

## ALTERNATIVE FEMORAL ENDARTERECTOMIES: TECHNICAL ASPECTS AND SHORT-TERM RESULTS

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*Background.* Femoral endarterectomies are often performed by means of longitudinal arteriotomies with patching. Autologous and synthetic patches can be used. Synthetic patches in the groin may expose patients to infection. We present two alternative techniques for the treatment of femoral atherosclerotic lesions.

*Material and methods.* The alternative endarterectomies (AE) included eversion (EE) and semi-closed endarterectomies (SCE). An EE with an oblique transection of a femoral bifurcation (FB) was used for lesions extending to the FB. The artery was reconstructed in an end-to-end manner. An SCE with a bovine pericardium patch (BPP) was used for lesions extending further. An arteriotomy was made from the superficial femoral artery just past the level of the profunda femoris opening (PFO). The plaque was cut proximally to the PFO, dissected circularly with a Swedish-type dissector, and then removed with Crile forceps. The distally remaining plaque was endarterectomized in a conventional manner. The arteriotomy was closed with a BPP.

*Results.* A total of 21 AEs were performed, 8 of which were accomplished in a hybrid setting. There were no periprocedural complications. One distal embolization after a balloon dilatation was registered during the early postoperative period. The median follow-up was 3 months. There were no deep wound infections, pseudoaneurysms, amputations, or deaths. A total of 20/21 patients reported complete symptom relief, with one requiring an additional femoro-popliteal bypass grafting owing to poor outflow. The primary patency rate of the endarterectomized segments was 100%.

*Conclusion.* Alternative methods of local endarterectomy can extend the available range of procedures for patients suffering from chronic lower-limb ischemia. According to our results, these endarterectomy techniques are safe and could be taken into consideration, as they provide some advantages over conventional methods.

**Key words:** femoral endarterectomy, eversion femoral endarterectomy, alternative femoral endarterectomy.

### INTRODUCTION

Femoral artery patching is believed to preserve the patency of an endarterectomized artery. A longitudinal arteriotomy is therefore often closed with a synthetic or bovine pericardium patch. Patching could, however, result in a prolonged procedural time and increased costs. Synthetic patches can expose patients to infection [1], which is associated with subsequent reoperations and a high rate of morbidity, mortality, and limb loss [1].

An eversion endarterectomy (EE) for the treatment of aortoiliac segments does not require patching. This technique was used decades ago [2] but has been partly forgotten. Lately, several reports have been published on the application of EE for the treatment of femoral arteries [3–6].

The relative disadvantages associated with the use of conventional endarterectomies have pushed us towards the management of femoral artery lesions with alternative modalities, independently of the reports mentioned above. For lesions limited to the femoral bifurcation (FB), we have used eversion techniques.

Lesions extending to the proximal superficial femoral artery (SFA) cannot, however, be managed with EEs. Therefore, a semi-closed endarterectomy (SCE) with a bovine pericardial patch closure could be suggested instead. Herein, we describe both modalities in a series of treated patients and present the short-term results.

### MATERIAL AND METHODS

Patients with signs or symptoms of chronic lower-limb ischemia were examined at Tampere University Hospital (Tays) between 02/2012 and 11/2019. Those presenting with an occlusion or significant stenosis of the common femoral artery (CFA) upon magnetic resonance angiography underwent femoral endarterectomies. In order to achieve adequate inflow or outflow, endovascular procedures were performed as an adjunct on other arterial segments as necessary.

The patients gave informed consent prior to surgery. An EE was performed when the location of the plaque was limited to the CFA or femoral bifurcation. An SCE was performed in cases where the plaque involved

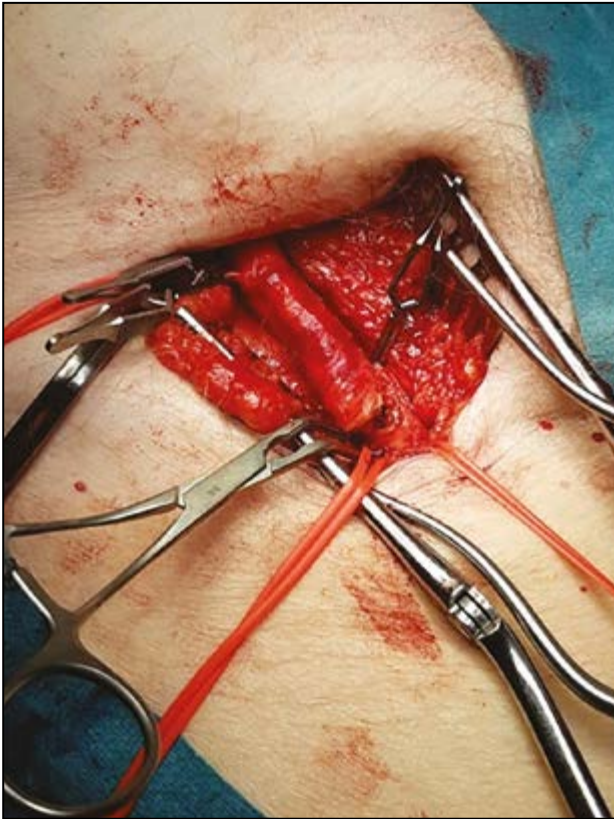


Fig. 1. Oblique arteriotomy



Fig. 2. The plaque is removed by the eversion of the adventitia

both the CFA and the proximal part of the SFA. The use of eversion and semi-closed endarterectomies was occasional, and the procedures were performed in selected cases by the same group of surgeons.

