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Clinical Research

Videoscopic Surgery for Arteriovenous Hemodialysis Access

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Background: When an arteriovenous fistula (AVF) is created using the basilic or deep cephalic vein, it is additionally necessary to transfer the vessels to a position where needling is easy; however, many patients develop wound-related postsurgical complications due to the long surgical wounds resulting from conventional superficialization of a deep AVF or basilic vein transposition. Thus, to address this problem, we performed videoscopic surgery with small surgical incisions.
Methods: Data from 16 patients who underwent additional videoscopic radiocephalic superficialization, brachiocephalic superficialization, and brachiobasilic transposition after AVF formation at our institution in 2018 were retrospectively reviewed.
Results: Needling was successful in all patients. No wound-related complications occurred. The mean vessel size and blood flow of the AVF just before the first needling were 0.73±0.16 mm and 1,516.25±791.26 mL/min, respectively. The mean vessel depth after surgery was 0.26±0.10 cm. Percutaneous angioplasty was additionally performed in 25% of the patients. Primary patency was observed in 100% of patients during the follow-up period (262.44±73.49 days).
Conclusion: Videoscopic surgery for AVF dramatically reduced the incidence of postoperative complications without interrupting patency; moreover, such procedures may increase the use of native vessels for vascular access. In addition, dissection using a videoscope compared to blind dissection using only a skip incision dramatically increased the success rate of displacement by reducing damage to the dissected vessels.

Keywords: Arteriovenous fistula, Endoscopy, Basilic vein

Introduction

The use of native vessels is generally recommended for achieving vascular access during hemodialysis in patients with end-stage renal failure [1]. In the absence of an appropriate native vein for hemodialysis, vascular access is achieved using an artificial graft; however, the use of an artificial graft is associated with several adverse outcomes, including an increased risk of thrombosis, need for additional interventions, low primary patency, and a high infection rate [2-4].

Generally, radiocephalic (RC-AVF) and brachiocephalic arteriovenous fistula (BC-AVF) formation is recommended first; however, if this procedure cannot be performed, fistula formation using a transposed basilic vein is considered the second option [1].

Even if an AVF is created with an appropriate vein and it successfully matures, puncturing to obtain vascular access is often difficult because of the deep positioning of the matured vessel. In such cases, inappropriate needling can lead to infiltration and aneurysm and hematoma formation, ultimately damaging the hemodialysis route [5]. To resolve this problem, superficialization of the vessel is crucial [6,7].

In many cases, the basilic veins are better preserved than other vessels owing to their medial deep anatomical position. Because of their large size, there is a high chance of maturation when they are used for fistula formation. However, the basilic veins run deep, near the median nerve and brachial artery. Therefore, puncturing them directly is risky, and superficialization and transposition to a more lateral position in the arm are required for a safer puncture [6]. Basilic vein transposition has been modified several

