Venous occlusion after incidental edge-to-edge suturing of a venous valve using suture-mediated closure devices

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Introduction

The vascular closure device is widely used for rapid hemostasis after percutaneous interventions; it is superior to manual compression in terms of achieving rapid hemostasis, reducing complications, and allowing for quicker ambulation.[1,2] Recently, feasibility of ambulatory pulmonary vein isolation work flow using the suture-mediated closure (SMC) device was reported.[3] However, reports describing complications associated with venous hemostasis using the SMC device are limited. Herein, we present a case of venous occlusion we encountered that required a surgical repair after incidental edge-to-edge suturing of a venous valve using the SMC device.

Case report

A 60-year-old man (161 cm, 62 kg, body mass index 23.9 kg/m^2) with symptomatic atrial fibrillation underwent the initial pulmonary vein isolation with minimally interrupted apixaban use.[4] Before groin puncture, ultrasonography was performed to rule out anatomical abnormalities. Groin punctures were performed under anatomical guidance at the level of the caput femoris. Four venous punctures were performed approximately 7 mm apart at an angle of 45°. Four sheaths, an 8.5F steerable sheath (Agilis NxT; Abbott, Chicago, IL), an 8.5F nonsteerable sheath (SL0; Abbott, Chicago, IL), and 2 short sheaths (7F and 5F), were inserted into the right common femoral vein (CFV) using the Seldinger technique. The ablation procedure was uneventful. The postclose technique was used for hemostasis with an SMC device (Perclose ProStyle; Abbott Medical, Santa Clara, CA) to achieve hemostasis at every puncture site.

KEY TEACHING POINTS

- Incidental edge-to-edge suturing of a valve is an under-recognized complication related to suture-mediated closure devices for venous hemostasis.
- Valve ligation should be suspected when there is swelling of the lower extremity without any sign of venous narrowing.
- Negative pressure application via the device marker lumen is helpful to recognize device entrapment in the venous valve. In case the device foot is trapped in the valve, blood flow would be aspirated via the marker lumen, as the marker port is still positioned in the vein.

All devices were smoothly advanced into the CFV, and backward flow was confirmed after applying negative pressure to the marker lumen. After opening the foot in the CFV, the device was pulled back until it came in contact with the venous wall. Before the device plunger was pushed, neither ultrasonography nor negative pressure application on the marker lumen was performed. Thus, the device's position in the CFV or the disappearance of backflow through the marker lumen could not be confirmed. Immediate hemostasis was not achieved after ligation using the device, and additional manual compression was required for several minutes.

Subsequently, swelling and livedo reticularis appeared immediately beneath the puncture site at the right groin. The patient did not complain of pain and was closely followed up with oral anticoagulant administration. The next day, although the purplish change in the leg diminished, the swelling worsened and was accompanied by the onset of pain (Figure 1A). Computed tomography (CT) demonstrated a severely dilated CFV at the distal puncture site (Figure 1B–1D). Ultrasonography showed a dilated CFV

