
قَالُوا سُبْحَانَكَ لا عِلْمَ لَنَا إِلا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ
[البقرة: 32]

Carotid Endarterectomy

- Conventional Vs Eversion Technique

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In Collaboration With
7th ANNUAL AL-AZHAR VASCULAR
SURGERY CONFERENCE

EVIDENCE BASED
VASCULAR PRACTICE

Classification

- carotid stenosis is generally classified as
  - severe (70 to 90 per cent)
  - moderate (50 to 69 per cent)
  - mild (less than 50 per cent).

Markedly severe stenosis causes slowing of internal carotid blood flow, resulting in delayed filling of intracranial branches as compared with extracranial ones

Radiological investigations

- Duplex ultrasound.
- CTA
- Magnetic resonance angiography (MRA).

Descision making of carotid artery disease in different subgroups

In Asymptomatic Patients

- *Asymptomatic* can refer to absence of symptoms in the carotid hemisphere ipsilateral to the carotid disease, the anterior circulation, or any brain/brainstem origin.
- Two trials:

1. Asymptomatic Carotid Atherosclerosis Study (ACAS)
2. European Asymptomatic Carotid Surgery Trial (ACST)

In Symptomatic Patients

- patients with recent ipsilateral carotid territory symptoms.
- Trials:

1. NASCET(The North American Symptomatic Carotid Endarterectomy Trial Collaboration (NASCET)
2. ECST(European Carotid Surgery Trialists Collaborative Group

Timing of Intervention

- It has been suggested that a much more aggressive approach (i.e., within 48 hours) is necessary for symptomatic patients.
- the risk for a new or recurrent stroke may approach 7% in 2 days and 10% within 7 days of the initial event.
- Operative risk is probably elevated with very early intervention.
- In patients who are medically stable and have relatively small or no infarcts seen on imaging studies, it seems reasonable to perform early intervention (i.e., within 48 hours) after a stroke.

RECOMMENDATIONS

Symptomatic patients
▪ Low-grade carotid stenosis (<50%) – Optimal medical therapy rather than revascularization (GRADE 1 recommendation, high-quality evidence)
▪ Moderate-to-severe carotid stenosis (≥50%) – CEA plus optimal medical therapy (GRADE 1 recommendation, high-quality evidence) – CAS potential alternative to CEA if high perioperative risk (GRADE 2 recommendation, low-quality evidence)
Asymptomatic patients
▪ Low-grade carotid stenosis (<60%) – Optimal medical therapy rather than revascularization (GRADE 1 recommendation, high-quality evidence)
▪ Moderate-to-severe carotid stenosis (≥60%) – CEA plus optimal medical therapy if low perioperative risk (GRADE 1 recommendation, high-quality evidence) – Recommendation against CAS with a possible exception if >80% stenosis and high anatomic risk for CEA (GRADE 1 recommendation, low-quality evidence)
CAS: Carotid artery stenting; CEA: Carotid endarterectomy. *Box modified from* [1].

Medscape

TREATMENT OPTIONS

- **MEDICAL**
- **SURGICAL: CEA / Conventional vs Eversion**

SURGICAL TREATMENT

- **INDICATIONS:**
- CEA should be attempted in any patient with carotid stenosis in whom surgery will improve the natural history of disease to a degree more than that by medical treatment.

IN SYMPTOMATIC PATIENTS:

1. One or more TIA's in past 6 months and carotid artery stenosis exceeding 50%.
2. Ipsilateral carotid artery stenosis more than 70% combined with CABG.
3. Progressive stroke and carotid artery stenosis more than 70%.

IN ASYMPTOMATIC good risk patients treated by surgeon with surgical mortality and morbidity of less than 3% the proven indication for CEA is stenosis more than 60%.

- **CONTRAINDICATIONS:**

CEA is contraindicated if patients general condition includes a serious illness that will substantially increase perioperative risk and shorten the life span.

Also contraindicated in patients presenting with acute major stroke with minimal recovery and altered sensorium.

In acute stage the the ischemic infarct may be converted to haemorrhagic infact leading to death.

Surgical Technique

- Anesthetic Considerations And Positioning
- Operative Procedure
- Intraoperative Monitoring And Shunt Use
- Patch Angioplasty
- Postoperative Care
- Complications Of Endarterectomy

ANESTHETIC CONSIDERATIONS AND POSITIONING

- Most surgeons perform carotid endarterectomy with the patient under general anesthesia

- The principal goals of anesthetic management are to maintain adequate cerebral and myocardial perfusion.

