Transradial Approach as the Primary Vascular Access with a 6-Fr Simmons Guiding Sheath for Anterior Circulation Interventions: A Single-Center Case Series of 130 Consecutive Patients

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■ OBJECTIVE: **In coronary intervention, the transradial approach (TRA) is increasingly used as the primary vascular access because of its numerous advantages over the transfemoral approach. However, in neurointerventions, conventional TRA with a straight-shaped guiding system is used as an alternative vascular access because transradial carotid cannulation can be technically challenging for right common carotid artery (CCA) lesions with steep angulation to the right subclavian artery or left CCA lesions with a nonbovine origin. The purpose of the present study was to evaluate the feasibility and safety of TRA as the primary vascular access with a pre-shaped Simmons guiding sheath for anterior circulation interventions.**

■ METHODS: **Between June 2018 and September 2019, 130 consecutive patients (75 carotid artery stenting and 55 cerebral aneurysm coiling cases) who underwent TRA as the primary vascular access were included in this study. A 6-Fr Simmons guiding sheath was introduced into the target CCA by selecting a cannulation technique based on preprocedural image assessment. We retrospectively analyzed the carotid cannulation success, procedural success, and periprocedural or vascular access site complications.**

■ RESULTS: **Carotid cannulation (69 right CCA, 6 left CCA with a bovine origin, and 55 left CCA with a nonbovine origin) and the subsequent procedure were successfully performed for all 130 patients without periprocedural or vascular access site complications.**

■ CONCLUSIONS: **TRA with a 6-Fr Simmons guiding sheath for anterior circulation interventions is highly successful and safe for all target CCAs and aortic arch types. This method can be utilized as the primary vascular access for anterior circulation interventions.**

INTRODUCTION

The transfemoral approach (TFA) is traditionally used as the primary vascular access to the common carotid artery (CCA) during neurointerventions. This approach, however, can be challenging or contraindicated in patients with unfavorable anatomy in the target CCA or the aortic arch, and/or peripheral vascular disease. In addition, TFA increases the risk of developing access site—related vascular complications.[1,2] The transbrachial approach can result in high rate of severe complications, including massive brachial hematoma, compartment syndrome, pseudoaneurysm, injury to the median nerve, or hand ischemia.[3,4]

The advantages of the transradial approach (TRA) for coronary interventions are well documented. These include fewer vascular

Key words
- Anterior cerebral circulation
- Carotid artery stenting
- Cerebral aneurysm coiling
- First-line access
- Neuroendovascular procedure
- Neurointervention
- Transradial access

Abbreviations and Acronyms
CAS: Carotid artery stenting
CCA: Common carotid artery
DAT: Descending aorta anchoring technique
ECA: External carotid artery
ICA: Internal carotid artery
SCAT: Subclavian artery anchoring technique
TFA: Transfemoral approach
TRA: Transradial approach

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complications, better patient comfort, and immediate ambulation.[4-8] During neurointerventions, previous studies have demonstrated that conventional TRA with a straight-shaped guiding system can be used as an alternative vascular access for accessing anterior circulation lesions, especially in right CCA lesions and left CCA lesions with a bovine origin.[9-20] However, TRA can be technically difficult for a certain population of patients with unfavorable acute takeoff of the target CCA, such as those with right CCA lesions with steep angulation to the right subclavian artery or left CCA lesions with a nonbovine origin.[10,11,13-16,21] We previously reported that TRA with a 6-Fr "Simmons-shaped" guiding sheath was useful even in such challenging conditions because a pre-shaped Simmons curve provides kink resistance and high stability.[22-25] The purpose of the present study was to evaluate the feasibility and safety of neurointerventional TRA as the primary vascular access with a 6-Fr Simmons guiding sheath specifically designed for transradial carotid cannulation.

METHODS

Patient Selection

From June 2018, we selected right TRA as the first-line, left TRA as the second-line, and TFA as the third-line vascular access during neurointerventions for anterior circulation lesions including carotid artery stenting (CAS) and cerebral aneurysm coiling at our institute. The selection criteria to prioritize TRA have been described previously[25]: (1) favorable access routes were confirmed based on preprocedural images, (2) the pulsation of the radial artery was detected, and (3) the Allen test was negative. Patients who fulfilled all these criteria were selected as favorable candidates for TRA (Figure 1).

From June 2018 to September 2019, 148 consecutive patients (148 lesions) underwent CAS or cerebral aneurysm coiling in anterior circulation at our institute. Of these, 130 patients who underwent TRA with a 6-Fr Simmons guiding sheath as the primary vascular access (124 right TRA and 6 left TRA) were included in this study. The other 18 patients were treated with TFA for the following reasons: (1) insufficient preprocedural image assessment for 14 (77.8%) patients, (2) severe tortuosity of the proximal target CCA in 2 (11.1%) patients, (3) the absence of bilateral radial artery pulsation in one (5.6%) patient, and (4) an unfavorable collateral pathway to the bilateral radial artery area on the Allen test in 1 (5.6%) patient.

This study was approved by the institutional review board. Written informed consent regarding treatment was obtained from all patients and/or their families before the procedure was initiated.

Preprocedural Anatomical Evaluation of the Target CCA.

The target CCA was classified into 3 groups: right CCA group, left CCA with bovine origin (bovine left CCA group), and left CCA with nonbovine origin (nonbovine left CCA group).

6-Fr Simmons Guiding Sheath

A 6-Fr Simmons guiding sheath (6-Fr Axcelguide Stiff-J-1 or Stiff-J-2 90 cm; Medikit, Tokyo, Japan) was used in this study (Figure 2).[22-25] This 6-Fr Simmons guiding sheath is commercially available only in Japan.