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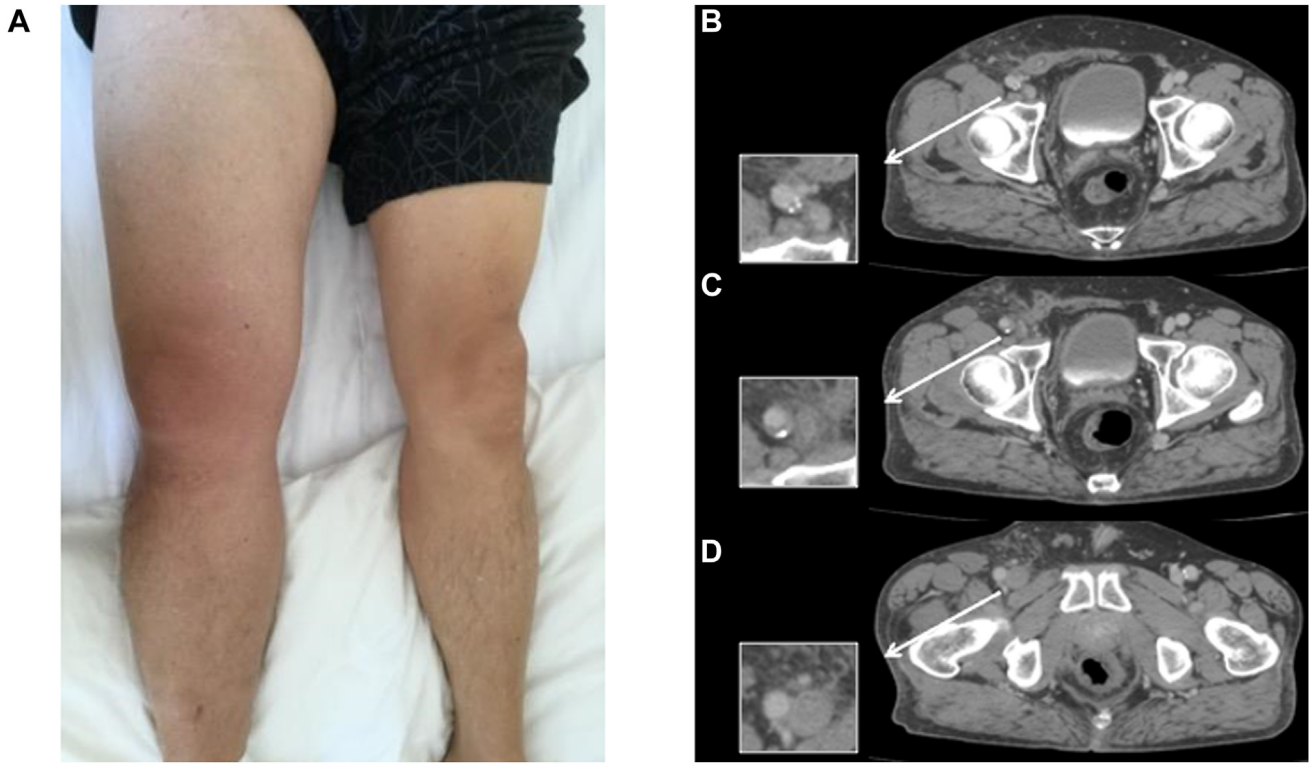

Figure 1 **A:** Gross appearance of the lower extremities on postablation day 3. **B–D:** Enhanced computed tomography from proximal to distal with magnified view of the right femoral vein and artery. At the level of the puncture site (**C**), the venous lumen was elliptic without enhancement. Distal to the puncture site, the vein was dilated (**D**).

filled with spontaneous echo contrast, suggesting stagnant venous flow (Figure 2A–2C). No venous narrowing was observed. The precise underlying mechanism of stagnation could not be ascertained; however, there was a high suspicion of venous occlusion owing to the SMC device application. Surgical intervention was recommended; however, the patient refused, and anticoagulation was intensified with heparin in the hope of improving the condition. Despite aggressive anticoagulation, the symptoms persisted, and venous thrombi were detected on repeat CT.

Finally, surgical intervention was performed on day 5 postablation. Direct visualization revealed that the bicuspid valve in the right CFV below the inguinal ligament was sutured with 2 threads. Two knots were located approximately 1 cm apart, obstructing the valve opening (Figure 2D). The section distal to the bicuspid valve was dilated and filled with thrombi (Figure 2E and 2F). After removal of all 4 threads, including the 2 sutured knots at the valve, the incision was directly closed with a nonabsorbable monofilament (5-0 Prolene; Ethicon, Somerville, NJ). After surgical repair, the pain and swelling resolved, and no thrombus was observed with the twice-daily use of 5 mg apixaban.

