Technical Note

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Single Tract Aortic Revascularization Technique in the Treatment of Aortoiliac Occlusive Disease

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Endovascular treatment is an acceptable option for patients with aortoiliac occlusive disease. However, bilateral passage of guidewires through the aortoiliac occlusion can be a challenging step in achieving successful revascularization. The aim of this article is to present a novel strategy for successfully passing bilateral guidewires through long aortoiliac occlusive lesions. After one guidewire is passed through the aortic and iliac lesions via one side of the femoral artery, the other guidewire is passed using the up-and-over technique and pulled out from the ipsilateral side of the body. This contralateral guidewire is then inserted into the ipsilateral angiographic catheter along with the ipsilateral guidewire. Subsequently, the angiographic catheter is removed in a manner similar to a peel-away sheath. Eventually, bilateral guidewires can be passed through the lesion via a single aortic tract.

Key Words: Aortoiliac occlusion, Recanalization, Chronic total occlusion, Endovascular procedures

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INTRODUCTION

Aortoiliac occlusive disease (AIOD) is a major cause of chronic symptoms such as buttock and thigh claudication, impotence, and femoral pulselessness. Thus, revascularization of the aortoiliac lesion is crucial for improving the patient's quality of life. In 2007, the TransAtlantic Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II) stratified aortoiliac lesions, and the lesion with infra-renal aortoiliac occlusion was categorized as a type D lesion [1]. The guideline recommended open reconstructive surgery for TASC D lesions, such as bypass or endarterectomy, because of their good long-term patency [2]. However, endovascular technologies have evolved dramatically over the past decades, with several studies reporting that endovascular therapy is not inferior to surgical management, offering lower morbidity, shorter length of hospital stays, and lower 30-day mortality rates [1,3-5]. The main obstacle to performing endovascular therapy is the failure to pass the guidewire through the lesion. The aim of this article is to report a novel strategy for successfully passing bilateral guidewires through long aortoiliac occlusion.

TECHNIQUE

The first critical step in percutaneous balloon angioplasty or stenting is the passage of the guidewire through the lesion. In cases of long occlusive lesions, such as AIOD, most procedural time can be spent on guidewire passage. For successful endovascular treatment of AIOD, bilateral guidewire passage should be achieved through the iliac and aortic lesions (Fig. 1A). However, even if one guidewire passes through the aortic lesion, the contralateral guidewire cannot be passed frequently because of the hard thrombus or severe calcification (Fig. 1B). Under these circumstances, the single-tract aortic revascularization (STAR) technique can be used to pass the guidewire through the lesion. The contralateral guidewire can be passed using the up-and-over technique and pulled out from the ipsilateral side using the rendezvous technique or a snare wire (Fig. 1C). It is then inserted into the angiographic catheter along with the ipsilateral guidewire (Fig. 1D). Subsequently, the inserted angiographic catheter is removed using a number 11 blade or cutting saw (Fig. 1E). Next, another angiographic catheter is inserted over an ipsilateral guidewire (Fig. 1F). A snare wire is inserted through the new angiographic catheter to grasp the proximal portion of the contralateral guidewire (Fig. 1G). While holding its proximal portion, the contralateral side guidewire is straightened by tightening to create a single aortic tract (Fig. 1H). Finally, the ipsilateral guidewire is inserted after removing the snare wire (Fig. 1I). This results in both guidewires being passed through a single tract for aortic revascularization using the STAR technique.