Positioning

The patient is placed in the supine position with the head turned away from the side of the operation with a small roll beneath the shoulder

Atherosklerotic Chatper 25,Ruherford's Vascular Surgery,7th ed

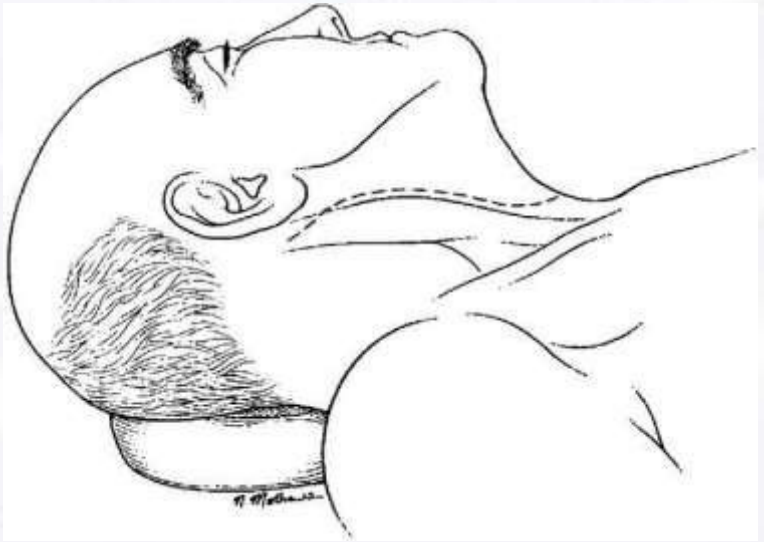
Skin incision

- Two types of skin incision were used:

1. A standard longitudinal incision : parallel to medial border of SCM.
2. A transverse skin crease incision usually 1-2 cm inferior to angle of jaw. Associated with excellent cosmetic result. But is difficult to extend caudally and cranially.

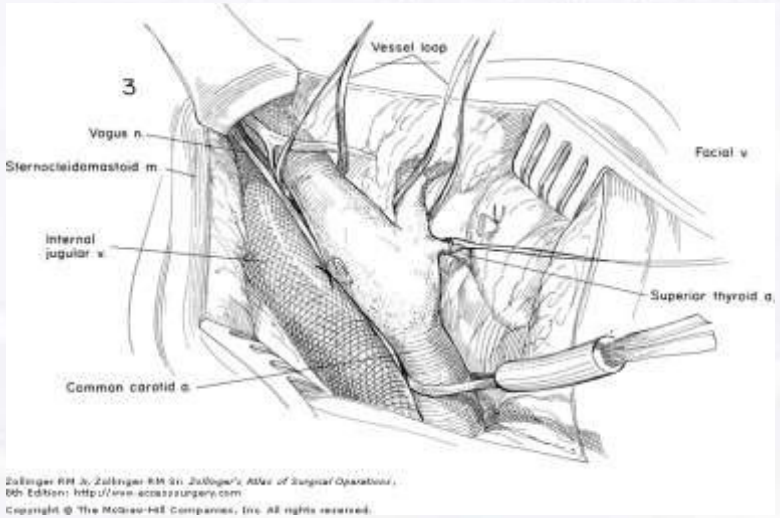
OPERATIVE PROCEDURE

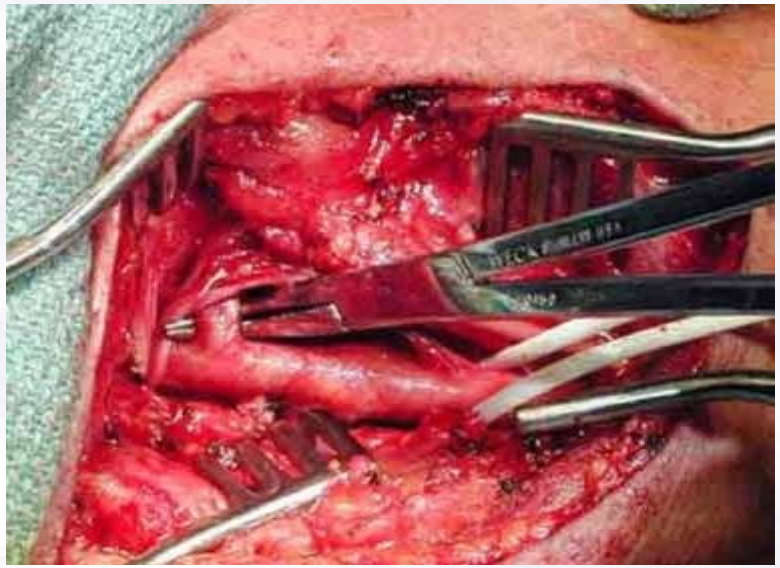
- The patient is placed in the supine position with a small roll beneath the shoulder and the head turned away from the side of the operation.
- The incision runs along the anterior border of the sternocleidomastoid muscle and curves posteriorly 1 cm below the angle of the mandible to avoid injury to the facial nerve.
- The platysma is incised, and the dissection is carried along the medial border of the sternocleidomastoid muscle.
- Keep the medial blade of self-retaining retractors in the superficial layers of the wound (deeper placement can cause injury to the recurrent laryngeal or superior laryngeal nerve.)