Discussion

Currently, venous hemostasis using the SMC device is attracting more attention because of its shorter time to hemostasis. Inadvertent ligation of the posterior wall is recognized as a venous complication after hemostasis using SMC.[5] However, no literature on incidental edge-to-edge suturing of a venous valve using an SMC device was found in the PubMed search.

The presence of a valve in the vicinity of the femoral puncture site is not rare.[6,7] The femoral vein contains 1–6 valves, and the deep vein valves are consistently located in the CFV within 5 cm below the inguinal ligament.[6] Another study established that approximately 70% of the veins have 1–2 valves within 10 cm proximal to the saphenofemoral junction, and 80% of these are located 1–5 cm proximal to the saphenofemoral junction.[7] True incidence of suturing of the venous valve is unknown, but single-valve ligation may not be uncommon, considering the anatomical background. Lower extremity swelling becomes apparent when a single ligation significantly obscures venous flow; patients may be asymptomatic if venous valve insufficiency already exists[8] or if single valve ligation slightly obscures valve opening. Incidental edge-to-edge suturing becomes apparent only when severe symptoms appear and persist. In our case, 2 devices were advanced over the valve and 2 sutures were placed, leading to total venous obstruction and severe symptoms. The deep insertion of devices and pulling out with the foot open should be avoided, especially when using multiple devices. This could increase the possibility of the device being trapped in the valve, leading to "multi-knots" on the valve.