A 74-year-old male patient presented with claudication extending 10 meters, which was more severe in the left leg, accompanied by a 5 kg weight loss over one month. He underwent surgery for spinal stenosis, but the claudication worsened thereafter. After repeated injections for pain control in the spine, the patient sought a second opinion at our vascular and endovascular center. The patient had diabetes mellitus and hypertension. Physical examination revealed no palpable lower extremity arteries, and both feet were cold. Muscle atrophy and hair loss were observed in the left leg. The preoperative ankle-brachial index (ABI) was 0.47 (right) and 0.37 (left). Computed tomography angiography (CTA) revealed total aortoiliac occlusion from the juxtarenal aorta to both iliac arteries (Fig. 2A). Endovascular revascularization was decided after a thorough discussion with the patient. The left-sided guidewire was successfully passed

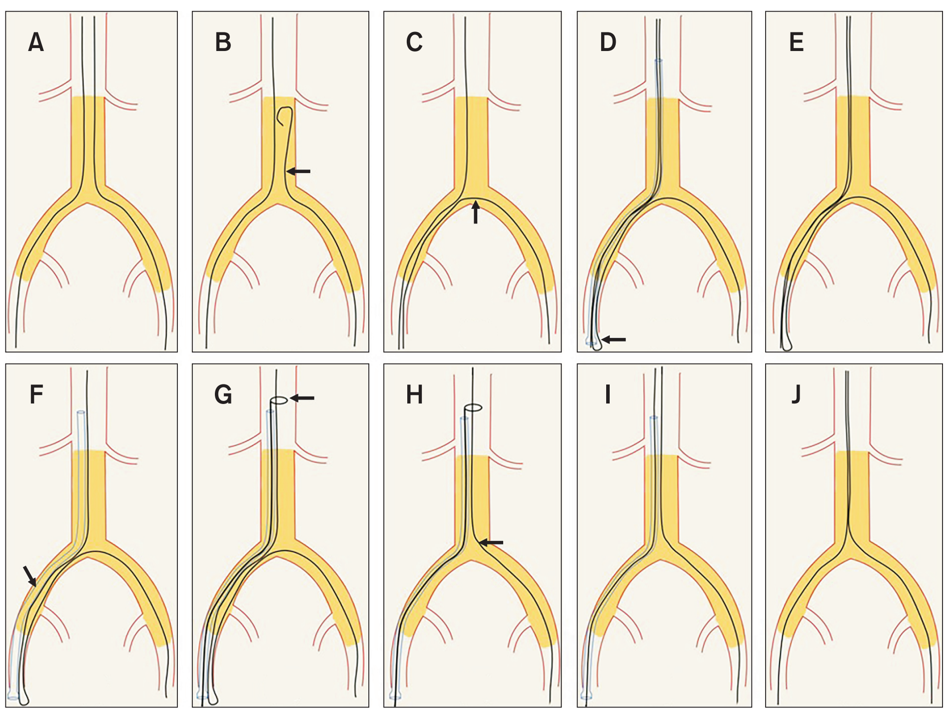

Fig. 1. Schematic illustration of the STAR procedure. (A) Usual guidewire passage for aortic revascularization; two guidewires were passed through two different tracts. (B) Despite one guidewire being passed through the aortic lesion, another guidewire could not be frequently passed due to the larger aortic diameter (arrow). (C) In the situation illustrated in (B), the guidewire inserted via the left side was passed through the up-and-over technique and pulled out from the right side using the body through technique (arrow). (D) The guidewire inserted via the left side was placed into the angiographic catheter, which was inserted via the right side (arrow). (E) The angiographic catheter was removed using a number 11 blade and cutting saw. (F) Another angiographic catheter was inserted through the right-side guidewire (arrow). (G) A snare wire was inserted through the angiographic catheter to grasp the proximal portion of the left-side guidewire (arrow). (H) The left-side guidewire was straightened with tightening to create a single aortic tract (arrow). (I) Finally, the right-side guidewire was inserted through the angiographic catheter. (J) Eventually, a single tract was created for aortic revascularization. STAR, single tract aortic revascularization.

