Left innominate vein stenosis treated with graft replacement with concomitant cardiac surgery

Kenichiro Takahashi, MD, Kazuto Chihara, MD, *and* Yosuke Ishii, MD, PhD, *Tokyo, Japan*

ABSTRACT

Left innominate vein stenosis is a serious complication that causes massive venous hypertension and vascular access failure in patients requiring hemodialysis. Percutaneous transluminal angioplasty has been the standard treatment strategy; however, the outcome has been unsatisfactory, with a low primary patency rate. We present the case of a 49-year-old man with symptomatic left innominate vein stenosis that was successfully treated with graft replacement concomitantly with aortic valve replacement via median sternotomy. During surgery, appropriate cardiopulmonary bypass circulation should be established to avoid cerebral venous hypertension, which can cause irreversible brain damage. (J Vasc Surg Cases Innov Tech 2021;7:488-91.)

Keywords: Arteriovenous fistula; Central venous stenosis; Graft transposition; Hemodialysis; Innominate vein stenosis

Left innominate vein (LIV) stenosis is a serious complication in patients requiring hemodialysis. If a functioning arteriovenous fistula (AVF) is present distal to such a stenotic lesion, massive venous hypertension can occur, resulting in arm swelling, ulceration, and vascular access failure.[1,2] The standard treatment strategy has been percutaneous transluminal angioplasty (PTA) with or without stenting, although the outcomes have been unsatisfactory. The primary patency rates of PTA with stenting were only 14% to 33% at 12 months.[3,4] Repetitive interventions can be required to maintain the AVF for hemodialysis.[2]

We have described, to the best of our knowledge, a previously unreported case of a graft replacement of a LIV stenotic lesion via median sternotomy with concomitant cardiac surgery. The patient provided written informed consent for the report of his case details and images.

CASE REPORT

A 49-year-old man with end-stage kidney disease who had been receiving hemodialysis was referred to Nippon Medical School Hospital because of dyspnea and left-sided chest pain. He also had experienced swelling of his left arm (Fig 1, *A*) during the most recent 4 years after the AVF had been created for hemodialysis. The cause of the left arm swelling could not be determined at the previous hospital to which he had been referred. He had undergone endovascular balloon angioplasty for the AVF twice; however, the left arm swelling had not resolved.

Echocardiography revealed a severe aortic valve stenosis. In addition, computed tomography angiography and diagnostic venography confirmed the presence of a severely stenosed proximal LIV and ectatic left subclavian vein (Fig 2). The LIV stenosis had not been previously diagnosed and had never been treated by PTA. His right innominate vein was intact. The patient was scheduled to undergo aortic valve replacement (AVR) and surgical repair of the LIV stenosis concomitantly via median sternotomy.

During surgery, narrowing of the LIV at the merging point with the superior vena cava (SVC) was observed (Fig 3, *A*). To establish cardiopulmonary bypass (CPB) circulation for AVR, a dual-stage atriocaval cannula was introduced into the right atrium, and an additional venous cannula was introduced to the distal LIV to achieve full flow. After completing the AVR and declamping the aorta, the stenosed LIV was repaired under CPB support. The SVC was partially clamped, and the stenotic lesion of the LIV was incised longitudinally. Intimal hyperplasia with thickening of a venous valve was observed in the entire stenosed LIV circumference (Fig. 3, *B*). Thus, patch plasty was abandoned, and graft replacement was chosen. An expanded polytetrafluoroethylene (ePTFE) graft (Gore-Tex Vascular Grafts; W. L. Gore & Associates, Inc, Flagstaff, Ariz) with a diameter of 10 mm was used to replace the stenosed LIV (Fig 3, *C*).

The surgery was successfully completed, and the postoperative course was uneventful. The swelling of his left arm had improved drastically (Fig 1, *B*), and the patient was asymptomatic at 10 months postoperatively.

DISCUSSION

Central venous stenosis is a complication of AVF that can lead to serious consequences. This has been especially common with the frequent use of subclavian vein catheters for vascular access.[5] However, our patient had never undergone subclavian or jugular catheterization. Oguzkurt et al[6] reported that 6 of 57 hemodialysis patients (10%) with central venous stenosis ipsilateral to

From the Department of Cardiovascular Surgery, Nippon Medical School.

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Correspondence: Kenichiro Takahashi, MD, Department of Cardiovascular Surgery, Nippon Medical School, 1-1-5 Sendagi, Bunkyo-ku, Tokyo 113-8603, Japan (e-mail: takahashi-ken@nms.ac.jp).