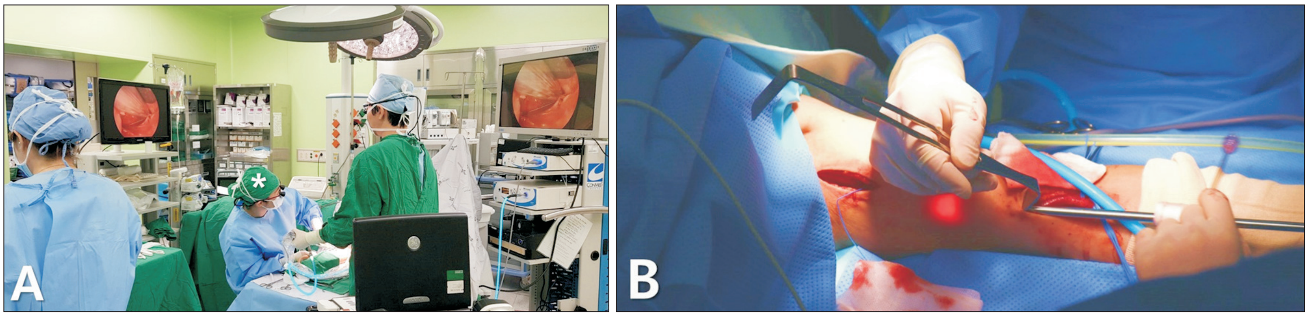

Fig. 1. (A) Operating room where videoscopic surgery was performed for vascular hemodialysis access. The asterisk indicates the operator. The assistant is on the right side of the operator, and the scrub nurse is on the left. (B) The operative field of brachiobasilic arteriovenous fistula dissection using a videoscope.

times in a minimally invasive manner since Dagher et al. [8] first published a description of this procedure in 1970.

Surgical superficialization of a deep AVF and basilic vein transposition have thus been traditionally used, but the lengthy incision and dissection along the vessels often result in post-surgical complications [9].

At Pusan National University Hospital, we perform videoscopic surgery using small surgical incisions in order to reduce the above-mentioned complications and to increase the use of native vessels. Here, we aimed to discuss the usefulness of surgical superficialization and transposition with a videoscope by monitoring postoperative flow and the possibility of needling of the AVF during follow-up.

Methods

This study involved the retrospective analysis of data from 16 patients who underwent surgical superficialization and transposition using a videoscope in 2018 at Pusan National University Hospital. We collected data on patient demographics and information regarding the maturation of the fistula, needling, and additional operations or procedures.

All operations involved fistula formation and videoscopic superficialization or transposition. Surgical superficialization was performed for patients who underwent RC-AVF formation with repeated needling failures owing to the deep anatomical position of the vessel and for those whose vein was 6 mm or deeper prior to the first needling. For all cephalic veins, arterial anastomosis was performed regardless of the vein size and once matured, transposition was performed using a videoscope.

Maturation was monitored using ultrasonography at weeks 2 and 4 after the first operation for fistula formation. Once the size of the AVF and the amount of blood flow were judged to be sufficiently matured, superficialization or transposition was performed. Maturation was determined in accordance with the criteria contained in the National Kidney Foundation-Dialysis Outcome Quality Initiative guidelines: the fistula had a flow of approximately 600 mL/min, was less than 0.6 cm below the skin surface, and had a minimal diameter of 0.6 cm [1].

A brachial plexus block procedure was performed in 15 patients, and local anesthesia was administered in 1 patient. The vessel pathway was mapped in detail via ultrasonography just before surgery.

Longitudinal incisions were created in the antecubital and axillary fossae for brachiobasilic AVF (BB-AVF) transposition, in the antecubital fossa and shoulder for BC-AVF superficialization, and in the wrist and antecubital fossa for RC-AVF superficialization. Each incision was approximately 2.5–3 cm in length. A 5-mm, 30° scope was used for dissection between the incisions (Karl Storz, Tuttlingen, Germany). A camera port was not used (Fig. 1). The vessels were retracted using vein and right-angled retractors for dissection. Tissue surrounding the vein branch that had been mapped using ultrasonography was dissected using a videoscope. After visually confirming the branch, it was clipped using an endoscopic clip and divided. In the case of large branch veins measuring >5 mm connected directly to the deep vein, small incisions were added and ligated if it was considered dangerous to control the vessel only through clipping in a narrow space.

