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TECHNICAL NOTE

Decalcification of a Heavily Calcified Common Femoral Artery and its Bifurcation with a Cavitron Ultrasonic Surgical Aspirator

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Introduction: Surgical endarterectomy is the preferred method for treating occlusive disease of the common femoral artery (CFA). However, endarterectomy is not always straightforward in cases with heavily calcified plaque. To overcome this limitation, a new method for decalcification, which utilizes a Cavitron ultrasonic surgical aspirator (CUSA) has been developed.

Report: The method involves full exposure of the calcified lesion. Following an arteriotomy, protruding calcification is removed using the CUSA, taking care to avoid vessel perforation. Preservation of the medial calcified layer can be accomplished by the accurate control provided by the device, which enables smooth termination in the distal area of the normal wall and does not require a tacking suture. A total of 12 patients underwent decalcification of 13 common femoral artery (CFA) lesions using CUSA with vein patch angioplasty. Concomitant profundaplasty was performed in five cases. The only intra-operative complication was perforation of the arterial wall in one patient, while another had a wound infection that required reintervention.

Discussion: Decalcification of a heavily calcified CFA with CUSA appears to be feasible, although long-term follow-up examinations are warranted.

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INTRODUCTION

Surgical endarterectomy is the preferred treatment for occlusive disease of the common femoral artery (CFA) and its bifurcation, because endovascular treatment is not optimal in such cases.[1—3] However, the procedure can be challenging when there is heavily calcified plaque, as it is difficult to preserve the external elastic lamina of a calcified lesion, leading to problems with distal flap control. To overcome this limitation, a new method has been developed that utilizes a Cavitron ultrasonic surgical aspirator (CUSA) (SonoSurg, Olympus, Tokyo), which enables precise fragmentation and aspiration of calcified plaque.

SURGICAL TECHNIQUE

The CUSA is an ultrasonic device that destroys targeted tissue, then washes the area and aspirates the fragmented mass (Fig. 1). The hand piece contains a hollow titanium tube that vibrates along its axis at a frequency of 23,500 Hz and the ultra high frequency vibrations dislodge calcium from adjacent softer tissues, which are more able to absorb the vibration energy. An irrigation system that uses saline is also built into the hand piece. During the process of fragmentation, tissue debris is suspended in the irrigation fluid and then evacuated by a suction system.[4]

An 83 year old woman presented with rest pain and a non-healing ischemic left foot ulcer. Pre-operative lower extremity computed tomography angiography (CTA) showed severe stenosis of a calcified left CFA and its bifurcation (Fig. 2). Under general anesthesia, the arterial segment containing the calcified lesion was accessed via a vertical groin incision. Next, proximal and distal dissections were extended until secure clamp sites could be achieved by direct inspection and palpation of the artery (Fig. 3A). The deep femoral artery was exposed distal to the level of the lateral circumflex femoral artery. Preparation of a greater saphenous vein graft for a vein patch angioplasty was performed in the same surgical field. Following administration of heparin (100 IU/kg) and arterial clamping, a longitudinal arteriotomy was performed until the calcified lesion and normal site were fully exposed (Fig. 3B). The arteriotomy of the CFA was extended to the deep femoral artery. Then, the calcified lesion was removed using the probe included with the CUSA appliance. The goal for this case was to remove only calcification protruding from the

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Figure 1. Cavitron ultrasonic surgical aspirator (CUSA) system and hand piece. The CUSA probe consists of a transducer, connecting body, and surgical tip.

Figure 2. Pre-operative computed tomographic angiography of the lower extremities, demonstrating heavily calcified plaque in the left common femoral artery extending to the deep femoral artery (arrow).

arterial wall. As the tip of the device vibrates in a longitudinal manner, it was found that employing it at an angle can prevent arterial wall perforation (Fig. 3C). With this technique, the output of the CUSA device was initially set to 70% of its maximal level and then gradually increased, depending on plaque hardness. In this way, preservation of the medial calcified layer can be achieved by accurate control, which enables a smooth transition in the distal portion of the normal wall area, thus a tacking suture is not required (Fig. 3D). Next, decalcification of the arteriotomy line was performed in order to reduce the risk of fraying sutures. For this case, another arteriotomy was performed for the proximal superficial femoral artery and calcified plaque located at its orifice was removed in the same way (see Supplementary Video S1). After flushing residual debris in the vessel lumen with a heparinized saline solution, the arteriotomy was closed with a vein patch to ensure an adequate lumen (Fig. 3E; Supplementary Video S1). A 6-0 synthetic monofilament was used for the vein patch suture. When the medial calcified layer is too hard for