Endovascular Procedures

All procedures were performed by 2 neurointerventionalists (Y.H. and J.K.). Under general anesthesia, we introduced a 6-Fr Simmons guiding sheath into the target CCA using the "push-in" and "pull-back" cannulation techniques (Figure 3).[22] The push-in technique is a procedure to coaxially advance a 6-Fr Simmons guiding sheath using a push-in maneuver (Video 1).[22] The pull-back technique is a procedure to coaxially deliver a 6-Fr Simmons guiding sheath using a pull-back maneuver after reformation of the natural reversed curve (Simmons curve) within the ascending aorta (Video 2).[22-25] Three reformation techniques to shape the Simmons curve were used

Video

Video available at www.sciencedirect.com

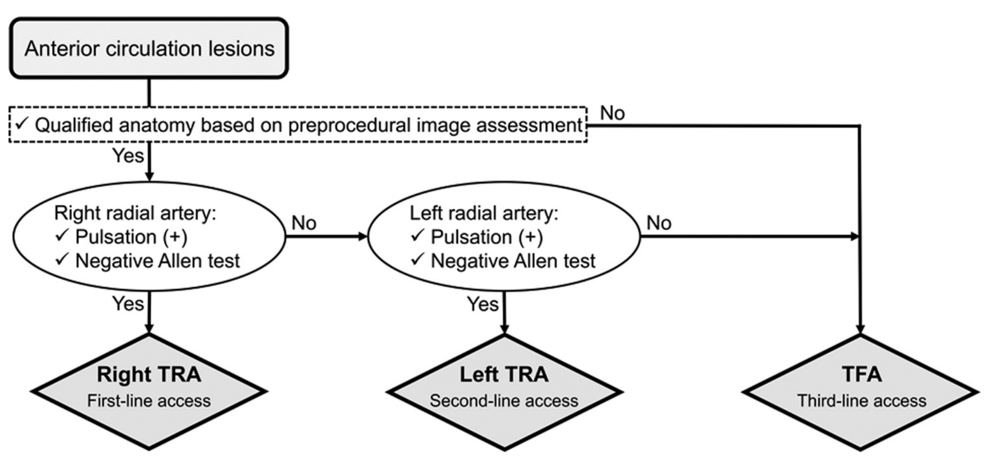

Figure 1. Flow chart of the vascular access selection. TFA, transfemoral approach; TRA, transradial approach.

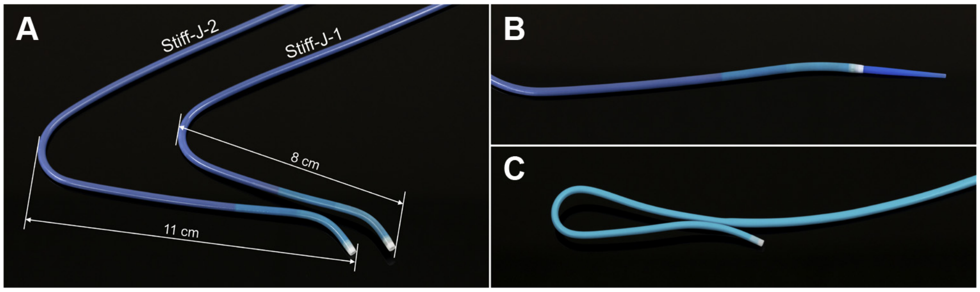

Figure 2. The 6-Fr Simmons guiding sheath (6-Fr Axcelguide Stiff-J-1 and Stiff-J-2 90 cm; Medikit, Tokyo, Japan) designed for the transradial approach. The sheath has a 6-Fr inner diameter (0.088 inch) with a pre-shaped modified Simmons-type tip. A 6-Fr coaxial SY-2 catheter (tip shape SY-2, 125 cm; Medikit) and dilator are packaged with this guiding sheath. (**A**) View of 6-Fr Simmons guiding sheaths. (**B**) View of a 6-Fr Simmons guiding sheath with an accessory dilator. (**C**) View of a 6-Fr SY-2 catheter.

(**Figure 4**): (1) "descending aorta anchoring" technique (DAT) (**Video 3**), (2) "subclavian artery anchoring" technique (SCAT) (**Video 4**), and (3) SCAT with snare (**Video 5**).[22-25] DAT was used for patients with a type II/III arch[26] treated with right TRA. SCAT was used for patients with a type I arch[26] treated with right or left TRA and SCAT with snare was used for patients with a type II/III arch treated with left TRA.

When the target CCA was the right CCA or the bovine left CCA treated with right TRA, either the push-in or pull-back technique was utilized. If ipsilateral CCA stenosis and/or cervical internal carotid artery (ICA) stenosis with external carotid artery (ECA) occlusion were preprocedurally detected, the pull-back technique was exclusively utilized. When the target CCA was the nonbovine left CCA treated with right TRA or any target CCA treated with left TRA, the pull-back technique was utilized.

In patients with cerebral aneurysm coiling, a 6-Fr distal access catheter (6-Fr Cerulean DD6, 113 cm; Medikit) was additionally delivered into the ICA at the petrous or distal cervical portion.

