# 7

# Endarterectomy

Jamal J. Hoballah

The histological examination of the cross section of the arterial wall will reveal three layers— the intima, the media, and the adventitia. The innermost layer is the intima, composed of the endothelium and the internal elastic lamina. The endothelium provides a smooth lining and has antithrombotic activity. The media is the inner layer of the arterial wall and is made of layers of smooth muscle cells oriented in longitudinal and circular directions. These layers are surrounded by basal lamina, collagen, and elastin fibers. The main role of the media is to regulate blood vessel resistance by constricting and controlling the vessel lumen. The adventitia is the outermost layer and contains the vasovasorum, which provides blood supply to the wall. In addition, it has a collagenous matrix that provides the artery's tensile strength. The purpose of an endarterectomy is to remove an obstructive atherosclerotic plaque from the arterial lumen. This usually results in removing the thickened intima and inner media, leaving behind the outer part of the media and the adventitia. The plaque can be removed by opening the vessel longitudinally and then separating the plaque from the vessel wall (Open Endarterectomy; section "Tacking the Endarterectomy Endpoint"). The plaque can also be removed by pushing and pulling the plaque, while everting the wall of the vessel (section "Eversion Endarterectomy"). Semiclosed endarterectomy refers to the procedure where an incision is performed proximally and distally in an artery. The plaque in the vessel segment between the arteriotomies is removed using special instruments known as plaque strippers. Currently, semiclosed endarterectomy is infrequently performed and will not be reviewed in this chapter.

Endarterectomy is ideal for treating focal atherosclerotic disease in medium- and large-sized arteries. Both open and eversion techniques can be utilized when conducting carotid endarterectomy, one of the most commonly performed vascular procedures. Aortoiliac endarterectomy, once a commonly performed procedure, is very infrequently performed, nowadays, with the availability of endovascular options. An aortobifemoral bypass is often selected over aortoiliac endarterectomy when endovascular interventions fail, as it tends to be a simpler operation. In the infrainguinal region, common femoral and profunda femoris endarterectomies continue to be performed in select cases as independent procedures or adjunctive procedures to infrainguinal bypasses. Below the knee endarterectomy is almost never performed and limited to very rare

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situations where the surgeon is forced to conduct an endarterectomy at the distal anastomotic bypass site, in order to place the anastomotic sutures.

## OPEN ENDARTERECTOMY

When performing an open endarterectomy, being in the right plane is very important. Start by holding the edge of the adventitia with a pickup and pulling it away from the plaque. A plane will then develop. Using the Freer elevator, the adventitial wall is pushed away from the plaque. The endarterectomy plane is developed on each side of the vessel wall and advanced posteriorly until it becomes circumferential. On the proximal end, when a normal part of the artery is reached, the plaque is transected flush with the arterial wall without leaving any significant protruding ledge. On the distal end, if a normal segment of the artery is reached, an attempt is made to move the endarterectomy plane to a more superficial level. This usually allows terminating the endarterectomy with a smooth endpoint. Remaining circular fibers of the media can be gently and meticulously peeled off.

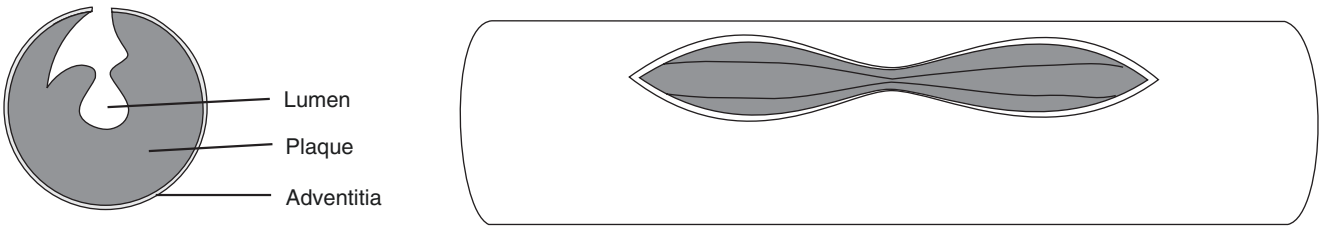
### TACKING THE ENDARTERECTOMY ENDPOINT

If the disease extends beyond the level where the endarterectomy needs to end, transecting the plaque will create a shelf at the endpoint of the endarterectomy. When prograde flow is resumed, this shelf could lift up and create a dissection or an acute thrombosis. If a smooth transition cannot be achieved at the distal endarterectomy endpoint, the shelf of thickened intima or remaining plaque should be fixed to the vessel wall by "tacking" sutures (section "Tacking Sutures"). This is achieved by placing sutures in the endarterectomized and nonendarterectomized vessel wall segment to prevent separation of the adventitia from the remaining part of the arterial wall. Start by placing the suture 0.5–1 mm from the edge of the endarterectomy in the nonendarterectomized segment. This suture should always be placed from the inside of the intima toward the adventitial side to prevent separation of the intima. Place the other suture very close to the edge of the endarterectomy. This suture is also placed from the inside to the outside. Continue by placing several similar sutures almost 3–4 mm apart. Each suture is then tied separately. Great attention should be given to having the appropriate amount of tension on the sutures while tying. Excessive tension can result in tearing of the suture through the intima and media in the nonendarterectomized segment of the wall. Heparinized saline irrigation is then used to test the wall of the artery to check for any area that can still be at risk for lifting up, causing an intimal flap or dissection.