All patients were administered acetylsalicylic acid (ASA) 100 mg/daily pre- and postoperatively. Low molecular weight heparin, enoxaparin sodium (Klexane®; Sanofi-Aventis, Maisons-Alfort, France), 40 mg twice daily was administered postoperatively until discharge from the hospital. Clopidogrel 75 mg daily in combination with ASA was administered post-procedurally for one month to those patients who underwent percutaneous transluminal angioplasties (PTA) of the SFA and/or proximal popliteal artery in addition to femoral endarterectomy.

The patients underwent a 1-month follow-up with noninvasive examinations (pulse palpation, ankle-brachial index measurement, and duplex ultrasonography). Further follow-up was arranged at different time intervals.

The Research Board of Tays approved the study (R20540). The data was assessed retrospectively.

#### TECHNICAL ASPECTS OF THE EE

In the EE procedure, an oblique transection of the CFA is first made (Fig. 1). The arteriotomy is started from the distal part of the femoral bifurcation or the proximal SFA and continued cranially towards the posterior wall of the CFA. The adventitia of the CFA is then everted, and the plaque removed (Fig. 2). The remaining debris is removed with forceps and the surface rinsed with heparinized saline. The bifurcation of the CFA is endarterectomized, and the intima of the SFA is tacked with interrupted 7–0 polypropylene sutures as necessary. The ends of the artery are reconnected with a continuous 6–0 polypropylene suture (Fig. 3). In order to avoid tension, the artery should be thoroughly dissected prior to closure. Finally, a completion arteriography or an intraoperative transit time blood flow measurement (VeriQ™, Medistim, Oslo, Norway) is performed.

#### TECHNICAL ASPECTS OF THE SCE

During an SCE, a longitudinal arteriotomy is started from the healthy SFA segment and continued through the plaque past the femoral bifurcation to allow access to the opening of the profunda femoris artery (PF). The arteriotomy is concluded at that level. The plaque is then dissected and cut transversely proximally to the profunda opening. A Swedish-type dissector is advanced proximally to separate the plaque from the adventitia circularly (Fig. 4). Once the plaque is properly dissected from the wall, it can be easily pulled out with Crile forceps. The remaining plaque in the femoral bifurcation and the SFA is subsequently removed using a conventional

endarterectomy. The distal intima of the SFA is usually tacked with 7–0 polypropylene interrupted sutures. We then close the arteriotomy with a bovine pericardium patch (BPP; XenoSure® Biologic Patch [LeMaitre, Germany]), followed by a routinely performed completion arteriography or an intraoperative transit time blood flow measurement (VeriQ™, Medistim, Oslo, Norway).

## RESULTS

A total of 21 alternative endarterectomies were performed (10 EEs and 11 SCEs) on patients with chronic limb ischemia. The technical success rate of the alternative technique was 100%. A total of 8 operations were accomplished as hybrid procedures. Half of them included common and external iliac artery PTAs, in addition to femoral endarterectomies. The remaining four procedures targeted the SFAs or proximal popliteal lesions. Quality assessment was carried out with transit time flow measurements, in addition to 8 angiographies during the hybrid procedures. The patients' baseline data are presented in Table.

There were no periprocedural complications. In the early postprocedural period, one patient developed a distal embolization of the SFA from the recanalized external iliac artery. The case was successfully managed endovascularly with aspiration and local thrombolysis. Another patient developed an operative site hematoma and required a blood transfusion. The hematoma developed owing to postoperative anticoagulation and was managed conservatively. The mean duration of hospitalization was 2 days (standard deviation 0.7).

The median follow-up was 3 months (interquartile range 4). None of the patients were lost to follow-up. There were no pseudoaneurysms, seromas requiring surgical treatment, or deep wound infections. No amputations or deaths occurred during the study period. Complete symptom relief was reported in 20/21 cases, with one patient requiring a femoro-popliteal bypass due to a chronic occlusion of the SFA and severe claudication.

The cumulative primary patency rate of the endarterectomized segments was 100% within the study period. The patients demonstrated improved limb perfusion according to pulse palpation and general clinical examinations. An increase of  $>0,15$  in the ankle-brachial pressure index was observed throughout the study series. Duplex scanning was performed, confirming the patency.