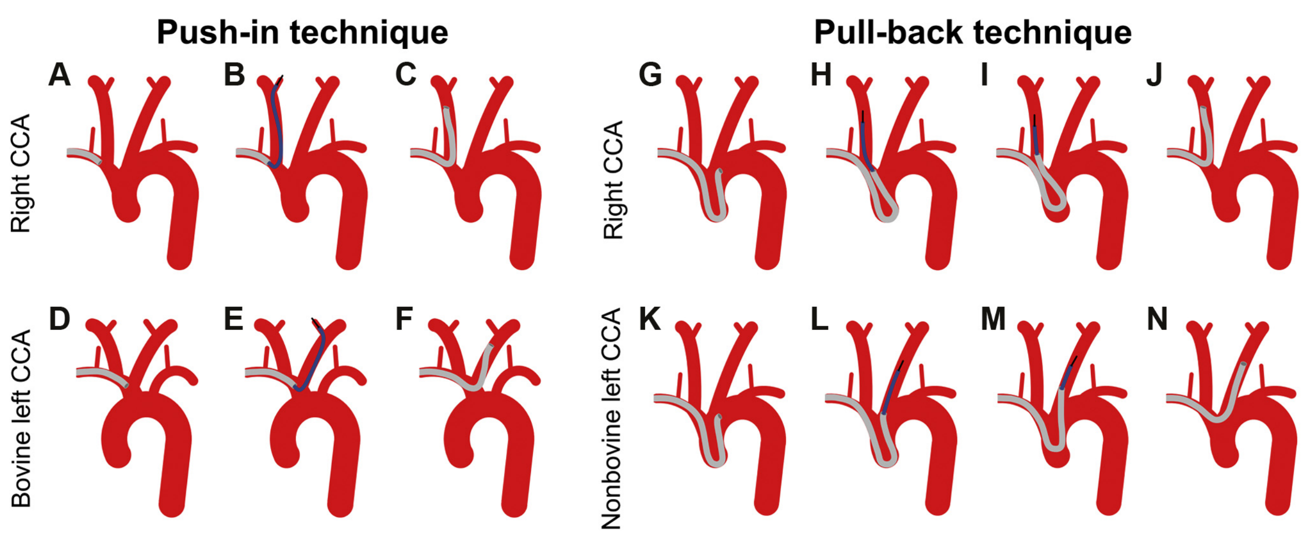

Figure 3. Two cannulation techniques: push-in (*left*) and pull-back (*right*) techniques. Push-in technique for right common carotid artery (CCA) (*upper left*) and bovine left CCA (*lower left*): (**A**, **D**) A 6-Fr Simmons guiding sheath is positioned at the right subclavian artery. (**B**, **E**) A 6-Fr SY-2 catheter is cannulated into the external carotid artery with a 0.035-inch standard guidewire (Radifocus guidewire M standard type 0.035 inches; Terumo, Tokyo, Japan). The guidewire is exchanged for a 0.035-inch stiff guidewire (Radifocus guidewire M stiff type 0.035 inches; Terumo). (**C**, **F**) The 6-Fr Simmons guiding sheath is coaxially advanced into the target CCA using a push-in maneuver, and the 6-Fr SY-2 catheter and guidewire are removed. Pull-back technique for right CCA (*upper right*) and nonbovine left CCA (*lower right*): (**G**, **K**) The Simmons curve is reformed in the ascending aorta. (**H**, **L**) The Simmons curve is cannulated into the orifice of the target CCA. A 5-Fr coaxial catheter (5-Fr Cerulean G 123 cm; Medikit, Tokyo, Japan) and a 0.035-inch standard guidewire are inserted into the target CCA. (**I**, **M**) The 6-Fr Simmons guiding sheath is pulled back. (**J**, **N**) The 6-Fr Simmons guiding sheath is completely introduced into the target CCA using the pull-back maneuver, and the 5-Fr coaxial catheter and guidewire are removed.