## EVERSION ENDARTERECTOMY

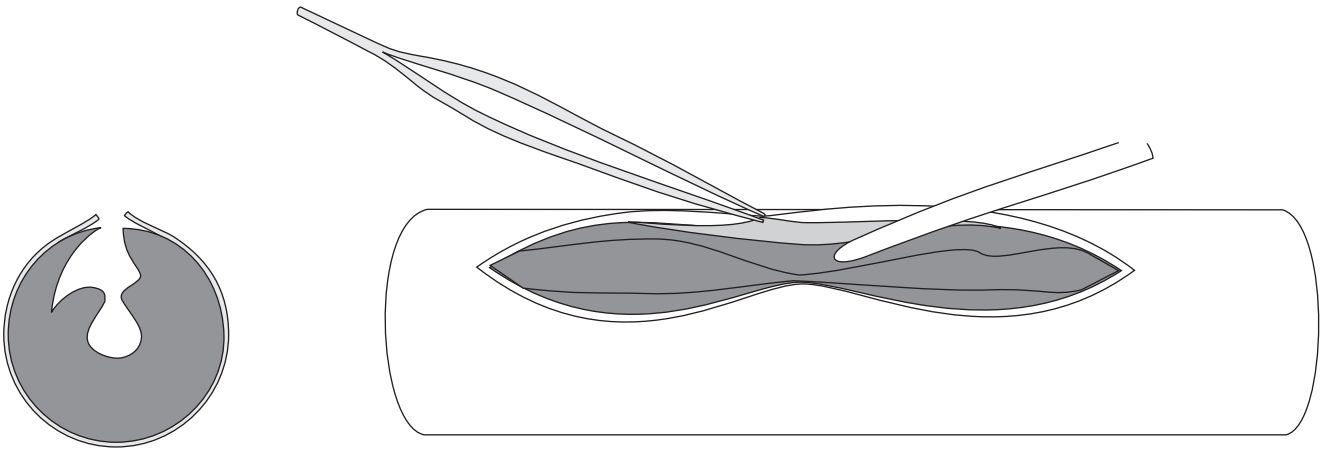
When the plaque is removed by everting the vessel wall and pushing the plaque out without opening the vessel longitudinally over the plaque, the procedure is called eversion endarterectomy (section "Eversion Endarterectomy"). It can be performed by transecting the artery and everting and rolling the adventitia away from the plaque as done is carotid eversion endarterectomy. It can also be performed without completely transecting the vessel as done with the external carotid artery during open carotid endarterectomy.

## Open Endarterectomy

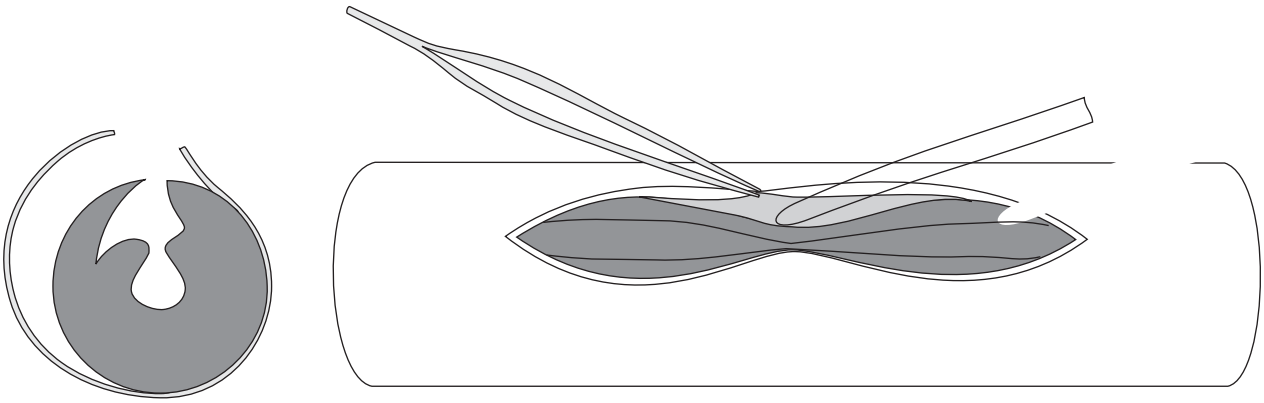



Cross Section

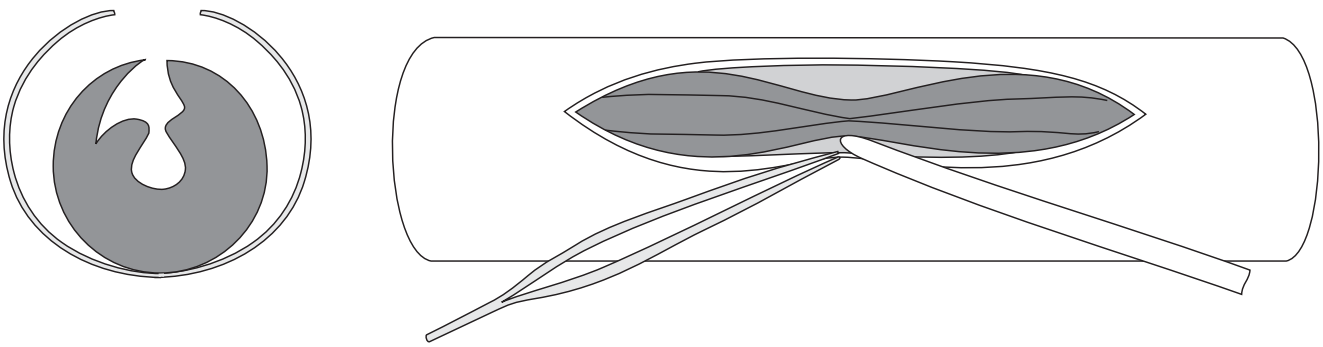
Incise the artery longitudinally through the plaque until a normal part of the artery is reached.



Hold the edge of the adventitia and gently lift it away from the plaque. Use the Freer elevator to identify the correct plane of endarterectomy.