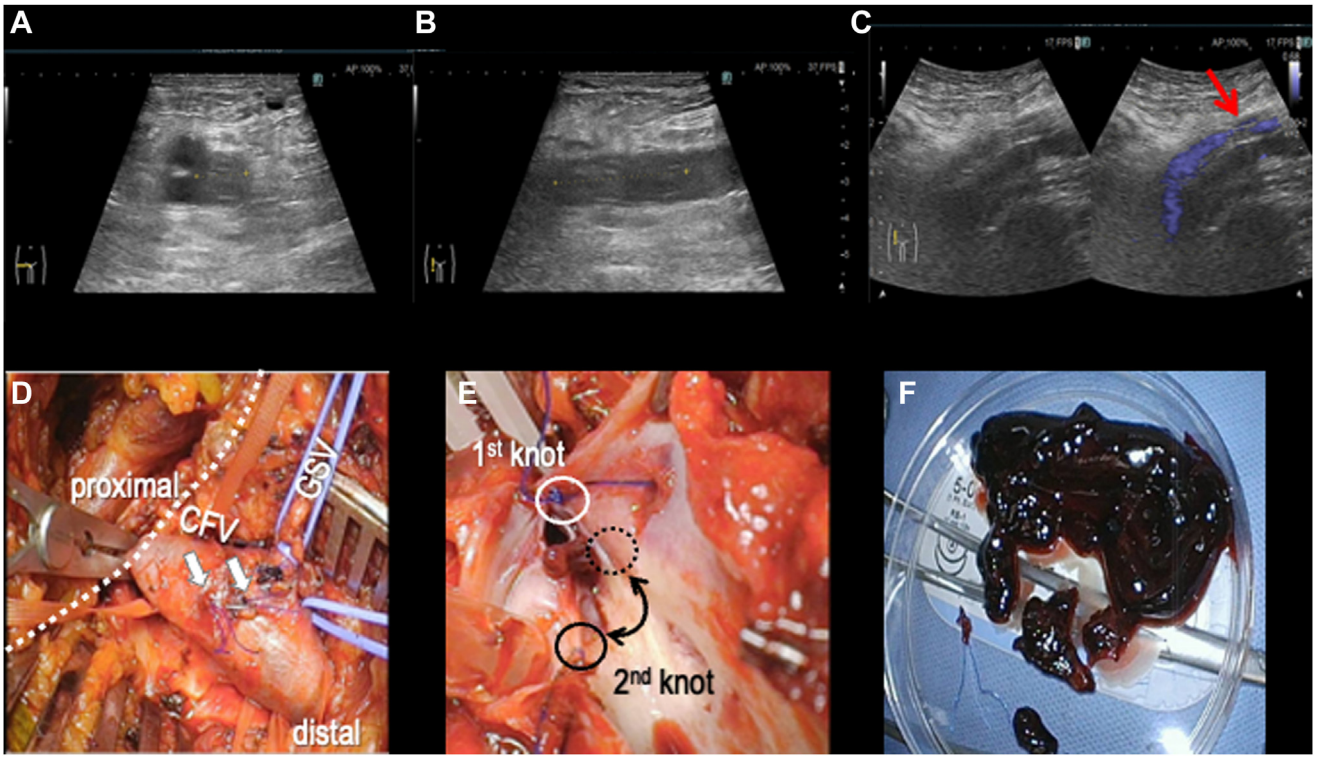

Figure 2 **A–C:** Ultrasonography of the femoral vein near the puncture sites. The cross-sectional image at the portion distal to the puncture site showed a smoke-like echo (**A**). In the long-axis view, the venous lumen was echolucent and noncompressible. Venous narrowing was not detected (**B**). Color Doppler imaging demonstrated a significant limitation of flow just proximal to the puncture site (*red arrow*) (**C**). **D:** Gross appearance of the right common femoral vein (proximally clamped) showed no evident stenosis. A white dashed line indicates the original position of the right inguinal ligament. Two of the 4 knots with long threads remained on the venous surface (*white arrows*). **E:** A longitudinal incision was made at the venous valve was bicuspid and 2 leaflets were sutured together by 2 threads. **F:** The venous lumen was filled with massive thrombi, which were removed manually. CFV = common femoral vein; GSV = great saphenous vein.

Inadvertent posterior wall ligation and venous valve suturing share a similar clinical presentation with lower extremity swelling. However, ultrasonographic findings and preventive approaches for these complications are different. Echo-guided venous puncture enables us to visualize needle entry into the vein, and is therefore now recommended.[9] Additionally, real-time assessment of anterior wall traction while pulling back the device before cutting the thread could potentially visualize inadvertent posterior wall ligation. If posterior wall ligation is present, the vein would transiently flatten and taper when the thread is pulled. In such cases, the knot can be cut by passing an 18G needle over the thread. By contrast, incidental narrowing or occlusion owing to edge-to-edge ligation of the venous valve may be difficult to recognize using ultrasonography. When the venous valve is sutured instead of the posterior wall, transient flattening or narrowing of the vein may not be apparent, as the venous lumen is preserved even though the thread was pulled back. Applying negative pressure via the device marker lumen is an adjunctive technique to avoid the incidental suture of the venous valve (Supplemental Movie 1). If the device foot is adequately in contact with the anterior venous wall, the marker port is positioned outside the venous lumen and back bleeding will stop with negative pressure application to the marker lumen (Figure 3, left panel). However, in case the device is advanced over the valve and the foot is trapped in the valve, the marker port is still positioned in the vein; thus, back bleeding would be continuously aspirated via the marker lumen (Figure 3, right panel). This adjunctive technique is considered to be important, because this is the initial step of the hemostasis and inadvertent device position can be suspected before pushing the device plunger. In addition, insufficient hemostasis may be apparent when the device is entrapped at the venous valve and the venous valve is incidentally sutured. When insufficient hemostasis owing to inadvertent valve ligation cannot be ruled out, removing the knot and switching to manual compression should be considered.

In this case, surgical repair was chosen as the treatment option owing to ongoing pain and persistent venous thrombi on CT. If the symptoms had gradually improved, watchful waiting with oral anticoagulants could have been considered. Efficacy of balloon venoplasty in patients with incidental valve ligation is unknown, but may be expected to be similar to venous narrowing when symptoms related to valve ligation are mild.[10] Aggressive venoplasty may be required for severe valve stenosis, but aggravation of valve function may appear after the intervention.