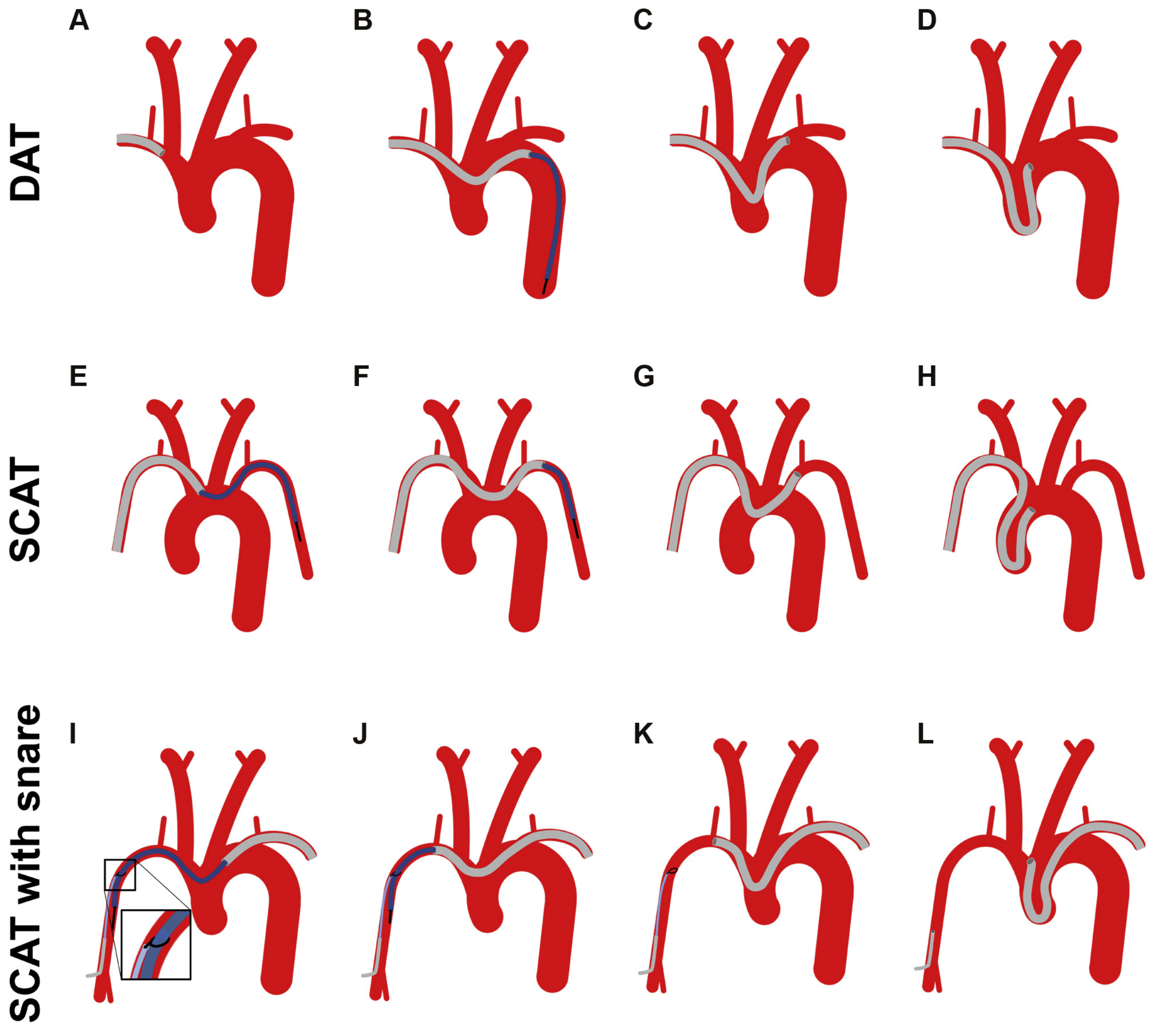

Figure 4. Three reformation techniques used to shape the Simmons curve of a 6-Fr Simmons guiding sheath: descending aorta anchoring technique (DAT), subclavian artery anchoring technique (SCAT), and SCAT with snare. DAT for type II/III aortic arch through the right transradial approach (TRA) (*upper*): (**A**) A 6-Fr Simmons guiding sheath is placed at the right subclavian artery. (**B**) A 6-Fr SY-2 catheter is advanced into the descending aorta with a 0.035-inch standard guidewire (Radifocus guidewire M standard type, 0. 035 inches; Terumo, Tokyo, Japan) and the guidewire is exchanged for a 0. 035-inch stiff guidewire (Radifocus guidewire M stiff type 0.035 inches; Terumo). The 6-Fr Simmons guiding sheath is advanced into the distal aortic arch while contacting the proximal lesser curvature of the aortic arch. (**C**) After adequately withdrawing the guidewire and 6-Fr SY-2 catheter, the 6-Fr Simmons guiding sheath is pushed into the ascending aorta. (**D**) The Simmons curve is reformed when it comes in contact with the proximal lesser curvature of the aortic arch. SCAT for type I aortic arch through right TRA (*middle*): (**E**) A 6-Fr SY-2 catheter is advanced into the left distal subclavian artery with a long 0.035-inch standard guidewire. The guidewire is replaced with a long 0.035-inch stiff guidewire. (**F**) The 6-Fr Simmons guiding sheath is advanced into the left subclavian artery. (**G**) The guidewire and 6-Fr SY-2 catheter are adequately withdrawn. The 6-Fr Simmons guiding sheath is pushed into the ascending aorta. (**H**) The Simmons curve can be reformed. SCAT with snare for type II/III aortic arch through left TRA (*lower*): (**I**) A 6-Fr SY-2 catheter is advanced into the right distal subclavian artery with a long 0.035-inch standard guidewire. A 4-Fr, 11-cm-long sheath is inserted into the right radial or brachial artery. A 10-mm goose-neck snare (Medtronic, Minneapolis, MN) with its 4-Fr catheter through the 4-Fr sheath is advanced into the right subclavian artery. The 6-Fr SY-2 catheter is snared with a goose-neck snare. (**J**) The 6-Fr Simmons guiding sheath is advanced into the right subclavian artery. (**K**) The goose-neck snare with its 4-Fr catheter, guidewire, and 6-Fr SY-2 catheter are withdrawn. The 6-Fr Simmons guiding sheath is pushed into the ascending aorta. (**L**) The Simmons curve can be reformed.

Table 1. Patient Characteristics

Characteristic	Value
No. of patients	130
Mean age ± SD (years)	70.9 ± 11.7
Sex	
Male	86 (66.2)
Target CCA	
Right CCA	69 (53.1)
Bovine left CCA	6 (4.6)
Nonbovine left CCA	55 (42.3)
Procedure	
CAS	75 (57.7)
Symptomatic	39 (52.0)
Asymptomatic	36 (48.0)
Cerebral aneurysm coiling	55 (42.3)
Ruptured	6 (10.9)
Unruptured	49 (89.1)
Aneurysm location	
ICA	39 (70.9)
ACoA	11 (20.0)
MCA	5 (9.1)

Values are presented as n (%) unless otherwise marked.
ACoA, anterior communicating artery; CAS, carotid artery stenting; CCA, common carotid artery; ICA, internal carotid artery; MCA, middle cerebral artery.