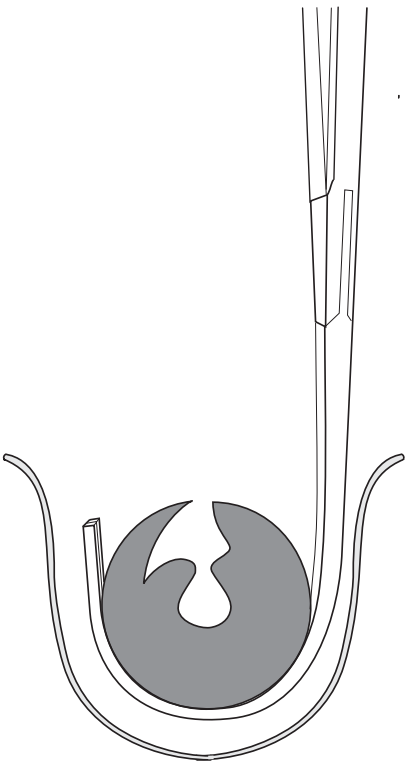
Continue separating the plaque from the adventitia by gently pushing the adventitial wall away from the plaque.

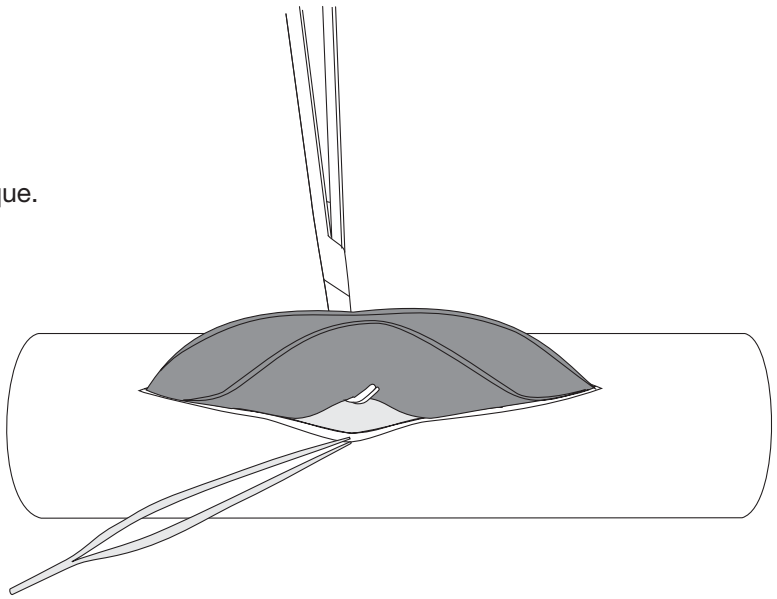


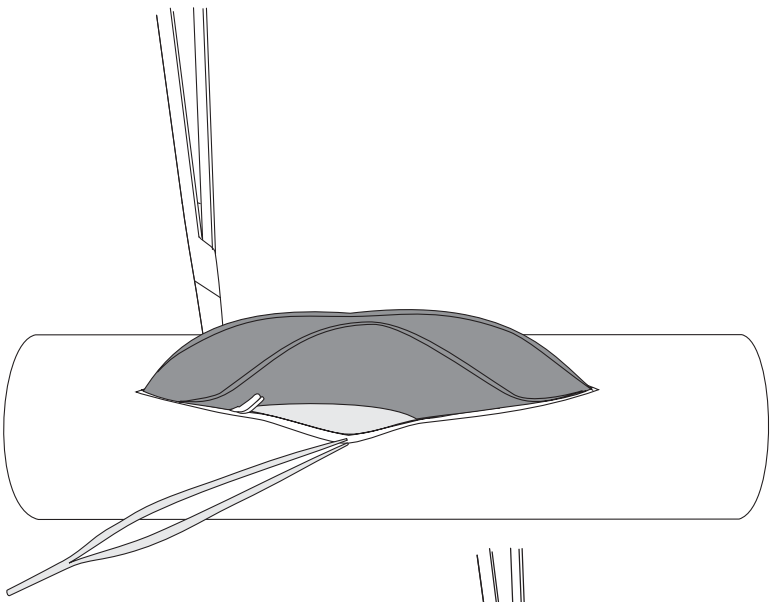
Repeat the same maneuver from the other side of the arteriotomy.

## Open Endarterectomy

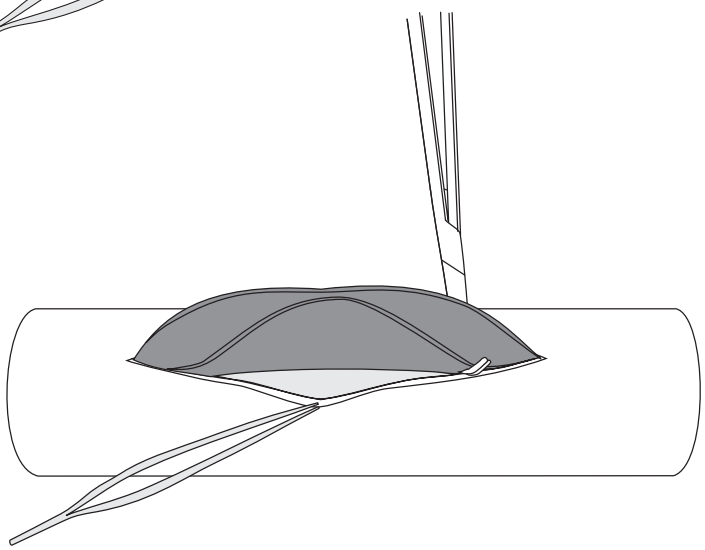
Pass a right-angle clamp underneath the plaque.







You may use the right-angle clamp to free the remainder of the plaque from the arterial wall by pushing the clamp toward each end of the arteriotomy.