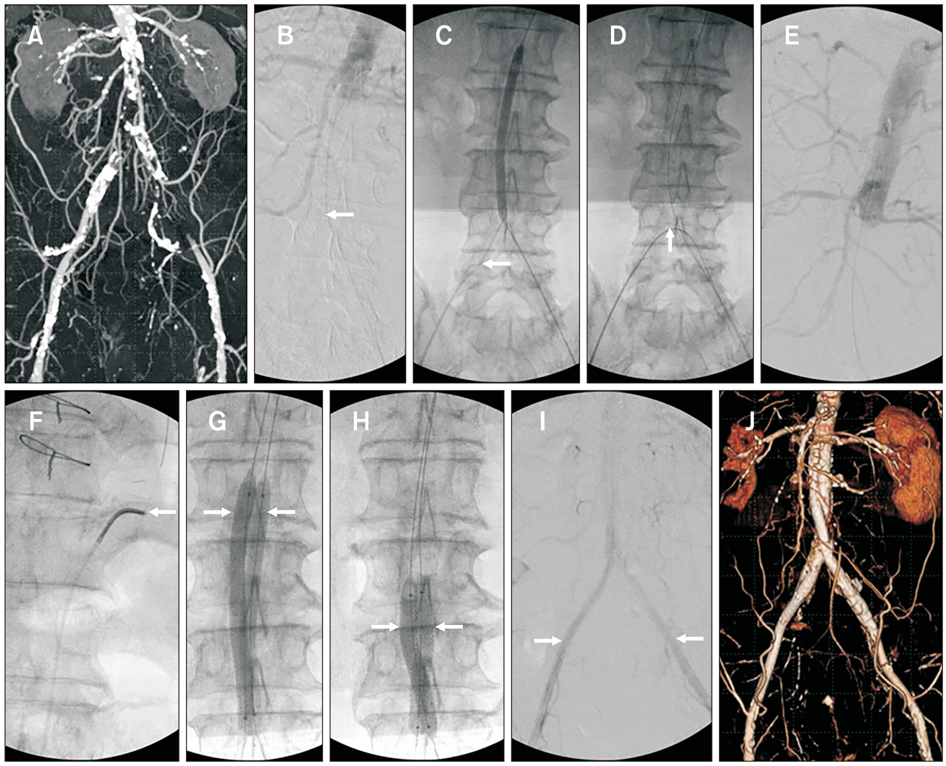

Fig. 2. Procedure details of patient 1. (A) Preoperative CT image demonstrated severely calcified aortoiliac occlusion. (B) One guidewire was successfully passed via the left-side (arrow). (C) Passage of the right-side guidewire was attempted after ballooning (arrow), but it failed. (D) The guidewire inserted via the right side was passed through the up-and-over technique and pulled out from the left-side using the body through technique (arrow). (E) The guidewire inserted via the right side was placed into the angiographic catheter, which was inserted via the left side. (F) The proximal portion of the right guidewire was grasped using a snare wire (arrow). (G) After achieving the single aortic tract, routine aortic kissing stents were placed (arrows). (H) Two balloon-expandable stents were deployed into the distal aortic lesions (arrows). (I) Completion angiogram obtained after placement of iliac stents demonstrated wide opening of the lesion (arrows). (J) Postoperative volume rendering CT image showed successful aorto-biiliac revascularization. CT, computed tomography.

through the aortic and left iliac lesions (Fig. 2B). We attempted to pass the right-sided guidewire using several supporting catheters or different guidewire sizes but failed (Fig. 2C). Thus, the right-side guidewire was passed over the aortic bifurcation using the up-and-over technique and pulled out on the left side (Fig. 2D). For the up-and-over technique, we first used a 0.035-inch angled Radifocus (Terumo) standard guidewire 260 cm in length with a 5F UF (Cordis) angiographic catheter. After subintimally achieving the entry tract of the orifice of the left common iliac artery, the guidewire was switched to a 0.018 inch High-Torque Command^{TM} ST (Abbott) guidewire 300 cm in length and pulled out through the left access site. This right-side guidewire was then replaced with a 0.014 inch High-Torque Command^{TM} ES guidewire 300 cm in length and inserted into the C2 (Cordis) angiographic catheter via the left side (Fig. 2E). The proximal tips of both guidewires were positioned at the aortic arch. Subsequently, the angiographic catheter was removed using a saw. During catheter removal, both guidewires were securely maintained to prevent them from falling out unintentionally. We grasped the proximal portion of the right-side guidewire using a snare wire inserted into a new catheter from left guidewire (Fig. 2F). The right-side guidewire was then straightened without any difficulty. After achieving the single aortic tract, the routine aortic kissing stenting was performed using two 10×57 mm Express LD (Boston Scientific) balloon-expandable stents (Fig. 2G). Additionally, two 9×59 mm Omnilink (Abbott) balloon-expandable stents and two 8×80 mm Absolute Pro (Abbott) self-expanding stents were deployed into the distal aortic lesions and both sides of the iliac lesions (Fig. 2H). A completion angiogram post-stenting showed a wide opening of the lesion (Fig. 2I). Posoperative ABI improved to 1.11 for both legs. Volume-rendering CTA confirmed successful aorto-biiliac revascularization using the STAR procedure (Fig. 2J).