Management

The antithrombotic regimen and hemostasis have been previously documented.[25] The 6-Fr Simmons guiding sheath was removed immediately after the procedure and hemostasis was obtained using a hemostatic device (XEMEX Hemostatic Device T type; Zeon Medical, Tokyo, Japan).[25]

Assessment

We retrospectively analyzed: (1) the transradial access success, (2) the procedural success, (3) periprocedural complications, (4) vascular access site complications, and (5) radial artery occlusion. Transradial access success was defined as the technical success for cannulating a 6-Fr Simmons guiding sheath into the target CCA without kinking. Procedural success was defined as the performance of the transradial procedure without the need for transfemoral conversion. Based on the modified Raymond-Roy classification,[27] we assessed intracranial aneurysm occlusion using postprocedural angiography. Periprocedural complications, vascular access site complications, and radial artery occlusion have been defined previously.[25]

RESULTS

The characteristics of the 130 patients are shown in Table 1. The target CCA was the right CCA for 69 (53.0%) patients, the bovine left CCA for 6 (4.6%) patients, and the nonbovine left CCA for 55 (42.3%) patients. Transradial access success was achieved for all 130 patients (Figure 5). Of these, 2 patients were successfully cannulated with crossover to another technique through TRA (Table 2 and Figure 5). TRA was not abandoned or switched to TFA for any patient. The neurointervention procedures consisted of CAS for 75 (57.7%) patients and coil embolization for 55 (42.3%) patients. CAS was performed under distal balloon protection using a Carotid GuardWire (Medtronic, Minneapolis, MN) for all 75 patients; a Precise stent (Cardinal Health, Dublin, OH) was used in 69 (92%) patients, and a Carotid Wallstent (Stryker, Fremont, CA) in 6 (8.0%). For cerebral aneurysm coiling, 24 of 55 (43.6%) patients were treated with the double catheter technique, and 15 of 55 (27.2%) patients were treated with the stent-assisted technique. Modified Raymond-Roy class I, II, and IIIa closures were obtained in 22 (40.0%), 14 (25.5%) and 19 aneurysms (34.5%), respectively. Procedural success was achieved for all 130 patients (Table 3). The guiding system was maintained as stable until the completion of the procedure. There were no periprocedural or vascular access site complications for all 130 patients. Asymptomatic radial artery occlusion occurred in 2 (1.5%) patients.

DISCUSSION

Our results indicate that TRA as the primary vascular access with a 6-Fr Simmons guiding sheath for anterior circulation interventions is highly successful and safe. Transradial carotid cannulation and the subsequent procedure were successfully performed without periprocedural or vascular access site complications for all 130 patients treated.

Conventional Transradial Carotid Cannulation with a "Straight-Shaped" Guiding System

In coronary intervention, TRA is increasingly used as the primary vascular access because it has numerous advantages compared to conventional TFA, which have been demonstrated in large randomized trials and observational studies. TRA has been associated with substantial reduction in vascular access site complications, excellent patient comfort, and immediate ambulation.[4-8] In neurointervention for anterior circulation lesions, however, conventional TRA with a straight-shaped guiding catheter or sheath is merely used as an alternative vascular access because transradial carotid cannulation can be challenging for right CCA lesions with steep angulation between the CCA and right subclavian artery or left CCA lesions with a nonbovine origin.[10,11,13-16,21] The guiding system can prolapse into the aortic arch because of unfavorable acute takeoff of the target CCA. This problem may be avoided by using a buddy wire and/or the loop technique.[12,14-16] The former increases the complexity of the procedure, however, and a weak aortic valve can cause the latter to fail. Additionally, cannulation of a straight-shaped guiding system into the target CCA can lead to kinking and device entrapment or fracture can occur in cases of extreme angulation.[14]