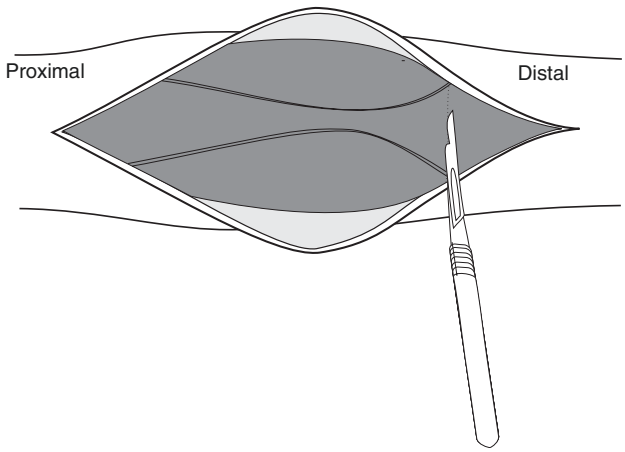


## Open Endarterectomy
### Tacking Sutures

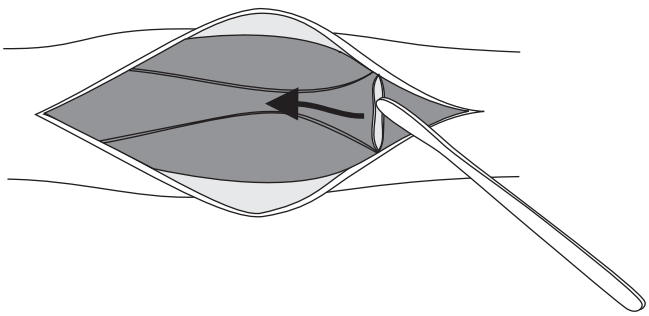
**At the level of the distal endpoint, changing the endarterectomy plane into a more superficial one can help in providing a smooth, well-feathered endpoint.**

**A 15 blade may be used to transect the plaque.**

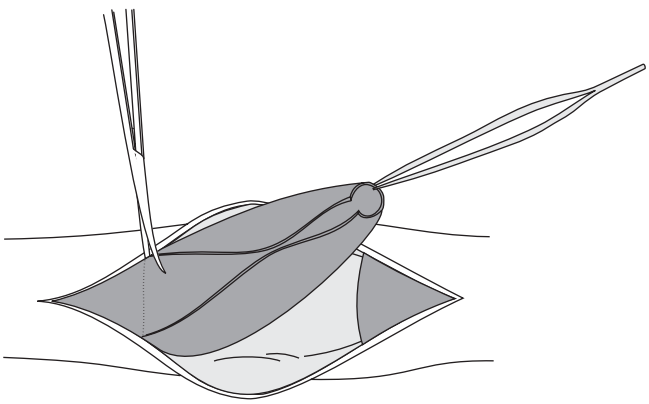
**Start by carefully incising the intima at the desired level.**



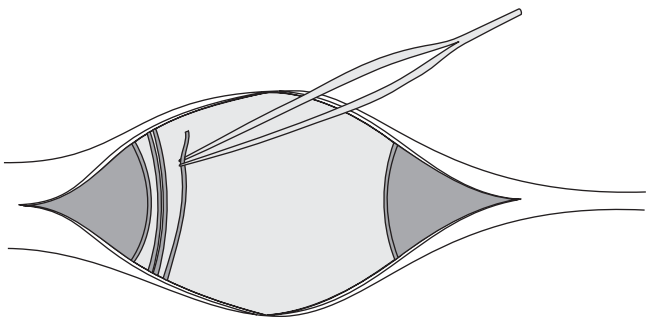

Use the Freer elevator to separate the plaque. Push with the Freer elevator using a sweeping motion toward the proximal endpoint.



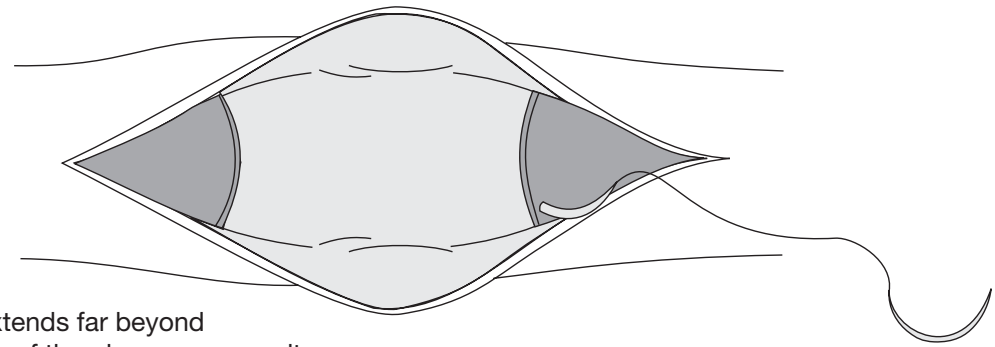
Alternatively, you may use the scissors to transect the plaque. Care is taken to avoid leaving an edge of plaque protruding at the endpoint.



Remaining circular fibers are individually peeled off.