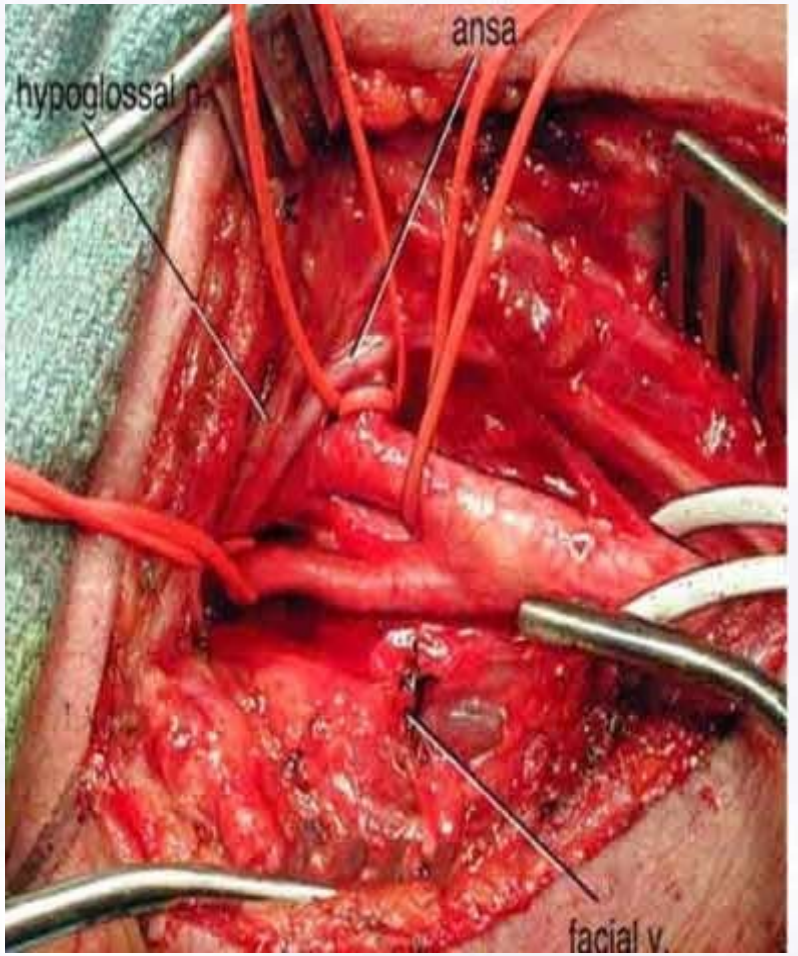
- Beneath the sternocleidomastoid muscle, the internal jugular vein is encountered.

- The common facial branch of this vein, which courses medially, is doubly ligated and divided, and the vein is gently retracted laterally
- The carotid artery can be gently palpated, and the carotid sheath is visible.
- The carotid sheath is opened inferiorly along the anterior surface of the artery to the level of the omohyoid muscle.
- The superior thyroid artery, the first branch of the external carotid, was next isolated.
- Dissection is then completed around the external carotid artery and superior thyroid artery, which are isolated with vessel loops.





- Proximal control of the common carotid artery is obtained by careful dissection of the posterior wall from the underlying vagus nerve and passage of a vessel loop
- A Rumel tourniquet is fashioned by placing the umbilical tapes on the internal carotid and common carotid arteries through a segment of rubber tubing.
- The hypoglossal nerve was located by following the ansa hypoglossi upward across the carotid bifurcation
- The hypoglossal nerve crosses the distal internal carotid artery.
- It can be mobilized and gently retracted medially for better distal exposure.
- All vessels were isolated and encircled with vessel loops.
- The area between internal and external carotid artery was not dissected, leaving the carotid sinus nerve intact.

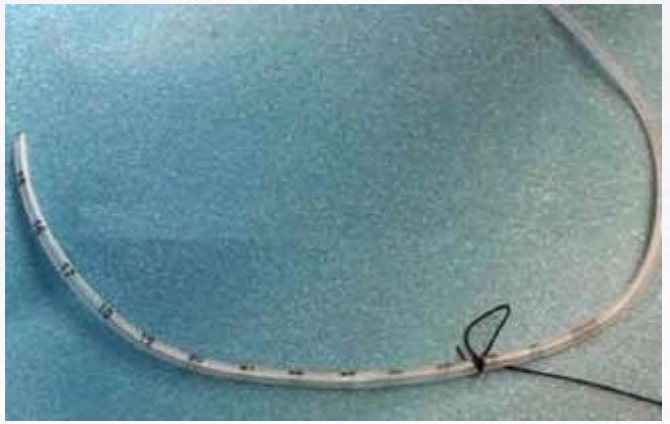


- Before manipulation of the carotid artery in the region of the bifurcation, lidocaine (2 per cent Xylocaine)

- without epinephrine is instilled into the carotid sinus and along the course of the nerve of Hering to minimize bradycardia and hypotension resulting from stimulation of these structures.

- The patient was anticoagulated with IV heparin, 100 units/kg .