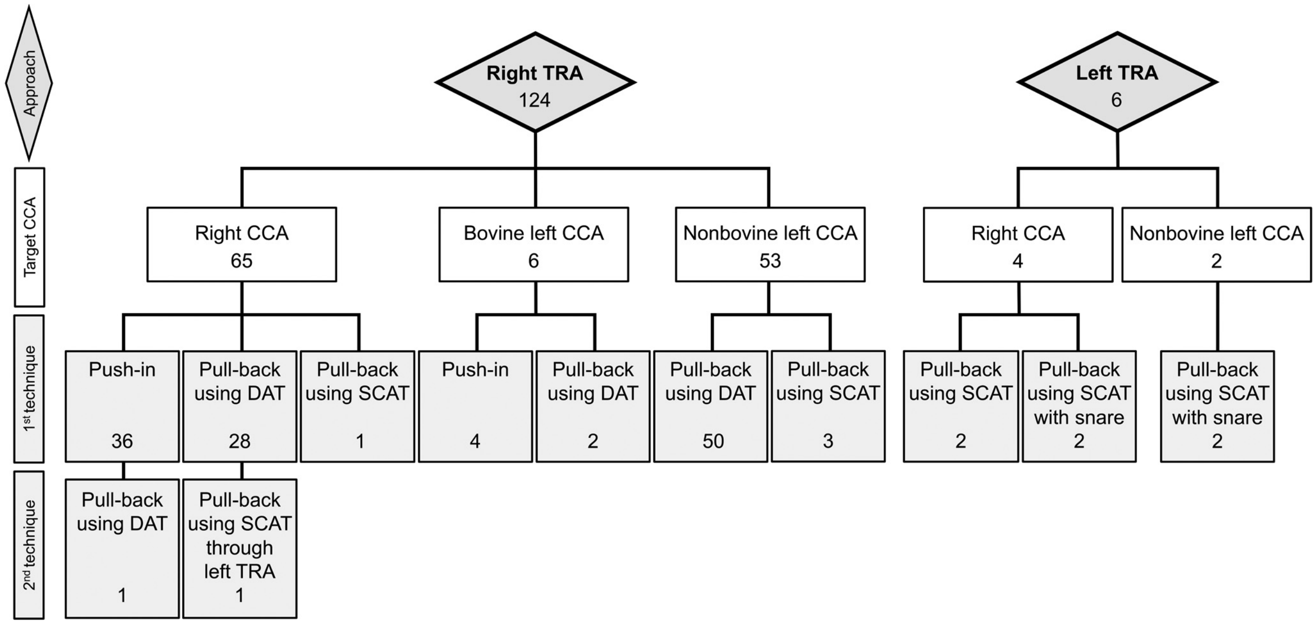

Figure 5. Summary of techniques used in transradial carotid cannulation for all 130 patients. Transradial access is successfully achieved in all 130 patients. Of these, transradial access success is achieved for 128 patients with the first technique and for 2 patients with the second technique. Transradial access is not abandoned or switched to transfemoral access for any patient. CCA, common carotid artery; DAT, descending aorta anchoring technique; SCAT, subclavian artery anchoring technique; TFA, transfemoral approach; TRA, transradial approach.

Novel Transradial Carotid Cannulation with a "Simmons-Shaped" Guiding Sheath

Based on our initial experience, we previously reported that transradial carotid cannulation with a 6-Fr "pre-shaped" Simmons guiding sheath was useful because the pre-shaped Simmons curve provides kink resistance and high stability.[22] In the present study, transradial carotid cannulation was accomplished with a high success rate by selecting the appropriate technique depending on preprocedural image assessment and access side. Based on the results of the present study, we created a technical algorithm (Figure 6).

Right CCA and Bovine Left CCA Through Right TRA

For the right CCA or bovine left CCA group treated with right TRA, the push-in technique should be first utilized, except for patients with ipsilateral CCA stenosis and/or ICA stenosis with ECA occlusion. Transradial carotid cannulation with the push-in technique ensures no contact with the aortic arch, which may reduce the risk of catheter-induced embolism.[28-31] Our results also confirmed that the push-in technique did not promote kinking, whereas pull-back through right TRA caused kinking in 1 of 31 (3.2%) patient. This was attributed to the following factors: (1) a 6-Fr coaxial catheter was used for the push-in technique, whereas a

Table 2. Summary of the 2 Patients Who Required Crossover to Another Technique

Sex	Age (years)	Lesion	Target CCA	Approach	Technique (1st Attempt)	Cause of Failure	Technique (2nd Attempt)	Complication
M	71	Right symptomatic cervical ICA stenosis	Right CCA	Right TRA	Push-in	Too sharp angulation of the bifurcation between the CCA and right subclavian artery for Simmons guiding sheath to pass	Pull-back using DAT	None
M	73	Right asymptomatic cervical ICA stenosis with CCA stenosis	Right CCA	Right TRA	Pull-back using DAT	Kinking of Simmons guiding sheath within the brachiocephalic artery during pull-back procedure	Pull-back using SCAT through left TRA	None

CCA, common carotid artery; DAT, descending aorta anchoring technique; ICA, internal carotid artery; M, man; SCAT, subclavian artery anchoring technique; TRA, transradial approach.

Table 3. Procedural Characteristics and Results

Characteristic	Value
CAS (n = 75)	
Stents	
Precise	69 (92.0)
Carotid Wallstent	6 (8.0)
Carotid stenosis before CAS, average %	81.9
Carotid stenosis just after CAS, average %	12.4
Cerebral aneurysm coiling (n = 55)	
Adjunctive technique	
Double catheter technique	24 (43.6)
Stent-assisted technique	15 (27.2)
Embolization result (modified Raymond-Roy classification)	
Class I	22 (40.0)
Class II	14 (25.5)
Class IIIa	19 (34.5)
Class IIIb	0

Values are presented as n or n (%), unless otherwise marked.
CAS, carotid artery stenting.

5-Fr coaxial catheter was used for the pull-back technique, (2) the reformed Simmons curve could be compressed within the brachiocephalic artery during the pull-back procedure (Figure 3I). Push-in was successfully achieved in 39 of 40 (97.5%) patients. The technique failed in 1 patient because of steep angulation of the bifurcation between the right CCA and subclavian artery (Table 2). We have 2 rescue technique options to resolve this technical failure: (1) pull-back through right TRA and (2) pull-back through left TRA (Figure 7). Pull-back through right TRA has the advantage of the ipsilateral approach, although this technique might induce kinking. The path of the right CCA during left TRA has a favorable angulation[13,14] and pull-back through left TRA is suited to the right CCA group with steep angulation to the right subclavian artery. Pull-back through right TRA was performed for the patient for whom push-in failed and successful carotid cannulation was achieved. In the case of ipsilateral CCA stenosis and/or ICA stenosis with ECA occlusion, the push-in technique can cause an iatrogenic cerebral embolism. The pull-back technique should be applied because the 6-Fr Simmons guiding sheath can be cannulated into the target CCA without passing the stenotic lesion.[23] The other failed case was in the right CCA group with ipsilateral CCA stenosis (Table 2). Pull-back through right TRA was first performed; however, kinking occurred. Pull-back through left TRA was next performed and resulted in successful cannulation into the right CCA.