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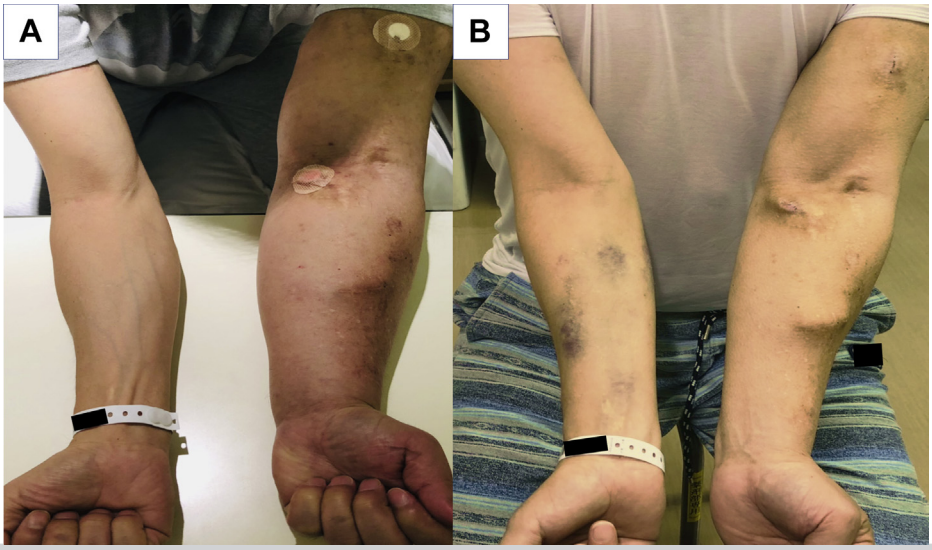

Fig 1. A, Photograph showing swelling of the left arm observed during physical examination at admission. **B,** Photograph showing that the swelling of the left arm had improved drastically after surgery.

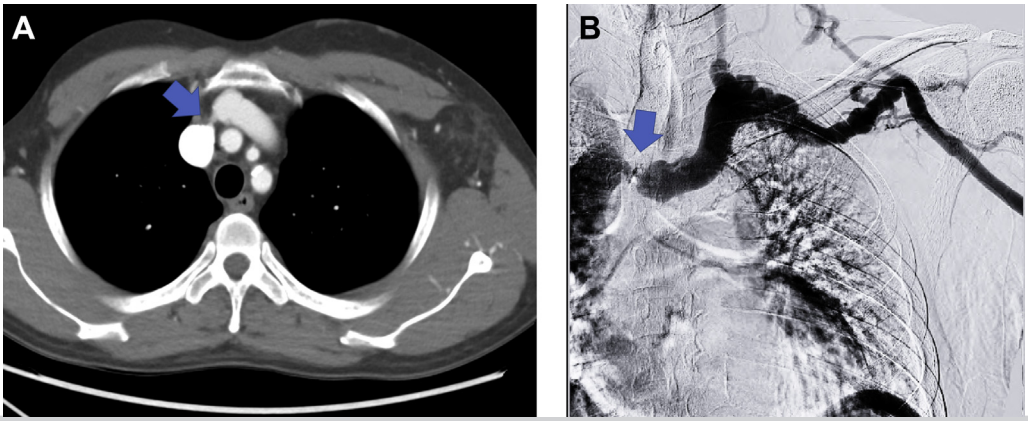

Fig 2. A, Cross section of computed tomography scan showing the left innominate vein stenosis at the point at which the left innominate vein (LIV) entered the superior vena cava (SVC; *arrow*). **B,** Venogram of the central veins showing severe stenosis of the LIV (*arrow*) and ectatic left subclavian vein.

the functioning vascular access did not have a history of previous central catheter placement. They also reported that patients with central venous stenosis had had vascular access with very high flow volumes.[6] Oguzkurt et al[6] reported that intravascular ultrasonography showed thickening of a venous valve at the site of the stenosis. These findings suggest that the stenosis had developed where a venous valve had been exposed under high pressure owing to the arterialized flow. We also speculated that a flow disturbance at the merging point with the SVC could be an additional factor inducing vein injury at this location. This would explain the common occurrence of stenosis at this site. In addition to these hemodynamic factors, a few studies have suggested that LIV stenosis without previous catheter placement will result from the extrinsic compression between the sternum and arch vessels.[7,8] These studies found that the stent did not remain fully open in patients treated for LIV stenosis using stents because of the anatomic compression.