- The blood pressure is maintained at or slightly above awake baseline, and the electroencephalography results are examined

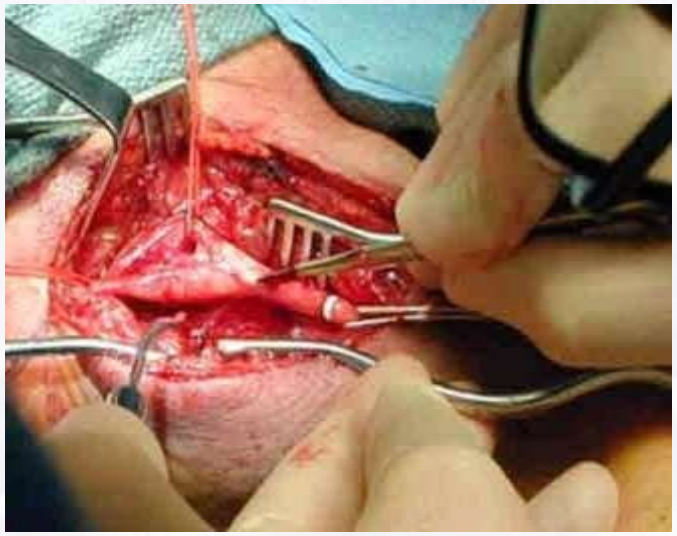


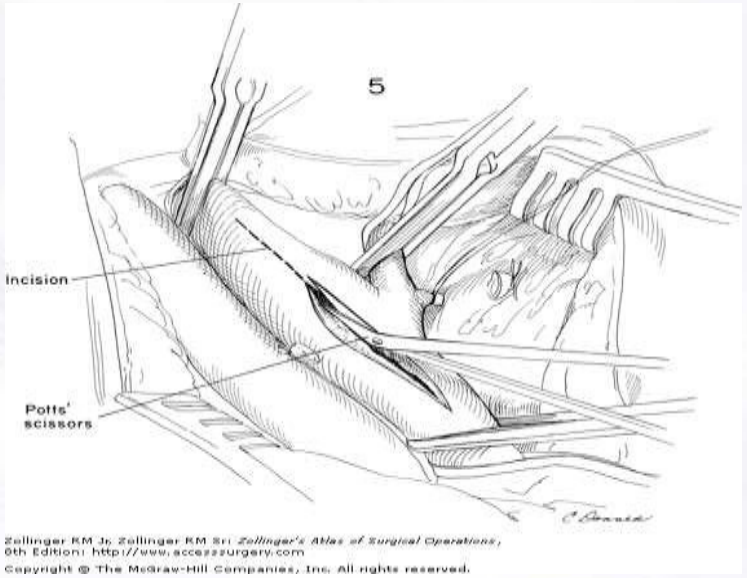
- The shunt tubing is filled with heparinized saline and clamped to ensure that there are no intraluminal bubbles, and it is compared with the internal carotid artery to ensure proper sizing.

- The internal carotid artery is clamped first to prevent any embolic episode. Artery is clamped distal to plaque and it is of bluish colour in plaqued region.

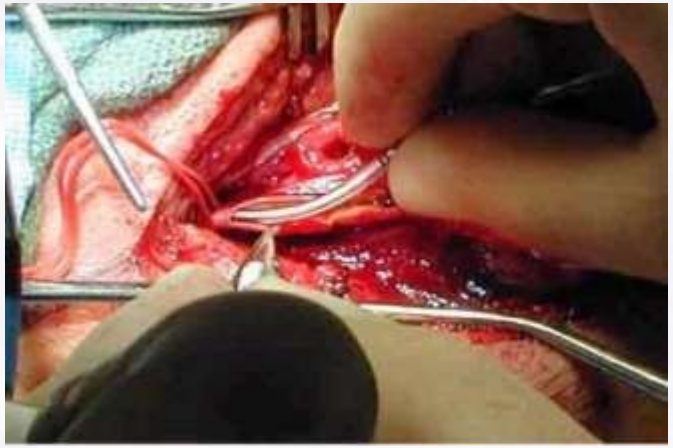
- The common carotid artery is then clamped and the external carotid artery and superior thyroid artery are clamped.

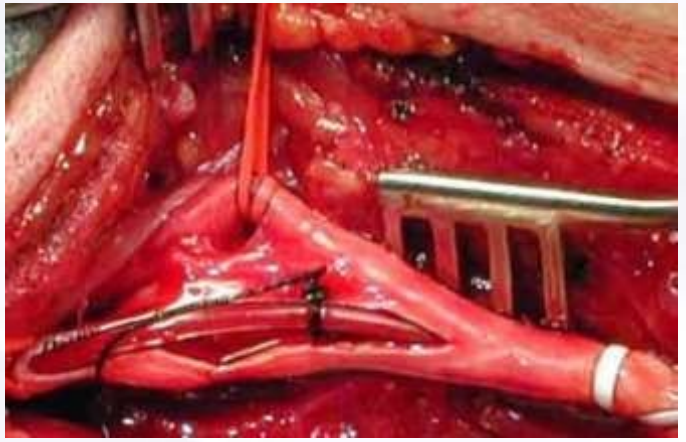
- An arteriotomy is started about 1 cm proximal to the bifurcation in the midline of the common carotid artery using a #11 blade
- The electroencephalogram is again examined to determine whether shunt placement is necessary
- If no changes have occurred, dissection is carried distally along the plaque is completed with an angled Pott's scissors (along the anterior midline of the internal carotid artery)
- Dissection must be carried to at least 1 cm distal to the end of the plaque to allow for posterior wall extension and placement of a shunt, if necessary
- The incision is carried through the arterial wall until plaque is encountered, and a smooth plane is developed between plaque and artery wall.