## DISCUSSION

In this paper, we have described two alternative femoral endarterectomy techniques. They appear to be safe, and their short-term patency rates are high.

EE is a convenient way of managing lesions of the common femoral artery and bifurcation without



Fig. 3. The ends of the artery are reattached



Fig. 4. The plaque is dissected from the adventitia with a Swedish dissector

a need for patching. The ostium of the deep femoral artery is adequately exposed, as the arteriotomy is oblique. Nevertheless, if the atherosclerotic process extends distally to the PF bifurcation, a conventional endarterectomy with profundoplasty appears to be more appropriate. The role of profundoplasty remains considerable in patients with femoral peripheral arterial disease and claudication without tissue loss [7]. Although EE requires a learning curve, the procedure seems to be relatively simple to perform.

Patient characteristics	
Variables	Number (N=21)
Age, years, median (IQR)	73 (12)
Sex, male	12 (57,1)
Arterial hypertension	20 (95,2)
Type 2 diabetes	12 (57,1)
Dyslipidemia	10 (47,6)
Renal insufficiency	2 (9,5)
Coronary heart disease	5 (23,8)
Atrial fibrillation	2 (9,5)
Pulmonary insufficiency	2 (9,5)
Ischemia, Rutherford category 3	13 (61,9)
Ischemia, Rutherford category 4	7 (33,3)
Ischemia, Rutherford category 5	1 (4,8)
CFA diameter (EE/SCE)	7,3 (1,3)/7,4 (1,3)
SFA diameter (EE/SCE)	4,9 (1,6)/4,9 (1,1)
Lesion length (EE/SCE)	22,0 (34,3)/43,0 (54,1)

*Values reported as numbers with percentage, unless otherwise specified. Diameters and lengths are reported in millimeters and presented as median data with interquartile range (IQR). CFA - common femoral artery; SFA - superficial femoral artery; EE - eversion endarterectomy; SCE - semi-closed endarterectomy.*

So far, all of our operations have been technically successful, with no peri- or postprocedural complications related to the surgical treatment of the target lesion. Dufranc and colleagues had extensive experience in eversion endarterectomies and reported a 6,8% technical failure rate [3]. The failures were due to a weak residual artery or an inability to tack a distal flap. In fact, post-endarterectomy adventitia weakening may also occur during a conventional procedure and may occasionally require corrections with short bypass grafts. Leaving a distal flap can be crucial. Unfortunately, inadequate distal flap control is sometimes difficult to manage through a cut-off arteriotomy. For that reason, we prefer an SCE if the lesion extends distally to the SFA. Furthermore, a completion angiogram or other intraoperative flow examinations are important [6]. We perform angiograms in hybrid cases and routinely measure transit flow time otherwise. The latter is a simple and evidence-based technique recommended by the National Institute for Health and Care Excellence in England [8]. This method is routinely used in Finland. We believe that these measures have prevented us from experiencing reocclusions in the short term.

The primary patency rate in our series was 100%. This result is in line with the previous report on 147 eversion endarterectomy patients (3). Interestingly, the cumulative 2-year primary patency rate after EE did not statistically differ from conventional endarterectomy with patching, as reported by Mirmehdi, et al. [4].

To our knowledge, there are no descriptions in the English-language literature of the SCE technique as it is used in our institution on the femoral segment. The SCE is a modification of a conventional endarterectomy technique. Its main advantage is the short arteriotomy and, therefore, freedom from extensive patching of the CFA and SFA. The method allows reliable distal intima tacking under visual control. Furthermore, no special instrumentation is required. Since the plaque dissection is performed with a dissector, however, care must be taken to not perforate the adventitia. We have used BPPs for closure. This biomaterial is a durable option even in infected sites [9]. We have encountered no subsequent wound infections or pseudoaneurysm formations so far.

The use of patching in femoral endarterectomies can be questioned. To the extent of our knowledge, there is no strong evidence to support the use of patches in the common femoral artery. The rationale for patch use is an assumed risk of restenosis, which could occur particularly in the SFA, thus explaining our strategy.

The primary aim of this work is to describe the feasibility of the alternative techniques. In our relatively small series, clinical examinations suggested that all of the treated arteries remained patent during the short-term follow-up. We have not, however, provided exact post-procedural ABI measurements since eight cases were managed with hybrid procedures. In our opinion, this could make the ABI interpretation confusing and would not reflect the results of the open procedure itself. We have also not presented the length of the procedure, as both hybrid and open operations were performed. Moreover, with the advancement of the learning curve, the duration of these operations will potentially decrease.

## CONCLUSION

Alternative endarterectomy techniques are safe and could be taken into consideration, as the methods described provide some advantages over conventional methods. Additional information on the long-term results will be beneficial.

**Conflict of interest: none declared.**

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