The outcomes of a surgical approach to treating LIV stenosis have remained uncertain owing to the small retrospective studies. If concomitant cardiac surgery had not been required for the present patient, PTA would have been the first choice of treatment. However, given the unsatisfactory outcomes of PTA for LIV stenosis, the current guidelines have recommended open surgery, including axillary–axillary bypass or axillary–femoral bypass as secondary or tertiary options.[9] Alternatively, AVF translocation to the contralateral upper extremity can be considered for refractory AVF malfunction. Surgical intervention for a stenosed LIV via sternotomy should be considered as the last resort. Although surgical option for LIV stenosis is rarely reported, surgical intervention for

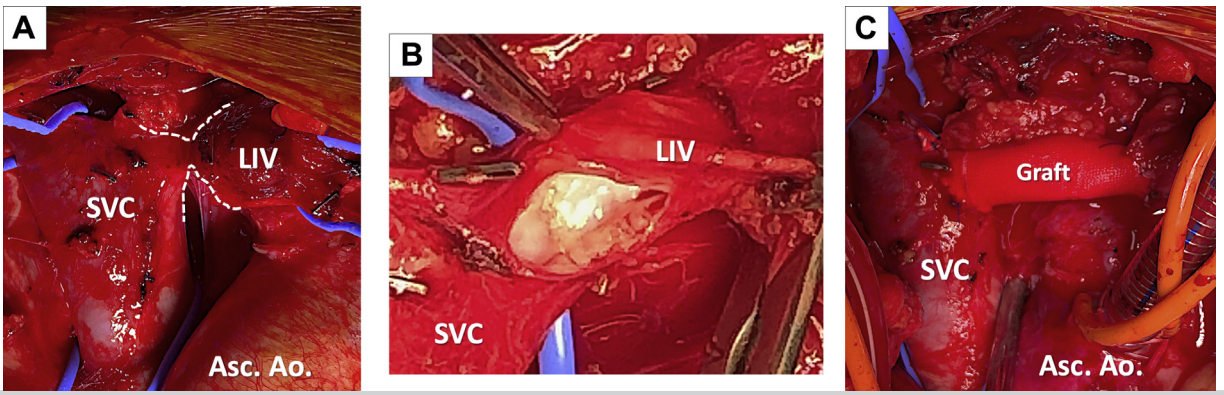

Fig 3. A, Intraoperative view showing the narrowed left innominate vein (*LIV*) at the merging point with the superior vena cava (*SVC*). **B,** Intraoperative view showing the proximal LIV incised longitudinally. Intimal hyperplasia with thickening of a venous valve can be observed in the entire circumference. The outer diameter of the isthmus was 4 mm, and the inner diameter was 2 mm. **C,** Intraoperative view showing the completed graft replacement distally anastomosed end-to-end using an expanded polytetrafluoroethylene (ePTFE) graft.

cephalic arch stenosis, which is also a significant cause of AVF malfunction, was reported as an effective option in a previous study. Davies et al[10] reported that surgical options offer superior long-term patency and functional results relative to endovascular interventions for patients with cephalic arch stenosis. Sigala et al[11] reported primary and secondary 1-year patency rates of 79% and 90%, respectively, after cephalic vein transposition, with a low reintervention rate at follow-up. These studies emphasized that surgical intervention, including transposition and bypass, should be considered earlier in the treatment of central venous stenosis.

The present patient underwent graft replacement of the LIV concomitantly with AVR under CPB support. During surgery, several techniques were required to achieve appropriate CPB circulation and avoid cerebral venous hypertension, which can cause irreversible brain damage. First, an additional venous cannula was necessary to drain the venous return from the LIV. The cannula should be placed in the distal LIV to avoid interference with the surgery required to repair the proximal LIV. If concomitant cardiac surgery with CPB support is not required, a venous cannula should be introduced as an external shunt into the SVC from the LIV. Second, the SVC was partially clamped during graft replacement. Presumably, total venous clamping will not cause brain damage because of the existence of a collateral venous network in patients with an obstructed SVC before surgery. However, abrupt clamping of the entire patent SVC will significantly alter the venous pressures owing to the lack of enough collateral venous pathways in patients with an unobstructed SVC.[12] Hence, partial clamping of the SVC was applied in the present patient to preserve the venous return from the right innominate vein. If the SVC must be clamped totally during the procedure, an additional venous cannula must be placed to the right jugular vein. For reconstruction of the LIV, an ePTFE graft without a ring was chosen to avoid compressing the brachiocephalic artery and carotid artery by the ringed graft. A concern was raised that the ePTFE graft without a ring would be compressed by the neighboring vessels and sternum. However, seeing the dramatic improvement in the swelling of his left arm postoperatively, the replaced graft did not seem to have become compressed or kinked after sternum closure.

CONCLUSIONS

Graft replacement of the stenosed LIV with concomitant cardiac surgery is a feasible and effective option for hemodialysis patients with symptomatic LIV stenosis. During surgery, appropriate CPB circulation should be established to avoid cerebral venous hypertension, which can cause irreversible brain damage.

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