An 80-year-old male patient presented to our hospital with claudication extending 10 meters, which was more severe in the right leg. He also had a history of diabetes mellitus and hypertension. He had undergone surgery for spinal stenosis 20 years prior; however, his leg pain persisted. Additionally, he was taking antiplatelet medication for a history of coronary artery bypass grafting (CABG) 20 years prior. Physical examination revealed no palpable femoral and ankle pulses on either leg. The preoperative ABI was 0.18 for the right leg and 0.41 for the left leg. Preoperative CTA revealed total aortoiliac occlusion (Fig. 3A).

Endovascular revascularization was decided due to multiple comorbidities. Initially, we attempted to pass the guidewire in a retrograde manner from the bilateral common femoral arteries to the aorta. However, the attempt failed. Therefore, a 7F long sheath was inserted into the suprarenal aorta via the left brachial artery (Fig. 3B). After several attempts, the left-side guidewire was successfully passed through the aortic and left iliac lesions using a snare wire. However, despite successful passage of the left-side guidewire, the right-side guidewire did not pass (Fig. 3C). The right-side guidewire was then passed over the aortic bifurcation using the up-and-over technique and pulled out through the left side using a 0.035 inch angled Radifocus standard guidewire 260 cm in length with a 5F UF angiographic catheter. After subintimally achieving the entry tract, the guidewire was changed to a 0.018 inch High-Torque Command™ ST guidewire 300 cm in length. The guidewire was pulled out through the left access site (Fig. 3D). Subsequently, the guidewire was inserted in a 5Fr