In the presence of a juxta-anastomosis stenosis, the vessel was divided near the arterial anastomosis incision after videoscopic AVF harvesting, and the divided vessel was repositioned using a tunneler just below the skin. Subsequently, the area of stenosis was resected, and a polytetrafluoroethylene interposition graft was placed (Fig. 2). In the absence of a juxta-anastomosis stenosis, the fistula was

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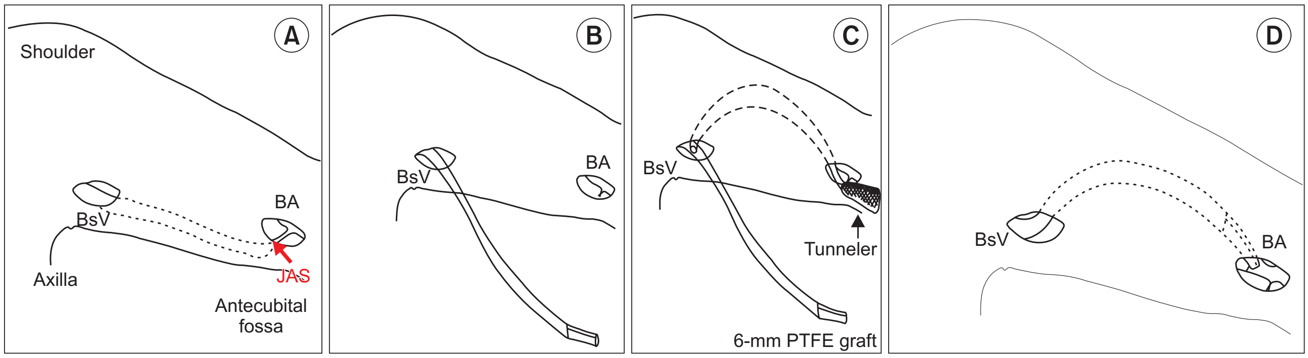

Fig. 2. (A) Brachiobasilic fistula with a JAS. (B) First, the entire brachiobasilic fistula is dissected using a videoscope. The arterial anastomosis part of the fistula is cut, and the vessel is taken out toward the proximal incision. Then, the part with stenosis is cut off and replaced with PTFE. (C) The tunneler is inserted into the proximal incision of the antecubital fossa and passed just below the skin. (D) Arterial anastomosis of the antecubital fossa is performed. JAS, juxta-anastomosis stenosis; BsV, basilic vein; BA, brachial artery; PTFE, polytetrafluoroethylene.

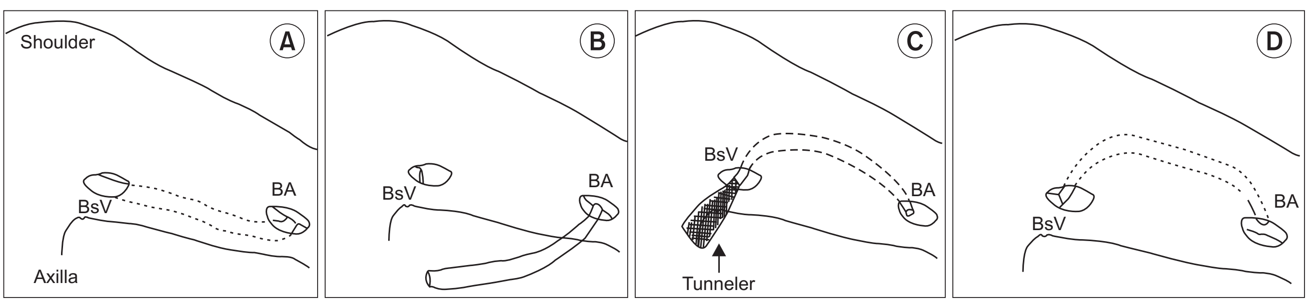

Fig. 3. (A) Brachiobasilic fistula without a juxta-anastomosis stenosis. (B) If a juxta-anastomosis stenosis is not present, the vein is divided on the proximal incision side after videoscopic dissection, and the dissected fistula is taken out toward the distal incision. (C) The tunneler is passed through the proximal incision just below the skin to reach the distal incision. (D) Re-anastomosis of the vein on the proximal incision side is performed. BsV, basilic vein; BA, brachial artery.

divided from the proximal incision side, and the divided vessels were then repositioned using a tunneler and reconnected (Fig. 3).