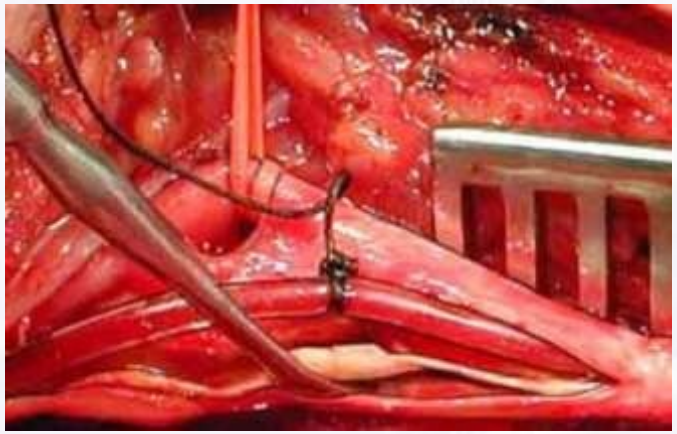


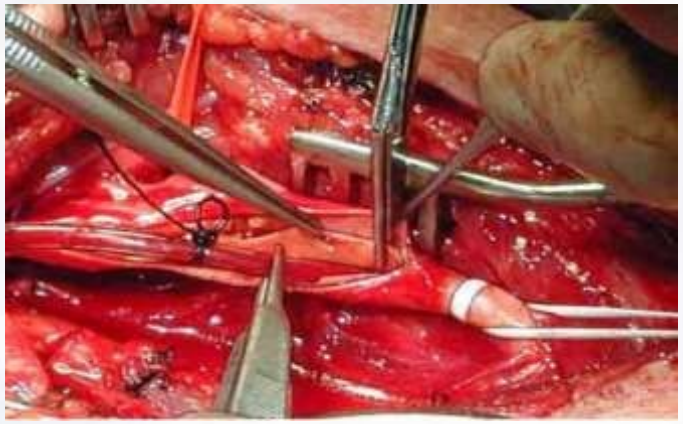
- The shunt was inserted into the distal internal carotid artery, taking care not to cause a dissection of the intima or embolization of debris distally.
- The proximal end of the shunt was placed in the common carotid artery and distal blood flow was reestablished.



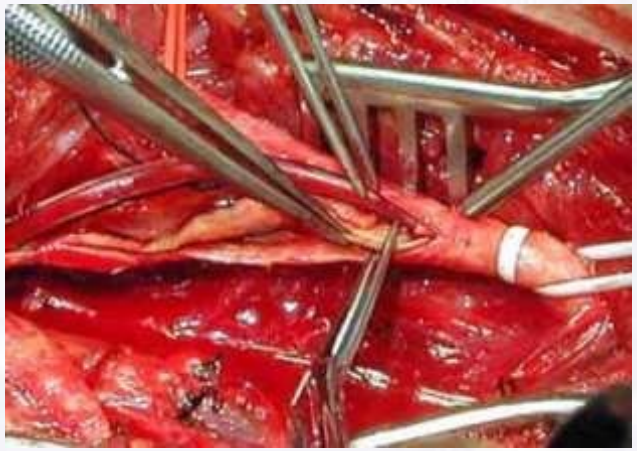


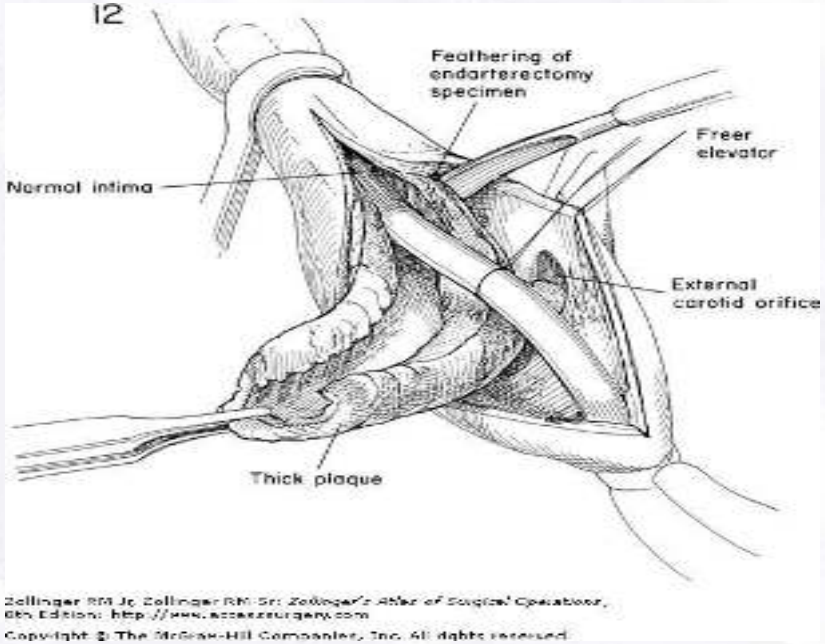
- carefully separate the plaque from the media, starting proximally with circumferential dissection of the plaque.
- A curved clamp is placed between plaque and artery wall, and the plaque is sharply incised with a scalpel.
- Care must be taken to ensure that the remaining plaque in the common carotid artery has a smooth edge
- The plaque is then dissected free from the arterial wall with the Penfield dissector to the bifurcation and into the external carotid artery.
- It is often helpful to have the assistant temporarily release the external carotid artery clamp as dissection proceeds up that artery and the plaque is gently torn free from its distal attachment.
- The line of cleavage is within the media, leaving the adventitia and media externa for closure.