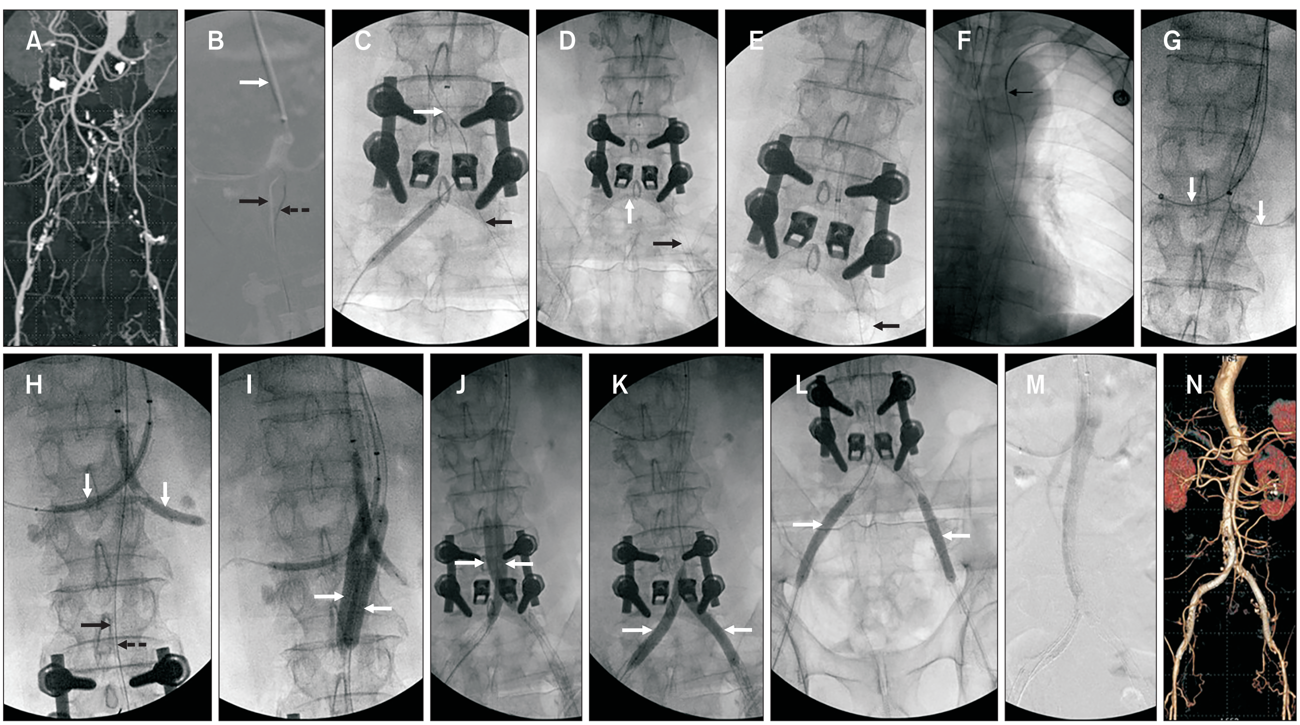

Fig. 3. Procedure details of patient 2. (A) Preoperative maximal intensity projection CT image demonstrated the flush occlusion of aortoiliac occlusive disease. (B) A 7F long sheath was inserted into the suprarenal aorta via the left brachial access (white arrow). Passage of the guidewire with retrograde direction via bilateral common femoral arterial accesses was attempted (black arrows). (C) Despite successful passage of one guidewire via the left-side (black arrow), the right-side guidewire did not pass (white arrow). (D) The guidewire inserted via the right side was passed through the up-and-over technique and pulled out from the left side using the body through technique (white arrow). (E) The guidewire inserted via the right side was placed into the angiographic catheter, which was inserted via the left side. (F) The right-side guidewire was pulled out from the brachial access site using the body through technique (black arrow). (G) After achieving the single aortic tract, two guidewires were inserted into renal arteries (white arrows). (H) Ballooning of bilateral renal arteries was performed to prevent renal embolization during stenting of flush occlusive aortic lesion (white arrows). (I) Two balloon-expandable stents were deployed into the proximal flush occlusive aortic lesions (white arrows). (J) Two balloon-expandable stents were deployed into the distal aortic lesions (white arrows). (K) Two balloon-expandable stents were deployed at the aortic bifurcation (white arrows). (L) Routine iliac stenting was performed (white arrows). (M) Completion angiogram demonstrated wide opening of the lesion. (N) Postoperative volume rendering CT image showed successful aorto-biiliac revascularization. CT, computed tomography.

Glidecath (Terumo) angiographic catheter after cutting the proximal hub, which was inserted via the left side (Fig. 3E). The right-side guidewire was then extracted from the brachial access site using a snare wire (Fig. 3F). The Glidecath catheter was then removed by cutting with a number 11 blade, similar to the peel-away sheath removal.

Following the successful passage of the bilateral guidewires using the STAR procedure, the guidewires from the brachial arteries were inserted into the bilateral renal arteries for balloon protection during aortic kissing stenting (Fig. 3G). Along with the ballooning of the bilateral renal arteries (Fig. 3H), two 9x58 mm Express LD balloon-expandable stents were deployed into the proximal flush occlusive aortic lesions (Fig. 3I). Additional 9x58 mm and 8x58 mm LifeStream (BD) balloon-expandable stent grafts were deployed into the distal aortic lesions (Fig. 3J). Finally, four Absolute Pro self-expanding stents were deployed into the bilateral iliac arterial lesions (Fig. 3K, 3L). A completion angiogram demonstrated a wide opening of the entire aortic and iliac lesions (Fig. 3M). After the procedure, the patient's post-operative ABI improved to 1.08 in the right leg and 0.92 in the left leg. The postoperative volume-rendering CTA image showed successful aorto-biiliac revascularization (Fig. 3N).