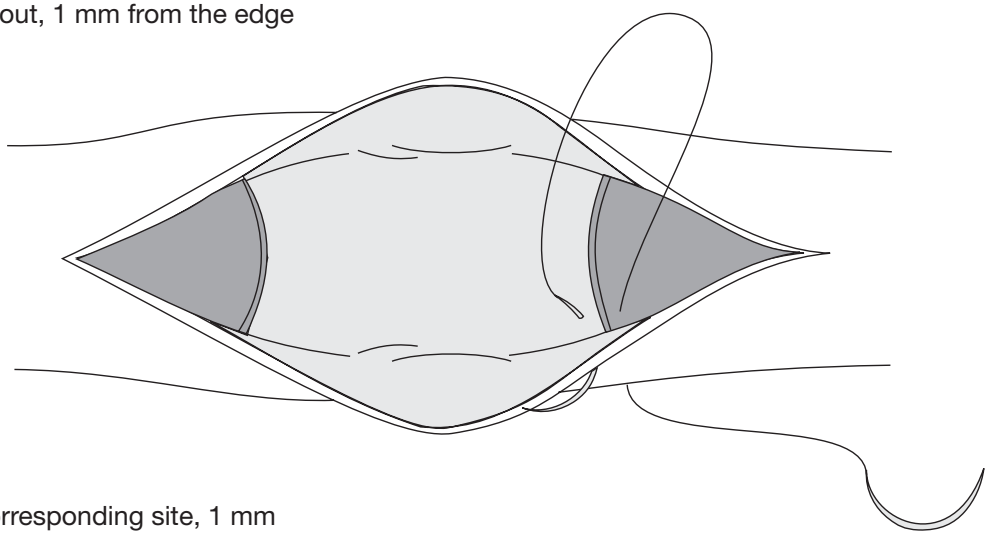


## Open Endarterectomy
### Tacking Sutures



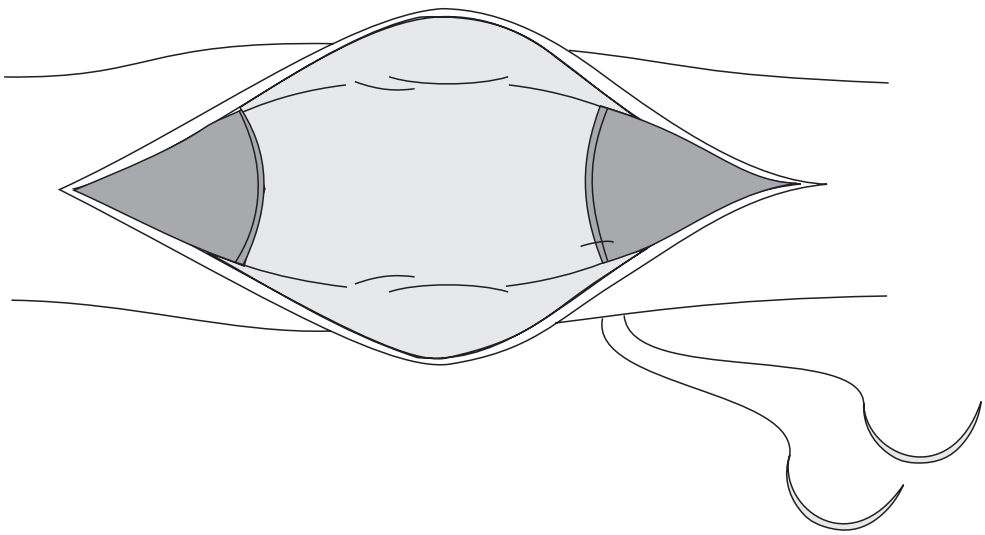
Occasionally, the plaque extends far beyond the arteriotomy. Transection of the plaque may result in an edge that could lift, causing dissection or thrombosis. Tacking the endarterectomy endpoint may be necessary.

Introduce the needle inside out, 1 mm from the edge of the endarterectomy.



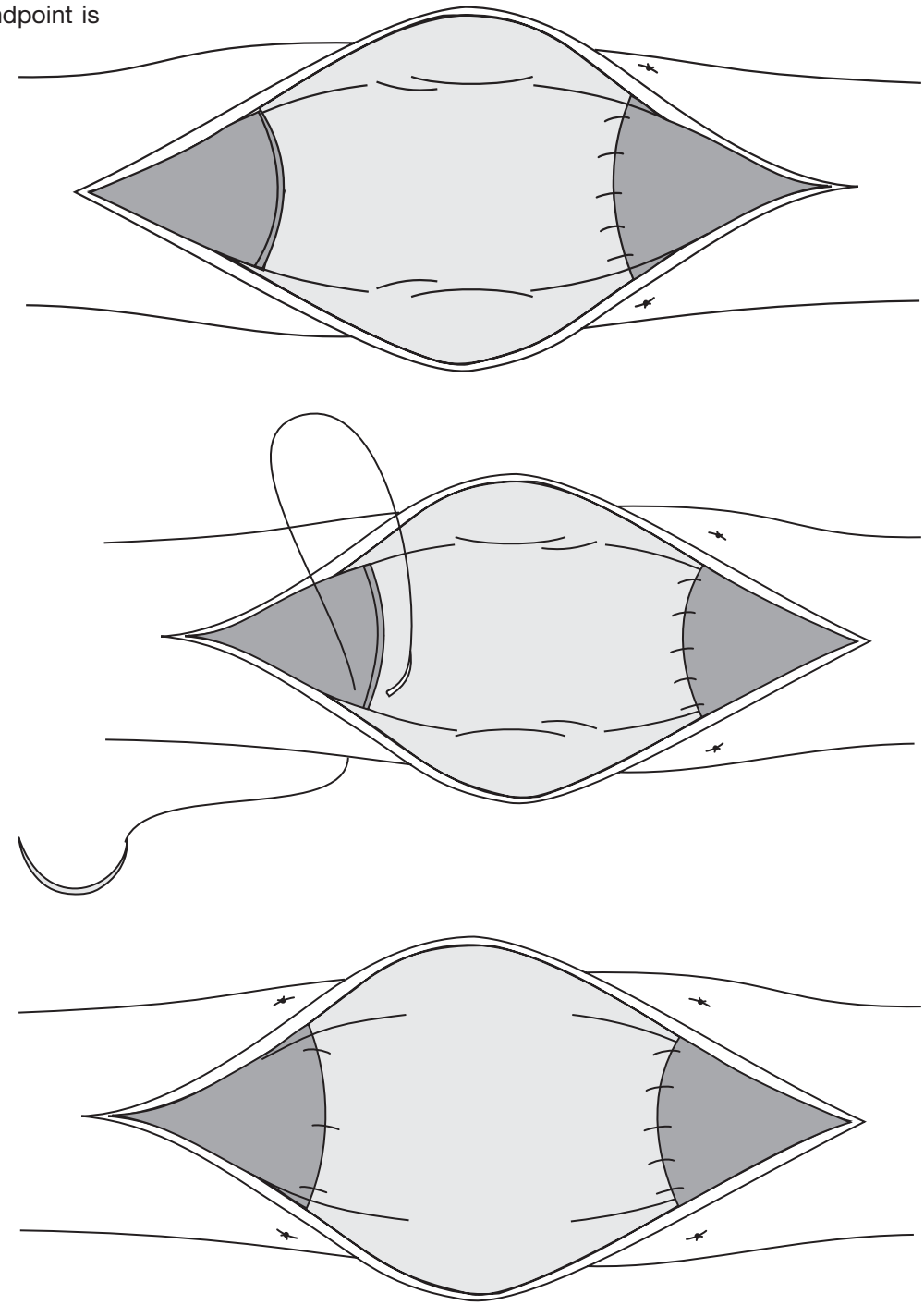
Introduce the needle in a corresponding site, 1 mm from the edge, again inside-out.

