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Technical Note

Initial experience of subcutaneous nitroglycerin for distal transradial access in neurointerventions

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ABSTRACT

Background: Transradial access (TRA) for diagnostic and interventional neuroendovascular procedures has gained significant popularity in recent years due to its improved safety profile and appeal to patients compared with transfemoral access. However, risks of TRA include hand ischemia in cases of poor ulnar collateral circulation and inability to cannulate the radial artery due to its relatively small diameter. By accessing the radial artery distal to the superficial palmar arch where ulnar collateral blood flow arises, in the anatomic snuffbox, the risk of hand ischemia is theoretically eliminated. The use of subcutaneous nitroglycerin and lidocaine to improve rates of success in radial artery access has been reported in the cardiac literature, however, has yet to be described for neurointerventional procedures. We discuss our technique and report our initial experience using subcutaneous nitroglycerin and lidocaine cocktail for access to the distal transradial artery in a variety of neuroendovascular procedures.

Methods: A retrospective review of our institution's database of neurointerventional and diagnostic procedures performed using dTRA was conducted, and 64 patients were identified between February and December 2020. Patient demographics, clinical data, procedural details, and radiographic information were collected and analyzed.

Results: A total of 64 patients underwent neurointerventional procedures using the subcutaneous injection for dTRA access. The procedures performed included diagnostic cerebral angiograms (n = 47), stent and balloon assisted aneurysm coiling (n = 5), flow diversion (n = 2), intra-saccular device placement (n = 1), mechanical thrombectomy (n = 1), tumor embolization (n = 1), middle meningeal artery embolization (n = 2), extracranial carotid stent placement (n = 2), and arteriovenous malformation embolization (n = 3). While no complications of hand ischemia were appreciated, the access site conversion rate was 3.1%; 2 cases required a switch to femoral artery access due to proximal vessel tortuosity and aortic anatomical variations, and not due to access site complication. Furthermore, on repeat angiograms by the same proceduralist, distal TRA (dTRA) was successful in 100% of the cases.

Conclusion: dTRA using subcutaneous nitroglycerin and lidocaine is a safe and effective method for neurointerventional and diagnostic procedures.

Keywords: Anatomic snuffbox access, Aneurysm, Distal transradial access, Neurovascular intervention, Nitroglycerine and lidocaine subcutaneous infusion

INTRODUCTION

Transradial access (TRA) for diagnostic and interventional neuroendovascular procedures has gained significant popularity in recent years due to its improved safety profile and appeal to patients

compared with conventional transfemoral access (TFA).[8] Numerous studies in both cardiac and neuroendovascular literatures highlight the superiority of TRA in terms of better patient satisfaction, fewer complications, and immediate patient mobility post procedure.[12] On the other hand, TFA has a 0.6% rate of severe complications including retroperitoneal hematoma, a 12% in-hospital mortality rate, and patient immobilization for 4–6 h post procedure.[10]

However, potential issues with TRA include radial artery occlusion and post procedural hand-ischemia due to poor ulnar collateral circulation, as well as ergonomic challenges in use of the left side.[1] The distal TRA (dTRA) approach, initially used in interventional cardiology, has been utilized with reports of significantly shorter post procedural hemostasis times and higher patient satisfaction rate compared to the TRA group.[6] For dTRA, the artery is accessed distal to the superficial palmar arch, thus diminishing the risk of hand ischemia due to the presence of sufficient collateral circulation between the superficial and deep palmar arches, as depicted by [Figure 1]. Rates of radial artery occlusion are lower for dTRA compared to TRA, although even in the rare event of occlusion, the proximal segment of the radial artery typically remains viable for future interventions through the standard TRA, as well as use for grafting. A puncture site in the anatomic snuffbox may also be more ergonomic improvement for cases accessing the left hand, since that the hand is more naturally positioned across the torso with the proceduralist standing on the right.[9]

dTRA has been successfully used for both diagnostic and interventional neuroendovascular procedures. In a series of diagnostic cerebral angiograms by Brunet *et al.*, 100% of the right distal radial arteries were successfully accessed without any complications, although 8.2% of patients had required conversion to standard TRA (1.2%) or TFA (7.0%).[1] Most common reasons for conversion to TRA or TFA were vasospasm or inability to advance the wire. A steep learning curve was also noted with 100% successful dTRA in the fourth quarter of the experience compared to a 14.3% conversion to TRA/TFA in the first and second quarters.