For a successful STAR procedure, it is essential to remove the ipsilateral angiographic catheter after placing both guidewires into it. In the first case, a pneumatically driven saw was used while securely holding the wire (Fig. 4). For the second case, we used a relatively soft Glidecath angiographic catheter after removing the proximal hub. It was then removed without difficulty using a blade. There were no significant complications, such as visceral or distal embolization, access site complications, thrombotic occlusion, or rupture in the two cases.

DISCUSSION

In AIOD, the endovascular approach is responsible for the two axes of recanalization, along with open surgery. Generally, endovascular approaches are preferred for simpler lesions, while surgical methods are used for extensive lesions and severe chronic total occlusions (CTOs) [5,6].

Over the past decades, as part of efforts to reduce the morbidity and mortality associated with open surgery, advances in instruments and techniques for lesion passage have enabled endovascular procedures to be performed in more difficult and complicated lesions. Consequently, clinical outcomes have greatly improved, and the role of endovascular approaches has gradually expanded.

For AIOD, the use of bilateral aortoiliac stents, known as the kissing stent (KS) technique, allows endovascular treatment of lesions involving the aortic bifurcation. Many studies have reported the clinical outcomes of KS. A systematic review indicated complication rates of 10.8% and primary patency rates of 89.3 %, 78.6 %, and 69.0% at 12, 24, and 60 months, respectively, which are considered acceptable [7]. However, endovascular approaches fail in approximately 20% of the cases [8]. The main causes of failure include heavily calcified total and long-segment occlusions.

In such challenging cases, the most helpful option for revascularization is to use the subintimal approach and reenter the true lumen after passing the lesion [9]. However, it is difficult to reenter an aortic lesion because of its larger diameter. There are no clear reports on why reentry is difficult in large-diameter aortic lesions. In our opinion, one possible explanation for this is hemodynamic causes. When ipsilateral guidewire passage is achieved through intraluminal route, it can generate significant positive aortic pressure in the ipsilateral tract. In this circumstance, if the contralateral guidewire creates a subintimal tract, the tract created by the contralateral guidewire may have low or no pressure. Therefore, the successful reentry of the contralateral guidewire could be difficult. Another explanation for the difficulty in guidewire passage in a larger aortic lumen is the presence of multiple subintimal tracts created by antegrade and retrograde guidewire passage attempts with a larger aortic diameter. Chen et al. [10] reported a procedural success rate of 84% in 120 patients who underwent subin-

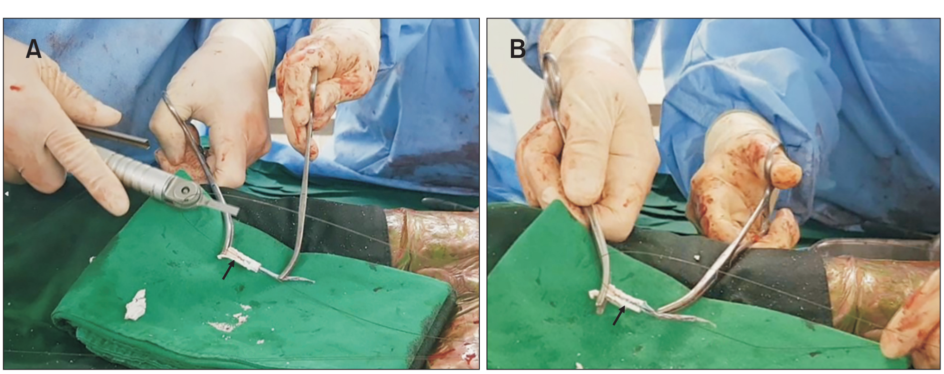

Fig. 4. Removal of the ipsilateral angiographic catheter using a saw. (A) Partial cutting status of the proximal plastic hub of angiographic catheter. (B) Fully opened plastic hub.

timal revascularization of iliac CTOs.