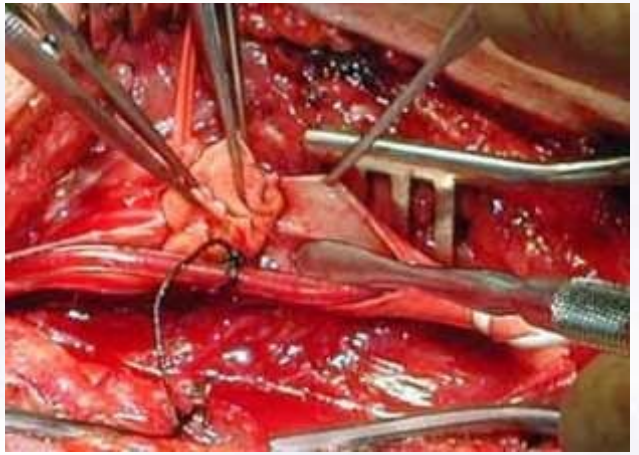




- Division of the proximal plaque was completed from the lateral side.
- The plaque was separated from the vessel wall up to the bifurcation
- A critical part of the dissection involves the distal attachment of the plaque to normal intima of the internal carotid artery.







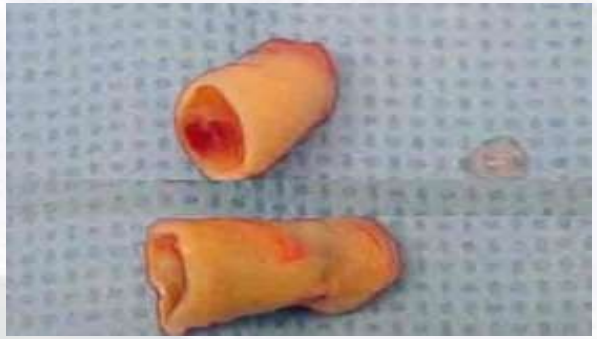
- The plaque was dissected distally to normal intima.
- Note the manipulation of the shunt to allow clear visualization.

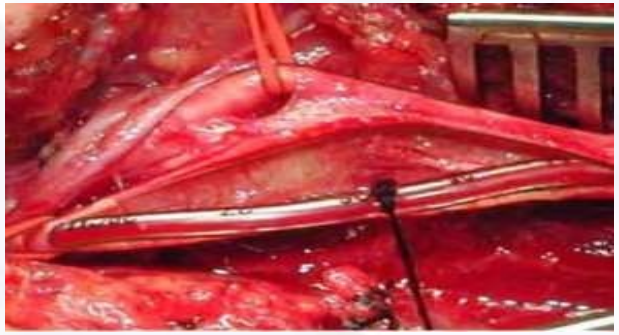
- By gentle dissection and proximal traction on the plaque (eversion endarterectomy), it will usually tear away from its distal attachment.

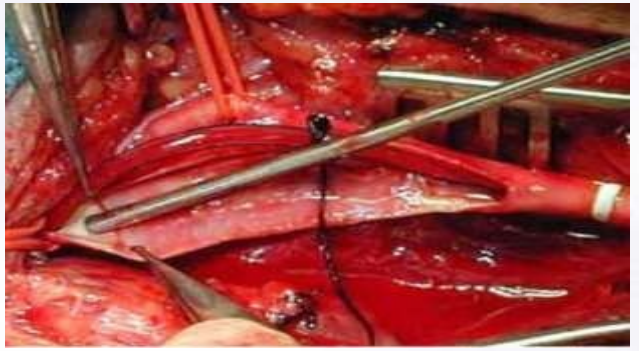
- The orifice of the vessel was probed with a small probe to remove any remaining plaque.