Nonbovine Left CCA Through Right TRA and All Target CCAs Through Left TRA

In the present study, the Simmons curve was reformed in the ascending aorta, and transradial carotid cannulation was successfully achieved with the pull-back technique for all 59 patients with nonbovine left CCA through right TRA and for all patients treated through left TRA. Our results demonstrated that a 6-Fr Simmons guiding sheath can be reformed to a Simmons curve, regardless of the type of aortic arch and approached side. In patients with type II/III aortic arch treated with right TRA, DAT can reform the Simmons curve; however, in patients with type I aortic arch treated with right TRA, DAT cannot be applied because of the anatomy (Figure 8).[22,25] The vascular configuration of the contralateral subclavian artery is better suited for advancing the guidewire and coaxial catheter distally compared with that of the right and left CCA.[25] Therefore, the contralateral subclavian

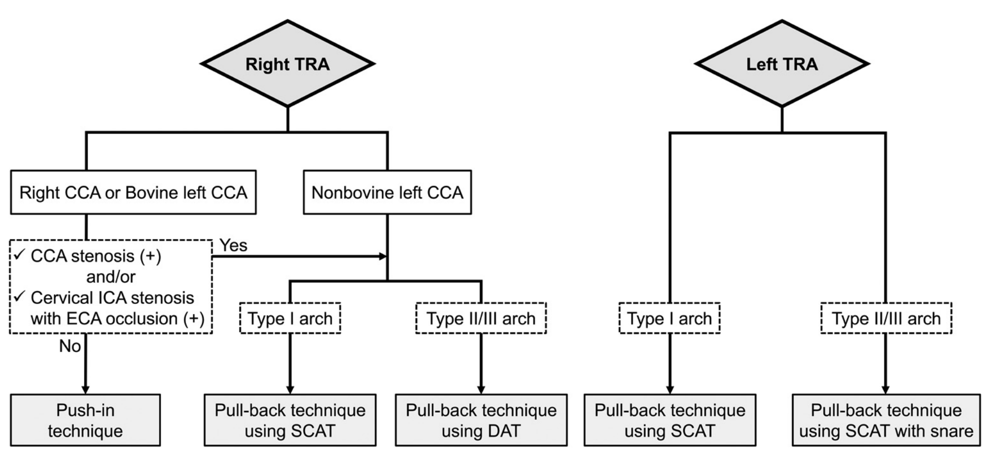

Figure 6. Technical algorithm for transradial approach with a 6-Fr Simmons guiding sheath. CCA, common carotid artery; DAT, descending aorta anchoring technique; ECA, external carotid artery; ICA, internal carotid artery; SCAT, subclavian anchoring technique; TRA, transradial approach.

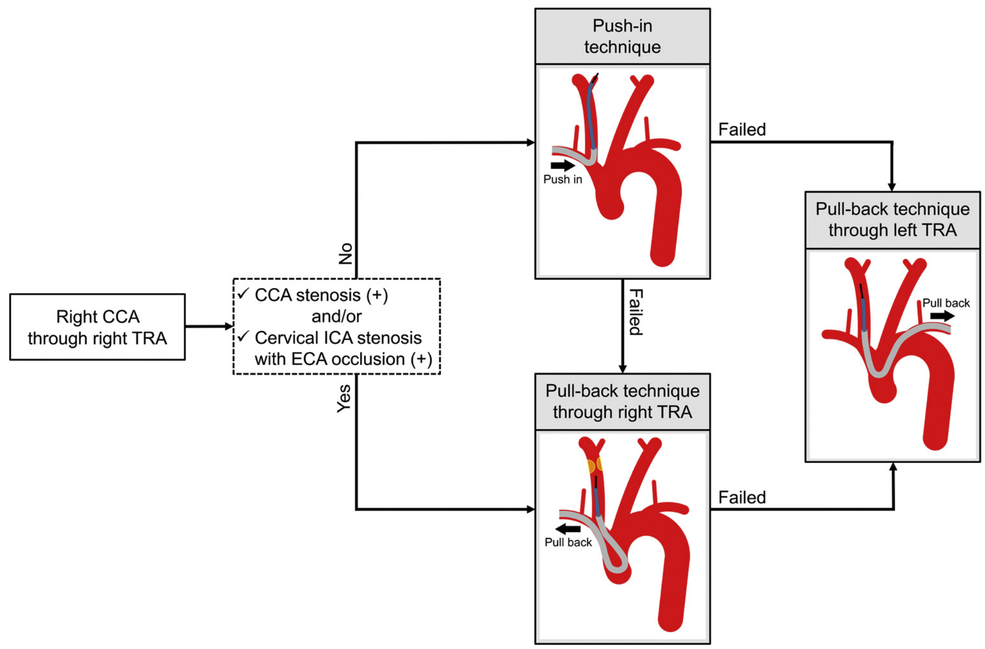

Figure 7. Technical algorithm for the transradial right carotid cannulation with a 6-Fr Simmons guiding sheath. CCA, common carotid artery; ECA, external carotid artery; ICA, internal carotid artery; TRA, transradial approach.

artery was used as the "anchor" for reforming the Simmons curve in patients with type I aortic arch who underwent right TRA and in all patients who underwent left TRA. The vertical distance between the brachiocephalic artery origin and the left subclavian artery origin is fairly short in the type I aortic arch and relatively long in the type II/III aortic arch. As a result, prolapse of the catheter into the aortic arch is common in the type II/III aortic arch. To increase the procedural success rate, we utilized SCAT with snare for patients with the type II/III aortic arch who underwent left TRA to provide sufficient backup support.[25]