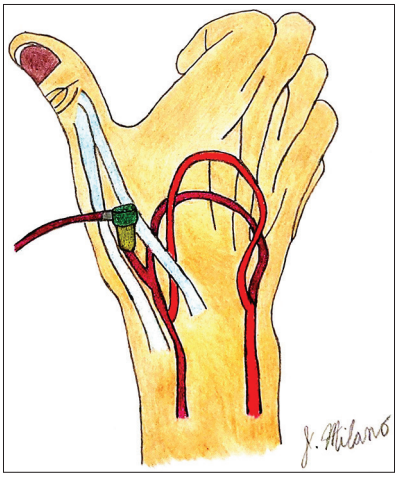

Figure 1: Distal transradial access is demonstrated in the anatomical snuffbox, formed by the tendons of extensor pollicis longus (medially) and extensor pollicis brevis and abductor pollicis longus(laterally). The deep palmar arch(DPA)[Dark red] and superficial palmar arch (SPA) [Light red] portray an elaborate network of anastomosis, with the DPA providing the distal branch into the anatomical snuffbox. These features account for the patency of proximal vessels for future access and the lack of complication of hand-ischemia.

A retrospective series of neurointerventions utilizing dTRA by Kühn *et al.* included aneurysm embolization, carotid artery stenting, and arteriovenous fistula embolization. There was a reported 10.4% conversion to TFA due to vascular tortuosity and "limited support of the catheter in the aortic arch." Radial artery vasospasm was noted and treated successfully with anti-spasmolytics in two cases (4.2%). Nevertheless, there was no report of radial artery occlusion or ischemic episode and the study concluded dTRA to be a safe and effective approach for various neurointerventions.[6]

One of the most commonly reported reasons for failure of dTRA in neuroendovascular procedures is radial artery vasospasm, for which no standard antispasmodic and/or vasodilator drug protocol currently exists.[7] Many interventionalists have adopted the use of an intra-arterial injection of nitroglycerin and verapamil to prevent radial artery vasospasm.[11] Subcutaneous infusion of peri-arterial nitroglycerine has also been shown to increase radial artery diameter and improve cannulation rates, but has not yet been described as part of a standardized protocol for cerebral angiography and neurointerventions.[4] Our case series is the first of our knowledge to report a standardized protocol of a subcutaneous injection of a nitroglycerine and lidocaine drug cocktail, in addition to the aforementioned intra-arterial infusion, to combat radial artery vasospasm for numerous neurointerventional endovascular procedures performed through the dTRA.

MATERIALS AND METHODS

This study was approved by our hospital institutional review board.

Table 1: Protocol for subcutaneous injection for neurointerventional surgery.

1. Placement of pulse oximeter on thumb or index finger of hand being accessed for continuous oximetry monitoring
2. Check Barbeau test to assess feasibility of proximal radial access in the event that distal radial access is unable to be performed
3. Subcutaneous injection of 1 milligram (mg) of 2 % lidocaine mixed with 200 micrograms of nitroglycerin
4. Ultrasound guided access to distal radial artery in anatomic snuffbox
5. After securing sheath, intra-arterial infusion of 2.5 mg verapamil mixed with 200 micrograms of nitroglycerin

A retrospective review of our institutionns database of neurointerventional and diagnostic procedures performed using dTRA was conducted, and 64 patients were identified between February and December 2020. Patient demographics, clinical data, procedural data, and radiographic information were collected and analyzed. [Table 1] lists the protocol for the subcutaneous drug cocktail infusion for the endovascular procedures.

RESULTS

A total of 64 patients were included for analysis. Of those patients, 50% were male and the mean age was 56 years (range 16–81 years). The interventional procedures included mechanical thrombectomy, stenting (extracranial carotid and intracranial), embolization (coil, balloon-assisted coil, liquid embolic, woven endobridge), and flow diversion (Pipeline [Medtronic, Dublin, Ireland]), as listed in [Table 2]. The left side was accessed in four cases (6.3%), with procedural success in each of those cases.

Vascular access through the anatomical snuffbox was successful in 100% of the patients, although two patients (3.1%) required conversion to the transfemoral approach (TFA). Conversion to TFA occurred due to near occlusion of the proximal radial artery in one patient [Figure 2] and due to significant tortuosity of the right brachiocephalic artery and variable configuration of the aortic arch in the second patient. In the single case of radial artery injury in the proximal forearm, pulse oximetry and clinical examination of the hand remained unchanged peri- and post-procedurally. As reported in [Table 3], no cases of hand ischemia or complications at the actual puncture site, such as clinically significant hematoma or inability to cannulate the vessel, were observed.