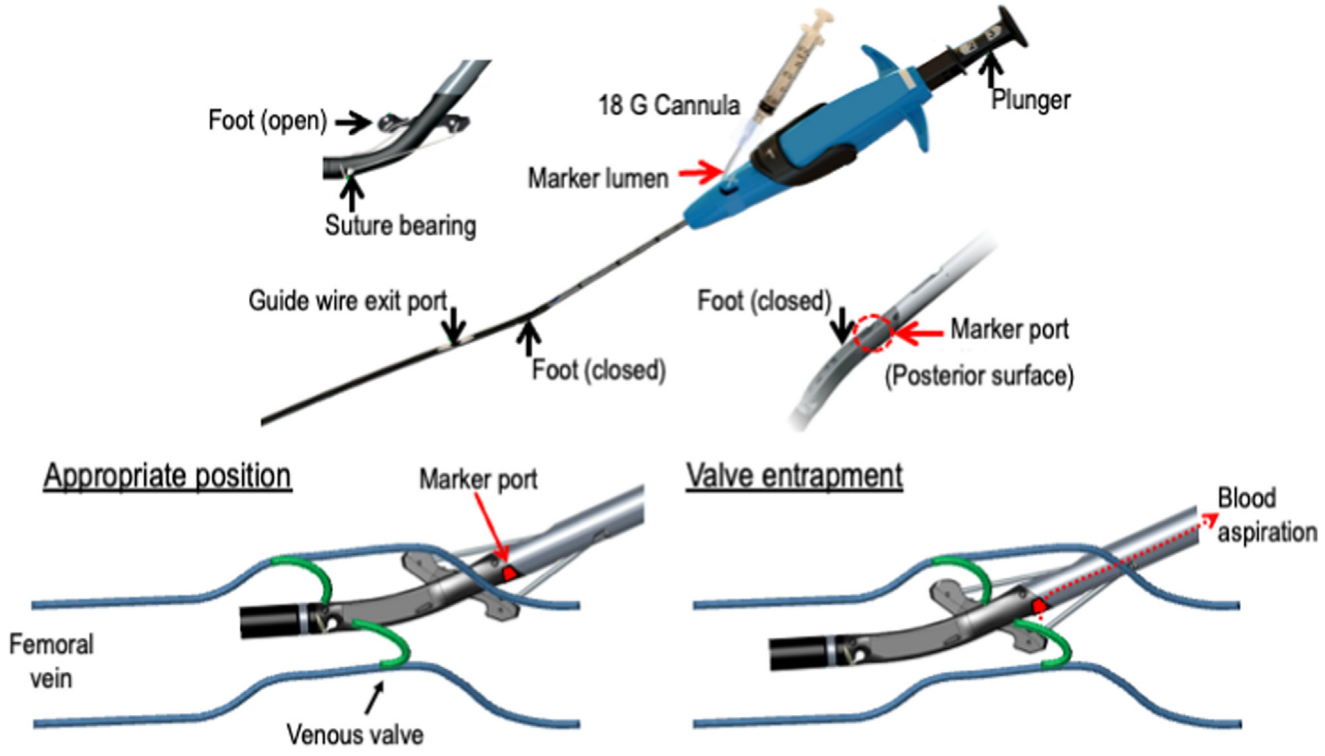

Figure 3 Schema of the device and comparison of appropriate device position and inadvertent deep device position. When the foot of the device has adequate contact with the anterior wall, the marker port, which is located at 2 mm proximal from the foot, will be positioned in the subcutaneous tissue. In this condition, only air can be pulled under the negative pressure (lower left image). When the foot is trapped in the venous valve (lower right image), the marker port is opened in the vein and blood can be aspirated under negative pressure.

Conclusion

Incidental edge-to-edge suturing of a valve is an under-recognized SMC device–related complication for venous hemostasis. Valve ligation should be suspected when swelling of the lower extremity is not associated with any sign of venous narrowing. Surgical intervention should be considered if severe symptoms persist.

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Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2023.06.011.

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