Incidence of Carotid Artery Restenosis After Carotid Endarterectomy: Primary Closure Versus Patch Closure.

Thesis for fulfillment of M.D. Degree in General Surgery

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بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

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List of Abbreviations

ACAS: Asymptomatic Carotid Atherosclerosis Study

ACST: Asymptomatic Carotid Surgery Trial

CABG: Coronary Artery Bypass Grafting

CAD: Coronary Atery Disease

CAS: Carotid Artery Stenting

CCA: Common Carotid Artery

CEA: Carotid Endarterectomy

CREST: Carotid Revascularization Endarterectomy vs. Stenting Trial

CT: Computed Tomography

CTA: Computed Tomographic Angiography

ECA: External Carotid Artery

ECST: European Carotid Surgery Trial

EEG: Electro Encephalogram

EPD: Embolic Protection Device

EVA-3S: Endarterectomy Versus Angioplasty in Patients with Symptomatic Severe Carotid Stenosis trial

FMD: Fibromuscular Dysplasia

ICA: Internal Carotid Artery

IMT: Intima-Media Thickness

INR: International Normalized Ratio

IVUS: Intravascular Ultrasound

LDL: Low Density Lipoproteins

MRA: Magnetic Resonance Angiography

MRI: Magnetic Resonance Imaging

NASCET: North American Symptomatic Carotid Endarterectomy Trial

PAD: Peripheral Arterial Disease

PET: Positron Emission tomography

PTFE: Polytetraflouroethylene

SSEP: Somatosensory Evoked Potentials

TCD: Transcranial Doppler

TIA: Transient Ischaemic Attack

US: Ultrasound

Abstract

Introduction: The efficacy of Carotid endarterectomy in the prevention of stroke has been proved by randomized control studies. There are still some variations in some aspects of the surgical procedure aiming at improving the results. One of the questions is about the best way to close the arteriotomy.

Materials and Methods: This is a prospective single center study. Two groups of patients were followed up for a year post carotid endarterectomy. All patients in the study underwent general anesthesia, EEG monitoring and routine shunting. In one group the artery was closed primarily (n=42). In the other group the artery was closed over a synthetic patch (n=50). Selection of the method of closure was surgeon dependent and dictated by the caliber of the artery. The rates of restenosis were checked in the 30 days follow up, and one year post operatively. The data were compared and statistically analyzed between both groups.

Results: There were no significant differences between the two groups in terms of demographics, modes of presentation or prevalence of risk factors. No intraoperative strokes in either group. 4 immediate postoperative strokes (2 in each group, p=0.858). None of them were related to thrombosis, dissection or narrowing of the lumen, as verified by immediate exploration (most probably a distally impacted embolization). One death in the patch closure group due to hemorrhagic stroke (p=0.357) and it was related to intracranial hemorrhage from hyperperfusion syndrome that can occur with any type of revascularization and not specific to any particular type of closure. No stenosis in either group at 30 days. 4 hemodynamically significant stenoses were detected in the primary closure group at one year follow up (9.5%) as opposed to none in the patch group (p=0.026)

Conclusion: Although some of the primary closure advocates report that they can properly select patients for primary closure based on the size of the artery and avoiding it in female gender, yet our data show that these patients still have poorer long-term outcomes (p=0.026). Thus, we recommend the routine use of patch closure after carotid endarterectomy whenever possible, regardless the patient gender or the caliber of the artery.

Key Words :

Intravascular Ultrasound- Coronary Atery Disease .