Place multiple sutures.

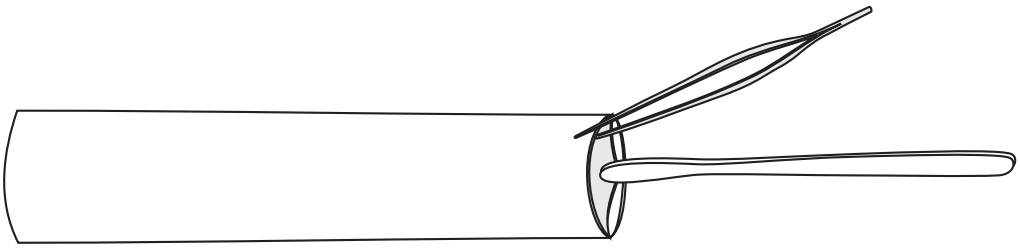


## Open Endarterectomy
### Tacking Sutures

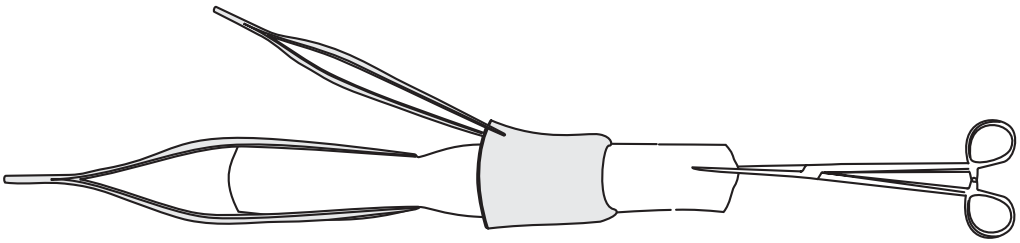
Tacking of the proximal endpoint is rarely needed.



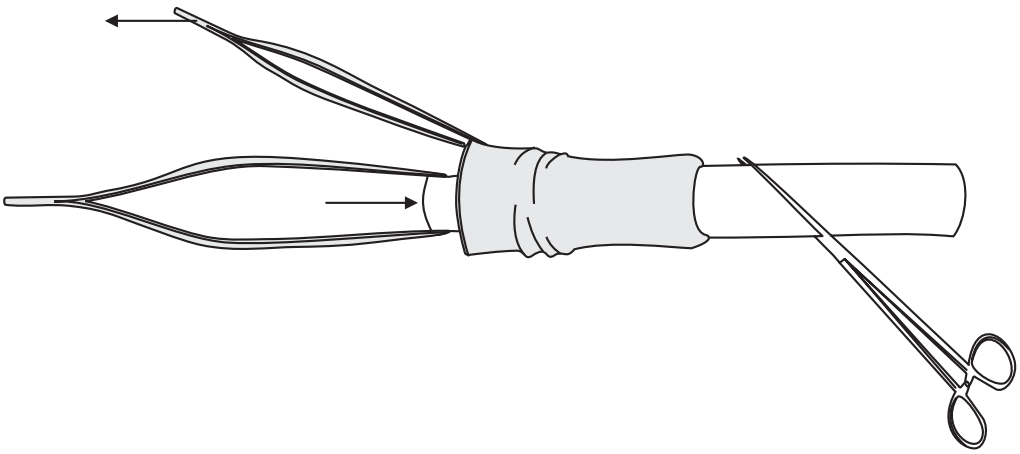
## Eversion Endarterectomy



Hold the adventitia with a pickup and gently lift it away from the plaque. Use a Freer elevator to circumferentially dissect the plaque.



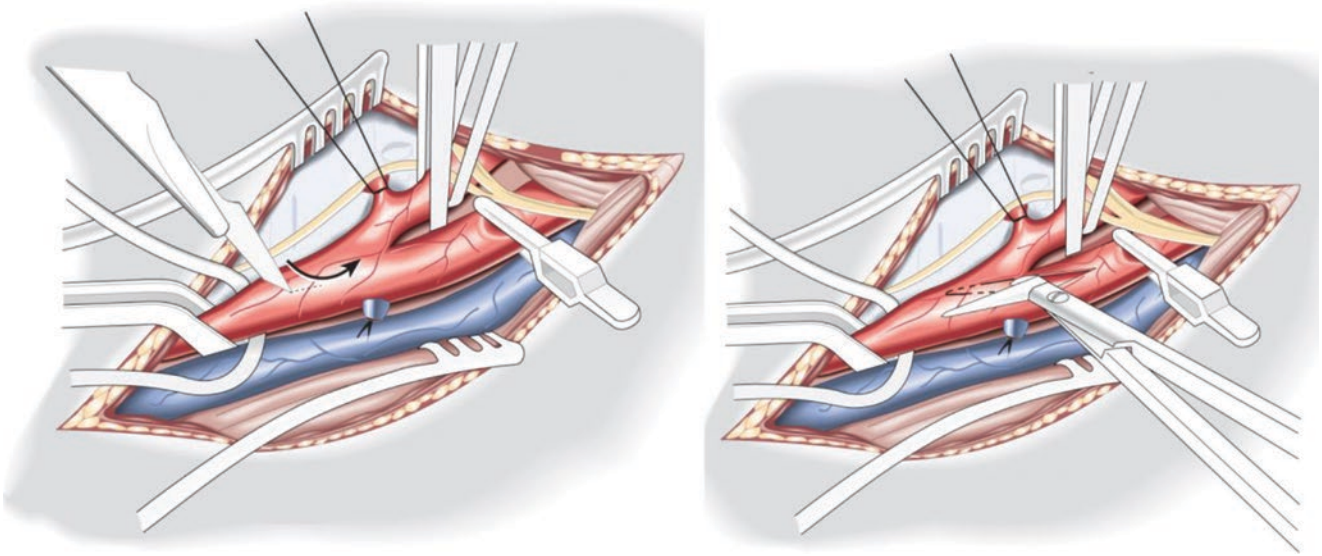
**Hold the plaque with a clamp, and gently pull on the plaque while everting the adventitial wall in the opposite direction.**



The eversion endarterectomy can be facilitated by pushing the entire artery with the forceps toward the clamp. This movement will help extrude the plaque from the artery.