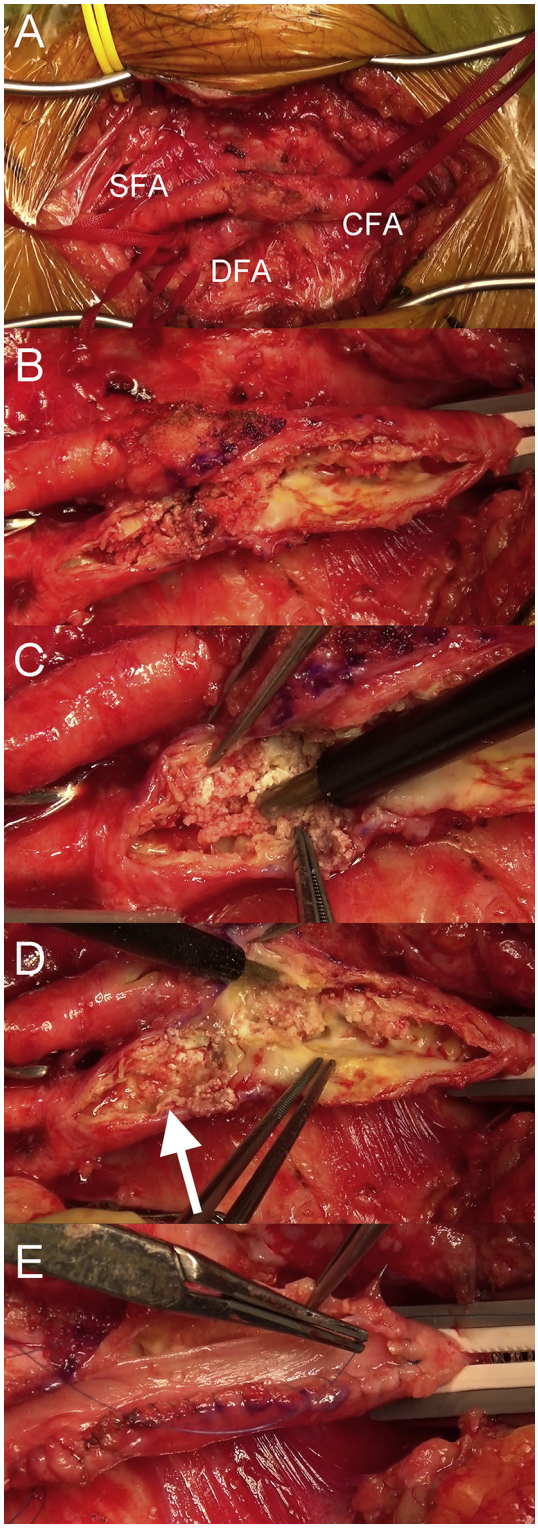

Figure 3. Procedure details. (A) The common femoral artery (CFA), superficial femoral artery (SFA), and deep femoral artery (DFA) were dissected until adequate exposure was attained. (B) An arteriotomy was performed from the CFA to DFA. (C) Protruding calcification was precisely removed by the Cavitron ultrasonic surgical aspirator (CUSA). (D) Decalcification of the arteriotomy line was performed. Shown is a representative image demonstrating a smooth termination in the distal area of the normal wall following CUSA (arrow). (E) Vein patch angioplasty was easily performed. Further details are shown in Supplementary Video S1.

penetration by the needle, the CUSA can be positioned vertical to the arterial wall, to soften or remove the calcified plaque. The femoral sheath and subcutaneous tissue were closed with 3-0 Vicryl interrupted sutures, and skin closure was performed with 3-0 nylon interrupted sutures. Following the procedure, the ankle brachial index improved from 0.39 pre-operatively to 0.61. The patient showed symptomatic improvement and the ulcer healed with no adverse events. Post-operative CTA findings revealed a fully restored vessel lumen of the common and deep femoral arteries (Fig. 4).

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.ejvssr.2016.09.003.

The following are the supplementary video related to this article:Supplementary VideoDecalcification procedure utilizing Cavitron ultrasonic surgical aspirator (CUSA) for a heavily calcified femoral artery and its bifurcation.

A total of 12 patients underwent decalcification of 13 CFA lesions using CUSA with vein patch angioplasty. Concomitant profundaplasty was performed in five cases. The only intra-operative complication was perforation of the arterial wall in one patient, which resulted in a small hole in the posterior wall of the CFA that was repaired with 7-0 Prolene, while another had a wound infection that required reintervention. Post-operative computed tomography findings showed that all treated vessels were patent at a mean 6 months post-operatively (range 1—13 months).