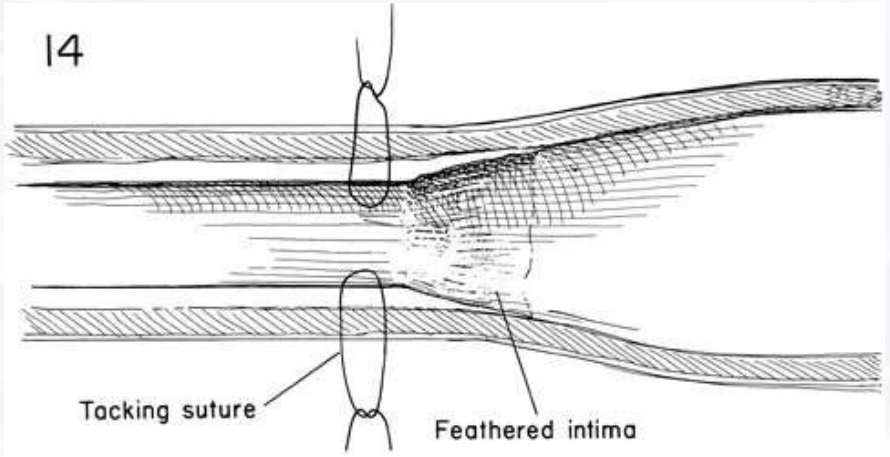
- If the intima at this site is not adherent, it should be
- further resected or, less commonly, tacked to the
- arterial wall with a 7-0 Prolene suture.

- The vessel is shown after removal of the plaque.

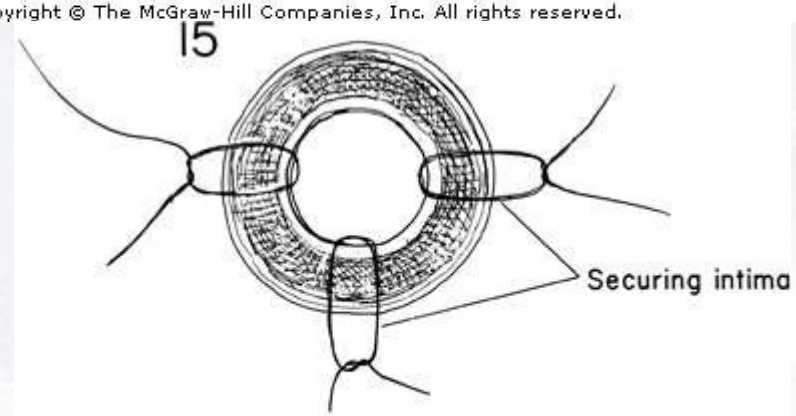








Zollinger RM Jr, Zollinger RM Sr: *Zollinger's Atlas of Surgical Operations*, 8th Edition: http://www.accesssurgery.com

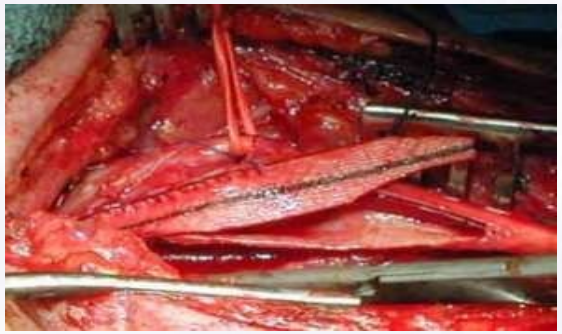


Zollinger RM Jr, Zollinger RM Sr: *Zollinger's Atlas of Surgical Operations*, 8th Edition: http://www.accesssurgery.com

- tacking sutures to prevent subintimal dissection. Double armed 7-0 polypropylene sutures were used to tack the distal intima to the media and prevent distal dissection

Zollinger RM Jr,Zolinger RM Sr: Zollinger's atlas of surgical Operations 8th edition

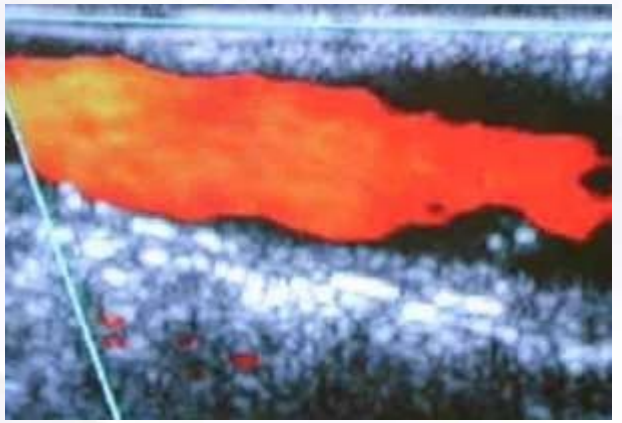
- The surface of the exposed media was carefully washed with heparinized saline and inspected under 3.5X magnification to wash away debris and ensure that there were no wisps of loose material.
- A collagen impregnated dacron patch was sutured with 6-0 polypropylene to the edges of the arteriotomy starting at the distal corner.
- Suturing of the medial wall of the patch was completed.
- The lateral wall was closed, leaving a 4 mm gap through which the shunt could be extracted.
- Note the stabilization of the vessel wall in preparation for removal.



- The distal end of the shunt was removed first. Just before final suturing at the proximal end of the arteriotomy, the internal carotid artery clamp is briefly released
- The resulting backflow of blood ensures that the artery is patent and flushes any residual debris from the lumen.
- The lateral suture line was completed.
- The superior thyroid artery clamp is removed as the final suture is placed in order to have continuous backflow of blood.
- The clamps are then removed in the following order:
  - external carotid artery
  - common carotid artery
  - internal carotid artery
- This sequence ensures that any potential embolic material
  is flushed into the external artery circulation.

