6F can be used in most patients. 6 French sheaths are used routinely in cardiac interventions, where the radial artery approach was initially popularized. Thus, most neurointerventional procedures, including aneurysm coiling, intracranial stent placement, and thrombolysis, are readily performed from a radial artery access site.

In all cases, we placed a short sheath in the radial artery and then placed guiding catheters through this sheath. We do not recommend the use of long sheaths in the radial artery system. In particular, the use of "guiding sheaths," where the sheath itself is advanced to the target territory as in transfemoral carotid stent placement, has not been done in our practice. Previous authors have applied this technique with resultant radial artery occlusion.[11]

When possible, we use the radial artery access site for vertebrobasilar interventions not only because of diminished risk of access site bleeding complications but also because of excellent guiding catheter stability afforded by the radial approach. Unlike femoral artery access, where the catheter traverses the large-diameter aortic arch, the guiding catheters with radial artery access are constrained in relatively small-diameter vessels. Thus, herniation of guiding catheters, as commonly seen from the femoral approach, may occur less frequently with radial access cases.

We also favor the radial artery access site for thrombolysis cases in the right carotid territory, because the radial access site essentially eradicates bleeding complications even in the face of a systemic thrombolytic state. Use of the radial access site for left carotid thrombolysis remains possible. However, except for anatomy such as a "bovine" arch, such cases can be quite challenging because of difficulty in gaining stable guiding catheter access in the left carotid from the right radial access site.

The radial artery access site can also be used for routine diagnostic angiography. Patients may prefer radial access compared with femoral access, because they can sit up immediately after the procedure and can be discharged promptly. The radial access site can also be used in patients receiving warfarin, because hemostasis can be achieved even in the setting of systemic anticoagulation.[12]

Concern remains regarding the risk of permanent injury to the radial artery, especially with the use of larger sheaths. There is vast literature regarding the risks of radial artery access procedures for coronary indications. This literature has shown the risk of permanent radial artery injury to be low, even after multiple procedures in the same radial artery.[13] If careful documentation of patency of the palmar arch is performed, then risk of injury to the hand is minimal even if the radial artery is permanently damaged. Another consideration that should be addressed is whether the patient may need coronary revascularization by using the radial artery as a donor graft. However, these procedures are usually done by using the radial artery in the nondominant arm, which would be the left radial artery in most patients. It would be prudent, however, to discuss use of the radial artery with the referring surgeon to avoid difficulty in the future.

Hemostasis at the radial artery access site can be achieved either with manual palpation or a compression device.[14] In our practice, if the patient is not anticoagulated, we prefer 10 minutes of manual palpation to achieve hemostasis. If systemic anticoagulation is to be continued or not reversed after the procedure, then we apply a compression device for 2 hours. The various compression devices designed for the radial artery allow for focused compression of the radial artery but avoid compression of the ulnar artery.

Conclusion

The radial artery is a safe alternative to femoral artery access in interventional neuroradiology cases. This is especially true for interventions involving the right vertebral and carotid arteries where radial artery access is often easier to accomplish. Interventional neuroradiologists should become familiar with radial artery access to provide comprehensive endovascular care to their patients.

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