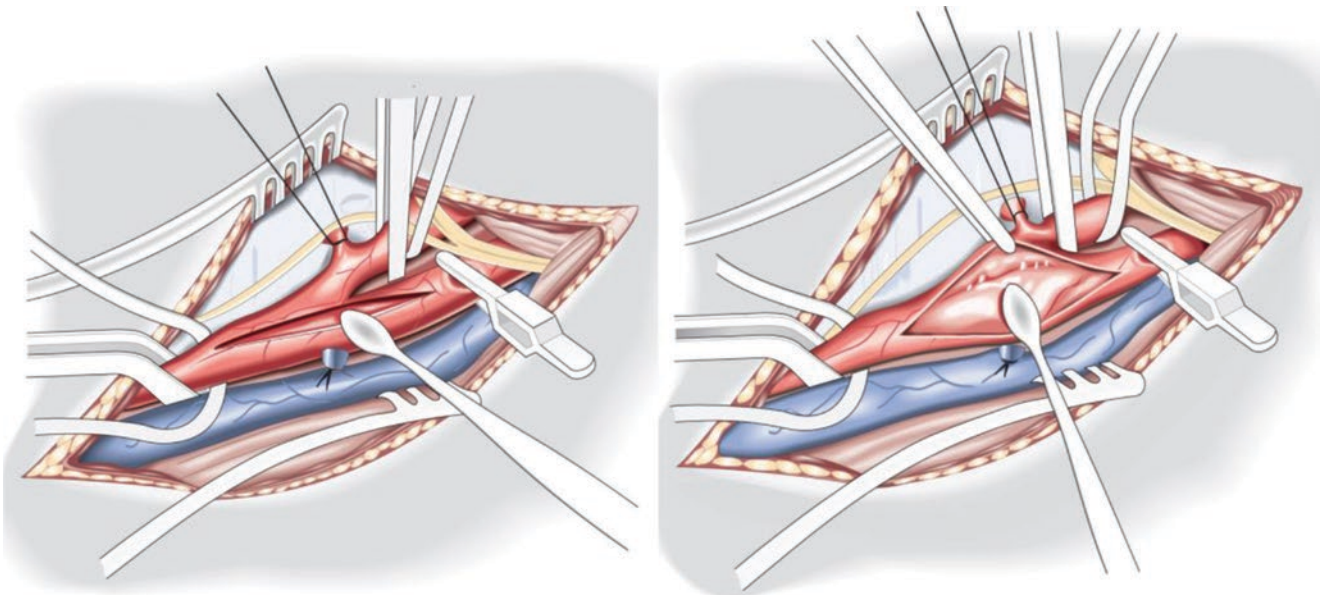
## Carotid Endarterectomy

Carotid endarterectomy is the best example for endarterectomy whether performed via standard open technique or eversion technique will be illustrated here. (*Reproduced with permission from* Lumley JSP, Hoballah JJ. Vascular Surgery. Heidelberg: Springer; 2009.)



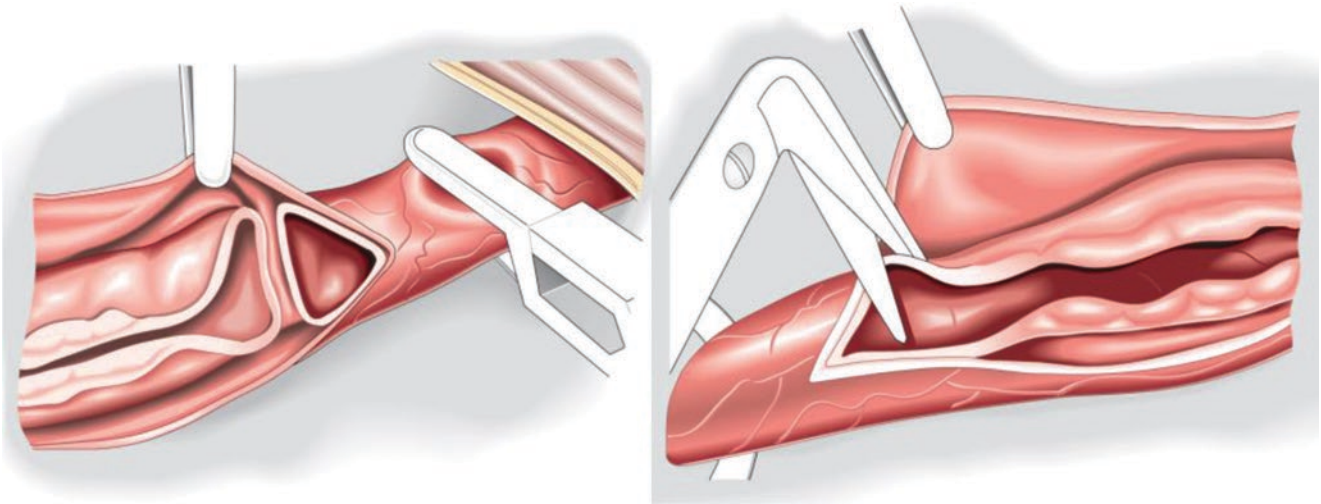
Carotid endarterectomy with vein patch angioplasty.

After controlling the common, external, and internal carotid arteries, an arteriotomy is started in the common carotid artery and extended with a Potts scissors.