To overcome heavily calcified CTOs using endovascular techniques, some authors suggest that intravascular ultrasound-guided true lumen reentry devices are very useful for iliac CTOs, with very high technical success rates [11]. However, in many countries including our own, these devices are not available and are not cost-effective. Therefore, they are not routinely used for the treatment of complex iliac lesions. In this regard, the STAR technique is a useful, simple, and key technique for recanalization, eventually resulting in the success of cases at a low cost.

There are several technical tips for the successful revascularization of heavily calcified CTOs using the STAR procedure. Multivessel access for antegrade or retrograde strategies is often required for recanalization based on pushability and workability. However, there is no standard recommendation for the best direction for crossing a lesion. A cohort study addressed the superiority of antegrade or retrograde strategies for common iliac artery (CIA) and/or external iliac artery CTOs [12]. However, many AIOD cases require a combined (antegrade and retrograde together) approach to pass the lesion. In our experience, this combined approach was useful for successful endovascular procedures. In the second case, we obtained additional support via brachial access because it is a reliable choice for interventional recanalization. In the STAR procedure, support by a snare is key to success because a pulling force is required from each side of the guidewire, as mentioned in the treatment section. However, in cases with brachial access, guidewires must pass through the aortic arch; therefore, this technique is not exempt from complications of the supra-aortic vessels, such as dissection, embolization, nerve injury, and stroke [13,14]. If the use of upper vascular access potentially burdens the patient with complications or comorbidities, a pulling force from each side of the guidewire can be produced through bilateral femoral approaches, as in the first case. In our experience, both approaches are easy and useful for successfully passing through the CTO lesions.

The STAR procedure offers several advantages. When attempting the subintimal passage of iliac CTOs, the catheter should sit at the aortic bifurcation so that it does not twist or spin when the guidewire is pushed. If the occlusion starts at the origin of the CIA or is more proximal, the catheter may not be able to find a place to rely on for obtaining pushability when the guidewire passes. Orellana et al. [15] reported a homemade device for obtaining steerability and support for subintimal antegrade recanalization. They used a 0.014 inch guidewire inside a 6Fr Flexor, and the guidewire was pre-looped inside an 8Fr Sheath to obtain pushability for passing iliac CTOs. A guidewire was passed through a flexible sheath, folded back on itself, and introduced into a non-flexible, wider sheath. By pulling back the end of the guidewire, the tip achieved the desired curvature, and rotating the larger nonflexible sheath allowed us to find the right direction. However, during the STAR procedure, external support can be obtained using a snare. Therefore, it is not necessary to spend time obtaining the optimal catheter position. A time-consuming process can be omitted, thereby reducing the procedure time. This is another advantage of the STAR technique.

Although the STAR procedure can shorten the procedure time, it has the disadvantage that it takes more time than general aortoiliac stenting procedures. In addition, because the lesion is distributed from the abdominal aorta to the iliac arteries, there is a risk of acute thrombotic occlusion and rupture. Therefore, it is necessary to prepare for these complications. In addition, open bypass surgery should be considered the first-line treatment modality for extensive aortoiliac lesions.

CONCLUSION

The STAR technique is a relatively simple, effective, and safe strategy for treating aortoiliac CTOs. This technique provides the additional support required for the guidewire to successfully pass through the lesion, thereby increasing the possibility of an endovascular procedure without complications.

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CONFLICTS OF INTEREST

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AUTHOR CONTRIBUTIONS

Concept and design: all authors. Analysis and interpretation: all authors. Data collection: all authors. Writing the article: all authors. Critical revision of the article: all authors.

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