Antiplatelet and anticoagulation therapies were not initiated after surgery. Postoperative follow-up was performed at 2 and 4 weeks after superficialization and transposition. Final maturation was determined based on the vessel flow, diameter, and depth at week 4, and the timing of needling was determined. After needling, follow-up was performed every 2–3 months.

Statistical analysis was performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA).

This study was reviewed and approved by the Institutional Review Board and informed consent was waived (IRB approval no., 1911-008-085).

Results

Table 1 shows patient demographics. The mean patient

Table 1. Patient demographics

Variable	No. (%)
Sex	
Male	6 (37.5)
Female	10 (62.5)
Cause of end-stage renal disease	
Diabetes mellitus	8 (50.0)
Hypertension	4 (25.0)
Glomerulonephritis	1 (6.25)
Interstitial disease	0
Cystic disease	1 (6.25)
Unknown	2 (12.5)
Operation method	
Basilic vein transposition	8 (50.0)
Superficialization	
Radiocephalic AVF	3 (18.0)
Brachiocephalic AVF	5 (31.0)
Permanent catheter insertion	11 (68.5)

AVF, arteriovenous fistula.

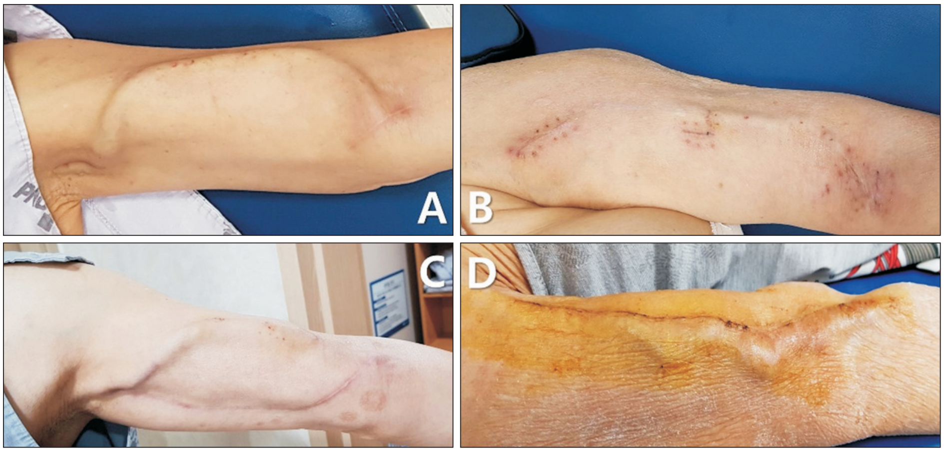

Fig. 4. (A) Brachiobasilic arteriovenous fistula after transposition using a videoscope. (B) Brachiocephalic arteriovenous fistula transposition using a videoscope. (C) Basilic vein transposition of the brachiobasilic arteriovenous fistula in the conventional manner. (D) Brachiocephalic arteriovenous fistula superficialized with a long incision.

age was 57.25±12.00 years. The most common cause of chronic kidney disease was diabetes mellitus (n=8, 50%), followed by hypertension (n=4), glomerulonephritis (n=1), cystic disease (n=1), and unknown causes (n=2).

In the first surgical procedure, 8 patients underwent BB-AVF, 3 underwent RC-AVF, and 5 underwent BC-AVF formation. The mean duration of surgery was 221.56±40.98 minutes. The mean time from videoscopic surgery to the first needling was 30.40±5.81 days, and the mean time from AVF creation to the first needling was 80.88±23.15 days.

Using ultrasonography, the mean vessel size immediately prior to videoscopic surgery was determined to be 0.66±0.13 cm and the flow was measured as 1,492.30±515.53 mL/min. The mean vessel size and flow at week 4 after videoscopic surgery, immediately before needling, were 0.73±0.16 cm and 1,516.25±791.26 mL/min, respectively. The mean vessel depth after surgery was 0.26±0.10 cm.