DISCUSSION

With any endarterectomy procedure, the atherosclerotic lesion must terminate distally in a normal area of the arterial wall. Although femoral endarterectomy is a standard procedure, approximately 2—3% of cases require CFA replacement as a result of heavy calcification attached to the wall. The CFA wall will become extremely thin following the procedure, making it difficult to hold sutures. Decalcification with the CUSA technique can help control removal of calcium with tapering at the distal external iliac artery, as well as in patients who have extreme calcification that does not allow clamping, and who require balloon occlusion. Although complete decalcification using CUSA takes several minutes, it allows for a smooth transition to the normal wall area. As the diameter of the tip of the CUSA is 2.4 mm, this technique could easily be applied to other lesions, such as those appearing in the superficial femoral and popliteal arteries. Presently, the midterm results of cases with a femoral bifurcation lesion, prior to expanding the indications for this procedure, are being compiled.

Successful decalcification of a heavily calcified aortic valve annulus or aortic wall by CUSA has been reported for cases complicated with aortic valve stenosis,[5—7] and these reports have encouraged the application of CUSA to the field of peripheral vascular surgery, especially for heavily calcified arterial occlusive disease. CUSA devices, which require only saline for irrigation and do not use disposables that must be replaced after each operation cost approximately 5,900,000 yen (US $58,000), and are widely used for neurosurgery and hepatobiliary surgery.

Although CFA endarterectomy has been utilized as an effective and durable method for over 50 years, endovascular treatment of CFA disease has been reported to be an unsatisfactory strategy.[8,9] Thus, surgical endarterectomy remains an important procedure, even in the endovascular

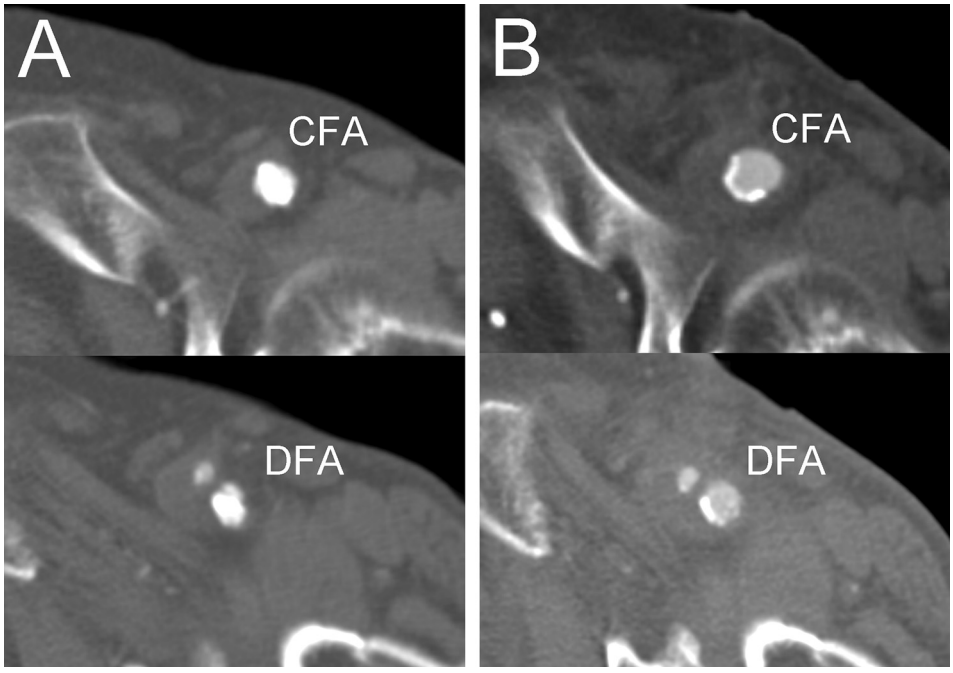

Figure 4. Pre- and post-operative computed tomography angiography findings. (A) Extensive calcification is evident in the common femoral artery (CFA) and deep femoral artery (DFA). (B) CFA and DFA after decalcification with the Cavitron ultrasonic surgical aspirator (CUSA) showing a fully restored vessel lumen. The diameter of the distal end of the treated lesion was approximately 5 mm.

era. The authors believe that a CUSA procedure may add to the armamentarium of vascular surgeons.

Potential pitfalls of this procedure are risk of artery perforation and insufficient plaque removal from the artery. In addition, the fate of the residual wall after decalcification performed with a CUSA device has not been investigated. Additional studies of cases with a long post-operative follow-up, with repeated imaging are essential to establish this procedure.

CONCLUSION

Decalcification utilizing CUSA for a heavily calcified CFA and its bifurcation appears to be feasible.

CONFLICT OF INTEREST

None.

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