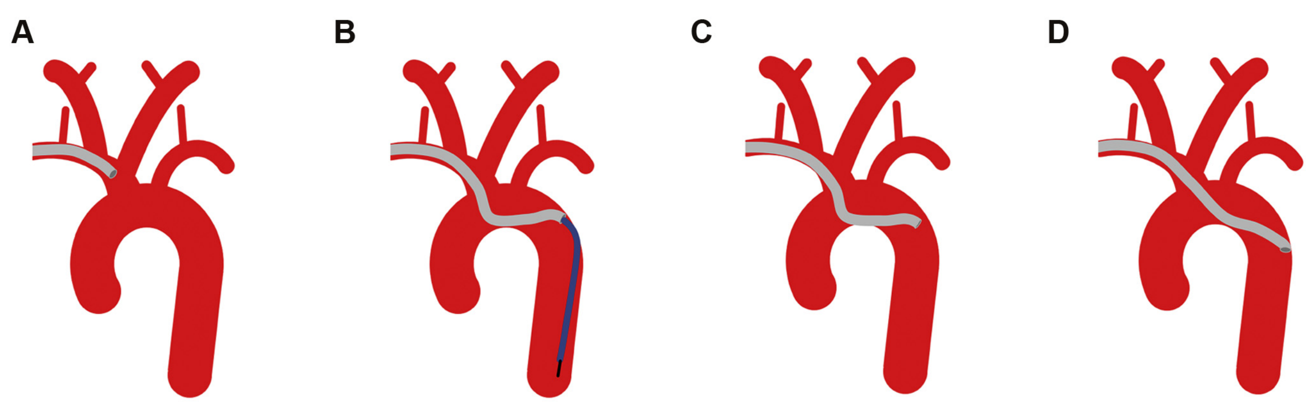

Figure 8. Descending aorta anchoring technique fails to reform the Simmons curve in type I aortic arch through the right transradial approach. (**A**, **B**) A 6-Fr SY-2 catheter is advanced into the distal descending aorta with a guidewire. The 6-Fr Simmons guiding sheath is directly introduced into the descending aorta without contacting the proximal lesser curvature of the aortic arch. (**C**) After sufficiently withdrawing the guidewire and 6-Fr SY-2 catheter, the 6-Fr Simmons guiding sheath is pushed in. (**D**) The 6-Fr Simmons guiding sheath is advanced into the distal descending aorta. The Simmons curve cannot be reformed.

Complications

No periprocedural or vascular access site complications occurred. Asymptomatic radial artery occlusion was found in 2 (1.5%) patients. There were no clinical symptoms in association with these occlusions due to the selection of patients with collateral blood supply through the ulnar artery. A previous meta-analytic study reported that radial artery occlusion occurred in 3% to 6% of cases after radial access.[32] The application of a hemostatic device may contribute to the minimization of radial artery occlusion.[33]

Disadvantages

Our novel TRA with a 6-Fr Simmons guiding sheath has 2 disadvantages; (1) the tip position of the guiding sheath within the target CCA is decided based on the length of the distal Simmons end, and (2) our guiding system cannot provide CAS using the proximal balloon protection method throughout the procedure. In the event of proximal CCA stenosis, the guiding sheath tip may contact the stenotic lesion during carotid cannulation. We should preprocedurally measure the distance between the orifice of the CCA and the proximal site of CCA stenosis to ensure safe cannulation. Our guiding system can establish a proximal balloon system temporarily using a 6-Fr balloon guiding catheter (Optimo 100 cm; Tokai Medical Products, Aichi, Japan) coaxially [24]; however, our system cannot provide a proximal balloon system throughout the CAS procedure.

Neurointerventional TRA as the Primary Vascular Access

Intracranial aneurysm coiling could be performed using an adjunctive technique with high support after the delivery of a 6-Fr distal access catheter into the ICA. During the study period, 130 of 148 (87.8%) patients underwent TRA as the primary vascular access. Of the remaining 18 patients, 14 (77.8%) patients were not treated with TRA because of insufficient preprocedural image assessment; this approach will apply to the great majority of patients. The results of the present study demonstrate that TRA can be used to treat anterior circulation lesions for all target CCAs and aortic arch types. Therefore, TRA with a 6-Fr Simmons guiding sheath can be utilized as the primary vascular access for anterior circulation interventions.

Limitations

The limitations of this study include the single-center, nonrandomized, retrospective nature. Additionally, the applied techniques require substantial transradial experience. All radialists involved in the study were highly experienced, and thus the results may not be applicable to operators with less experience. Potential anatomical limitations, such as hypoplasia of the radial artery (1.7%), stenosis (1.7%), torsion (5.2%), and the presence of a radioulnar loop (0.9%), should also be taken into consideration.[34] Detailed anatomical assessment before the procedure is essential to achieve favorable outcomes.

CONCLUSIONS

Based on our experience, TRA with a 6-Fr Simmons guiding sheath for anterior circulation interventions is a highly successful and safe method for all target CCAs and aortic arch types. This method can be utilized as the primary vascular access for anterior circulation interventions. A preprocedural anatomical assessment is required for favorable outcomes.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Yoshiki Hanaoka: Conceptualization, Methodology, Data curation, Writing - original draft, Investigation. **Jun-ichi Koyama:** Conceptualization, Writing - review & editing, Validation. **Daisuke Yamazaki:** Investigation. **Yoshinari Miyaoka:** Investigation. **Yu Fujii:** Investigation. **Takuya Nakamura:** Investigation. **Toshihiro Ogiwara:** Supervision. **Kiyoshi Ito:** Supervision. **Tetsuyoshi Horiuchi:** Writing - review & editing, Supervision.

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