Postoperative needling was successful in all 16 patients. None of the patients developed a wound-related complication. Four patients underwent percutaneous balloon angioplasty after surgery owing to stenosis of the mid-cephalic vein in the upper arm (n=1), proximal anastomosis stenosis in the graft interposition site (n=1), proximal basilic vein stenosis (n=1), and proximal cephalic vein stenosis (n=1). The mean follow-up period was 262.44±73.49 days.

Discussion

Traditional superficialization in deep AVF or basilic vein transposition surgery involves longitudinal incisions, which may cause wound-related hematoma and infection [9]. Harper et al. [10] reported that patients who underwent traditional BB-AVF transposition surgery showed high rates of bleeding (13%), edema (17%), wound infection (19%), and poor maturation (11%). Multiple attempts have been made to lower such complication rates.

Jairath et al. [11] chose to make two or three 1- to 2-cm incisions along the vein branch and dissected the space between the incisions, instead of making a long incision along the basilic vein, in 24 patients. Their surgical technique was identical to the traditional approach except for the incision and dissection steps. Through reducing the dissection area by making small incisions, the incidence of postoperative hematoma and wound infection was lowered to 3.33% and 6.67%, respectively, with a maturation failure rate of 10% [11].

Tordoir et al. [12] in 2001 performed endoscopy-assisted BB-AVF transposition in 12 patients. There were no wound infections, but 1 patient (8.33%) developed a hematoma.

Leone et al. [13] also performed videoscope-assisted transposed BB-AVF surgery in 21 patients under general anesthesia in a single-stage procedure; these are key points of difference in comparison to our surgical technique. However, their technique was similar to ours in that they made a small incision in the axillary and antecubital fossae and dissected the basilic vein in the space in between using a videoscope (Fig. 4). Despite the presence of differences in some details, their results showed that using a similar incision and dissection method also avoided any surgical site infection or problems with lymphatic fluid collection and drainage. In light of these findings, reducing the length of incision and area seemed to help reduce postoperative complications.

In our study, we used a videoscope for 2 major reasons: to make a small incision and to achieve a better field of view when dissecting small branches that are difficult to detect using preoperative ultrasonography. These small branches are often damaged when dissected through a small interrupted skin incision. However, using a videoscope improves the field of view, which helps the surgeon to dissect the vessel without causing damage.

Unlike other cases of single-stage procedures, we limited our study population to patients who underwent videoscopic surgery after maturation. Single-stage surgical procedures were also performed at our center for simultaneous AVF formation and transposition in patients whose vein measured >4 mm prior to AVF formation. However, in this study, we only analyzed patients who received additional videoscopic surgery because it was challenging to dissect the vessels without causing damage due to the thin vein walls and the small size of branches before maturation in single-stage procedures.

After the additional operation using videoscopic surgery at our center, needling was performed successfully in all patients. The effects of the postoperative use of antiplatelet agents on patency remain controversial, but for patients at our center, AVF surgery itself was not considered to be an indication. Although balloon percutaneous angioplasty had to be performed owing to partial stenosis of blood vessels in 4 patients (25%), our patients are continuing to undergo hemodialysis, and 100% patency has been maintained throughout the mean follow-up period of 262.44±73.49 days.

A limitation of our study is that it only contained 16 participants, with a short follow-up period. However, the patients maintained patency throughout the follow-up period, presumably because the videoscope ensured a sufficient visual field, thereby reducing damage to the blood vessels during dissection.

Two-stage surgery requires a longer time to reach the puncture, but yields a higher puncture success rate than single-stage surgery [14]. However, a disadvantage of this technique is that the duration of hemodialysis using a permanent catheter is prolonged in some patients who undergo additional videoscopic surgery.

Nonetheless, the incidence of wound complications was reduced without problems with patency, and we expect these results to increase the degree to which it is possible to use native vessels as opposed to artificial vessels for patients with deep veins or only the basilic vein.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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