- Thrombin-soaked cellulose foam was applied to the vessel to seal any residual needle puncture sites, and gentle pressure is applied to the wound with a sponge for about 1 minute.
- Meticulous hemostasis is maintained during closure; occasionally, a small drain is placed in the superficial wound.
- The vagus nerve is seen posteriorly between the carotid and internal jugular vein.

- Ultrasound was standing by for intraoperative assessment of the repair.
- The sterily wrapped ultrasound head was applied to the distal internal carotid artery.
- Duplex scanning showed a good caliber vessel with good flow, normal velocity and no intimal flaps.
- A closed suction drain was placed for 24 hours.
- The closed incision is shown.



Eversion endarterectomy

- Two different versions of eversion endarterectomy are performed.
- DeBakey originally described eversion endarterectomy with partial transection of the anterior portion of the carotid bifurcation.
- Etheredge improved on DeBakey's technique with complete transection of the bifurcation,which allowed the origins of both the ICA and ECA to be everted for a longer distance.

- The endarterectomy is performed by mobilizing the entire circumference of the carotid adventitia off the plaque

(described as a “circumcision” by Etheredge) and then everting the adventitia and mobilizing it upward while gentle caudad traction is applied to the plaque.

- This maneuver is performed distally into the orifices of the ICA and ECA and then proximally into the CCA.
- Once the endarterectomy is complete, the divided bifurcation is reunited with a simple end-to-end anastomosis.

- Advantages of this technique are that the anastomosis can be performed rapidly and it is not prone to restenosis, and therefore patching is not required.
- Disadvantages:

1. more extensive dissection is sometimes necessary to mobilize the vessels during the eversion,
2. the procedure does not lend itself readily to shunting (although shunting is not precluded by this technique).
3. it can be difficult to visualize the endpoint in the ICA after the plaque has been removed; the artery tends to retract as soon as the plaque pulls away from the adventitia.

- Kieney's modification:

1. A modification of eversion endarterectomy in which the origin of the ICA is excised obliquely off the carotid bifurcation, the ICA is inverted on its own, and endarterectomy of the CCA and ECA is performed through an arteriotomy in the side of the carotid bifurcation.
2. This technique allows rapid plaque extraction, the anastomosis is not prone to restenosis, and no prosthetic material is required. This technique is particularly effective for dealing with redundant, coiled, or kinked ICAs.

Comparison of Conventional and Eversion Carotid Endarterectomy

- EVEREST (EVERsion carotid Endarterectomy versus Standard Trial study), a randomized prospective multicenter study performed in Italy that was published in 1997.
- There were no statistically significant differences in outcomes between the two techniques, although a slightly higher incidence of perioperative complications was noted with eversion CEA and a slightly higher incidence of restenosis with standard CEA.
- EVEREST trial demonstrated that patients who underwent eversion CEA had a lower incidence of restenosis than standard CEA (patch and primary closure), but standard CEA with patch angioplasty had the lowest incidence of neurologic complications and the lowest rate of restenosis—1.5% —versus 2.8% for eversion CEA and 7.9% for standard CEA with primary closure.

Which best ???

- Numerous studies have compared conventional CEA plus patching with eversion one .Regarding the total operating and ischemic time, as well as perioperative complications,

Ballotta et al.,2000

- One of these studies that compared conventional and eversion CEA has been conducted and designed in a truly interesting manner. Namely, on the one carotid artery at the same patient, Ballotta and associates performed eversion, while on another side conventional CEA. Regarding early and long term results, eversion CEA has been better

- In Cochrane review from 2009 that included a total of 2465 patients with 2589 arteries, authors of EVEREST trial did not find a significant differences in the rate of perioperative stroke and/or death (1.7% vs. 2.6%; odds ratio [OR], 0.44; 95% confidence interval [CI], 0.10–1.82) and stroke during follow-up (1.4% vs. 1.7%; OR, 0.84; 95% CI, 0.43–1.64) between eversion and conventional CEA techniques. They concluded that only one advantage of eversion endarterectomy is low risk of carotid restenosis and occlusion

- An updated systemic review that analysed randomized controlled trials and observational studies was publisehed in 2018. According to this paper an eversion CEA was superior to conventional once regarding peri-operative outcomes (death, stroke, death/stroke, and late restenosis). However, when eversion CEA outcomes were compared with outcomes after patched CEA, there were no significant differences

- Besides previous facts recommendations regarding technique of the CEA from the current European Society for Vascular Surgery guidelines are not clear . According to it the choice between eversion and “patched” endarterectomy should be left to the discretion of the operating surgeon.

Conclusion

- The choice of CEA :Conventional vs Eversion is limited by a lack of adequate evidence.
- There are no good data regarding the adverse event rate of both techniques appropriately stratified by patient symptom status for the typical patients who have been undergoing CEA.
- The published trials of Conventional versus Eversion have not yet established any technique as the procedure of choice regarding the risk of periprocedural stroke.

Thanks

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