DISCUSSION

The limitations of proximal radial artery access for neurointerventional procedures are being improved on by use of the distal radial artery for vascular access. Use of the distal branch in the anatomic snuffbox leads to decreased complication rates and patient satisfaction as compared to traditional TRA and TFA. Nevertheless, guidelines across the nation are in the favor of the traditional access via the proximal forearm and the groin due to the relatively lesser data on the use of dTRA.[2,5,12] One factor that may serve to limit the use of the approach by hospitals across the nation may include the steeper learning curve associated with the approach due to the smaller diameter of the distal branch, a more angular route of the artery as compared to the relatively straight path in the forearm, and the design of catheters

Table 2: Types of Neurointerventional Procedures Comprising the Case Series.

Procedure	*n*
Diagnostic angiography	47
Stent and balloon assisted aneurysm coiling	5
Flow diversion	2
Intra-saccular device placement	1
Mechanical thrombectomy	1
Arteriovenous malformation embolization	3
Tumor embolization	1
Middle meningeal artery embolization	2
Extracranial carotid stent placement	2

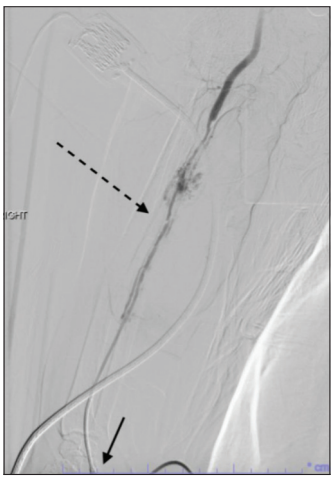

Figure 2: Right radial artery angiography in one case demonstrates near occlusion of the radial artery with a small area of contrast extravasation in the proximal forearm after advancement of a 0.035 inch glidewire (Terumo, Somerset, NJ). The vascular access site is seen distally in the anatomic snuffbox (short solid arrow) and the area of near-occlusion is seen in the proximal forearm (long dashed arrow). The brachial and ulnar arteries remained patent. Radial artery access was aborted and the procedure was completed through a transfemoral route.

Table 3: Data of Procedural Complications.

Complication	n (%)
Limb Ischemia	0
Radial artery occlusion/injury	1 (1.6%)*
Clinically significant vasospasm of the radial artery	0
Conversion to proximal radial artery access	0
Conversion to femoral artery access	2 (3.1%) · Radial artery injury in proximal forearm (*n*=1) · Anomalous brachiocephalic artery and aortic arch anatomy (*n*=1)

*Radial artery near-occlusion in the proximal forearm was observed in one case requiring conversion to an alternative vascular access route; however, the brachial, radial, and ulnar arteries remained patent and no signs or symptoms of hand ischemia were appreciated.

specific to the traditional approaches rather than the "novel" relatively longer path through the distal branch.

With increasing reports of the use of distal transradial approach, the main reported complication of the occlusion of the radial artery can be countered through pharmacologically preventing arterial vasospasm and increasing vessel diameter. Our case series reports the use of a novel drug cocktail of subcutaneous nitroglycerine and lidocaine at the cannulation site, so as to allow of an enhanced vasodilatory effect on the radial artery, in addition to the intra-arterial infusion of nitroglycerin and verapamil. While subcutaneous infusion of a calcium channel blocker and nitroglycerin has been reported to aide in radial artery vasospasm for various types of procedures; to the best of our knowledge, we are the first to report a standardized protocol for its use in both diagnostic and interventional cerebral angiography in addition to the previously reported intra-arterial antispasmodic infusion.[3]

Notably, the two cases in our series that required conversion to TFA were due to more proximal anatomic anomalies and not due to the vasospasm of the cannulation site itself. Furthermore, no occlusion was appreciated on repeat angiograms performed by the same proceduralist, and distal radial artery was successfully accessed in 100% of the repeat cases. Thus, subcutaneous nitroglycerin and lidocaine infusion before radial artery cannulation are an easy and effective way to increase the arterial diameter and prevent vasospasm, contributing to our low access-site conversion rate of 3.1% (n = 2), which is on the low end of the range of 0.3–11% reported in the literature (Kühn *et al*.)

This study is limited by its retrospective nature and relatively small sample size; however, despite those limitations, we believe that this series demonstrate our protocol relatively small sample size contributing trther study may include larger comparative studies with and without the subcutaneous infusion for neurointerventional procedures using dTRA to further strengthen or debunk the current evidence supporting its use.

CONCLUSION

dTRA using subcutaneous nitroglycerin and lidocaine is a safe, easy, and effective method for neurointerventional and diagnostic procedures.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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