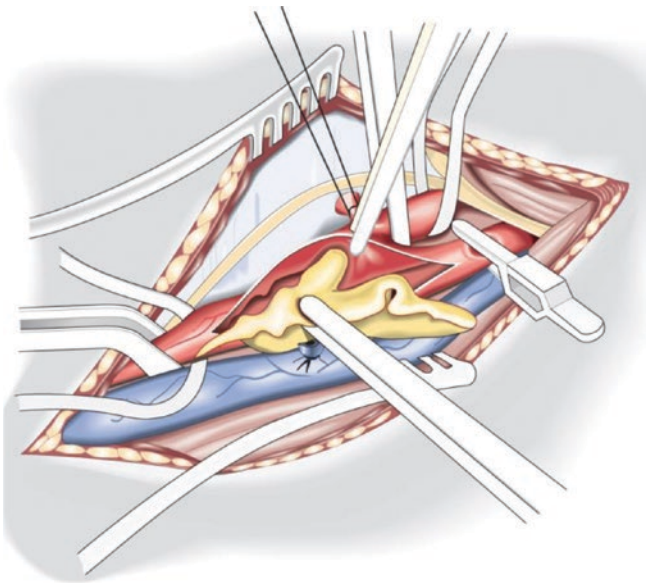
A plane is created between the adventitia and plaque and developed circumferentially.

## Carotid Endarterectomy

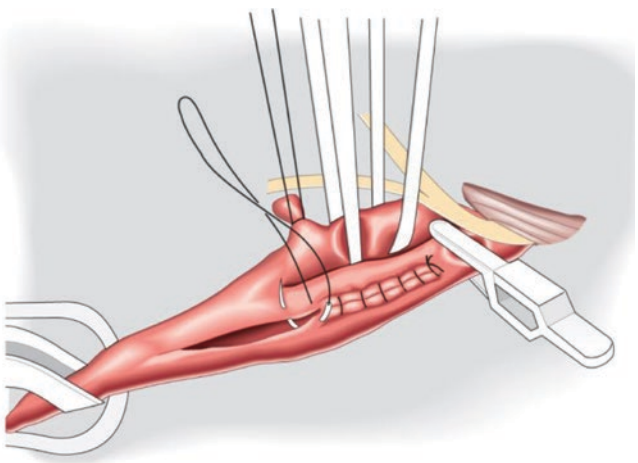


The plaque is then transected or feathered at the internal and common carotid arteries.

Eversion endarterectomy of the external carotid artery is performed and the plaque removed.

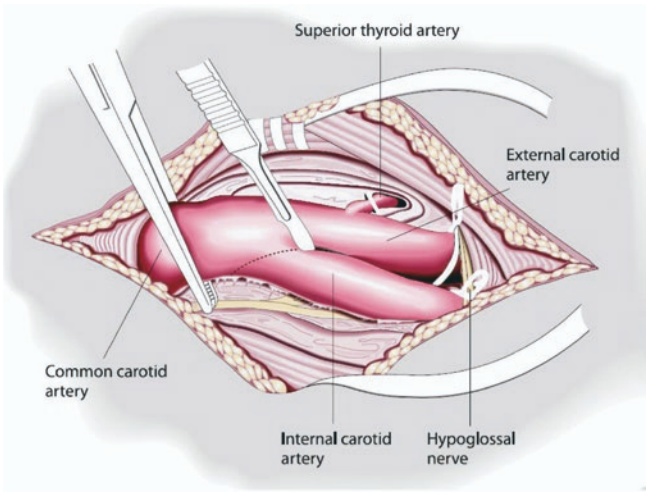


After making sure the endarterectomized surface is smooth and without any debris and removal of the circular smooth muscle fibers, the arteriotomy is typically closed with a patch although some surgeons will use primary closure if the internal carotid artery is larger than 5 mm as shown below.

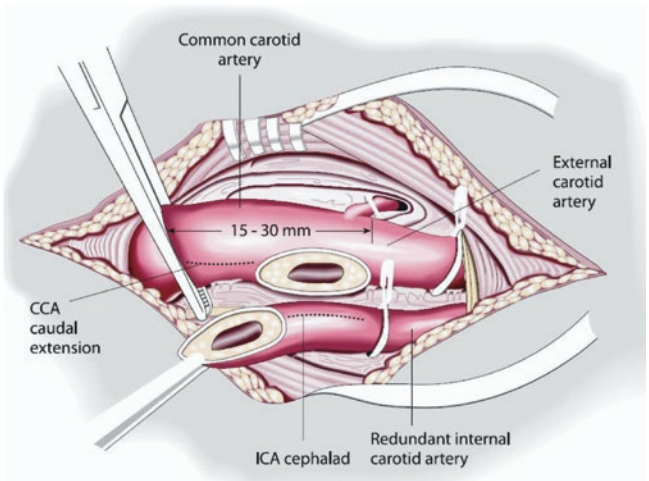


## Eversion Carotid endarterectomy

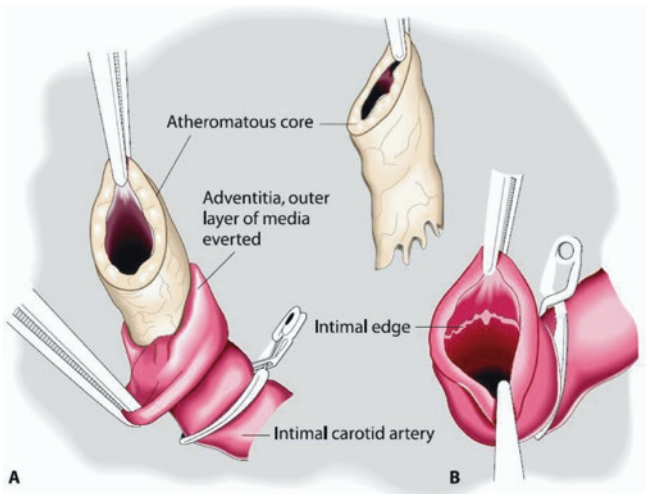
After controlling the common, external, and internal carotid arteries, the internal carotid artery is transected in an oblique manner at its origin.




The arteriotomy can be further extended caudally into the common carotid artery if needed.




Eversion endarterectomy of the internal carotid artery is performed.



## Eversion Carotid Endarterectomy

The internal carotid artery is sutured back on to the common carotid bifurcation.