Introduction

The efficacy of carotid endarterectomy (CEA) in the prevention of stroke has been proven in randomized, prospective trials. However, a number of controversial questions still remain regarding a variety of the technical aspects of the operation. ***(NASCET, 1991)***

Arterial endarterectomy and reconstruction during CEA can be performed in a variety of ways, including standard endarterectomy with primary closure, standard endarterectomy with patch angioplasty, and eversion endarterectomy with reimplantation of the internal carotid artery. Furthermore, patch angioplasty itself can be performed with a diverse choice of both autologous and synthetic materials. The optimal method of arterial reconstruction remains a matter of controversy. ***(Brott et al, 2011)***

Variations in the technique of arterial repair after CEA depend mainly on the length of the arteriotomy. The advantage of primary closure is speed, but disadvantages include higher incidences of residual and recurrent stenosis. The advantage of patch closure is preservation of luminal diameter, but the disadvantage is the greater length of time required for closure. Multiple comparative reviews have failed to demonstrate a consistent difference in outcomes with either technique compared with the other ***(Gelabert et al, 1994. De Letter et al, 1994)***. There is still no solid level of evidence to mandate patch closure over primary closure. ***(Brott et al, 2011)***

This study aims at comparing two groups of patients, in which the arteriotomy is closed with two different methods (primary versus patch closure) to detect the rate of complications associated with each method.

Surgical Anatomy of the Extracranial Carotid Artery

The normal anatomy of the aortic arch and its branches is subject to considerable variation. Three aortic arch morphologies are distinguished on the basis of the relationship of the brachiocephalic artery to the aortic arch ***(Cho et al, 2006)***. Most commonly, the brachiocephalic artery, left common carotid artery, and left subclavian artery originate separately from the aortic arch ***(Schneider et al, 2004)***. The term bovine aortic arch refers to a variant of human arch branching in which the brachiocephalic and left CCA share a common origin. This anatomy is not generally found in cattle, so the term bovine arch is a misnomer. ***(Bizzari et al, 2008)*** **(Figure 1)**.

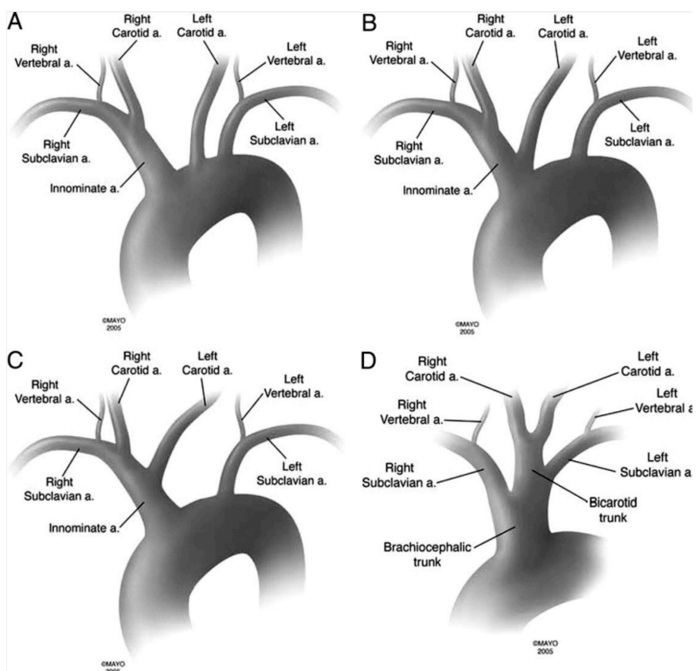

Figure 1: Aortic Arch Types

Panel A. The most common aortic arch branching pattern found in humans has separate origins for the innominate, left CCA, and left subclavian arteries. **Panel B.** The second most common pattern has a common origin for the innominate and left CCA. This pattern has erroneously been referred to as a "bovine arch." **Panel C.** The left CCA originates separately from the innominate artery. This pattern has also been erroneously referred to as a "bovine arch." **Panel D.** The aortic arch branching pattern found in cattle has a single brachiocephalic trunk originating from the aortic arch that eventually splits into the bilateral subclavian arteries and a bicarotid trunk. a indicates artery. ***(Layton et al, 2006)***

The distal common carotid artery typically bifurcates into the internal and external carotid arteries at the level of the thyroid cartilage, but anomalous bifurcations may occur up to 5 cm higher or lower. **(Figure 2)**. The common facial vein junction to the internal jugular vein can be a good intraoperative landmark to the level of bifurcation. ***(Scott-Conner et al, 2009)***

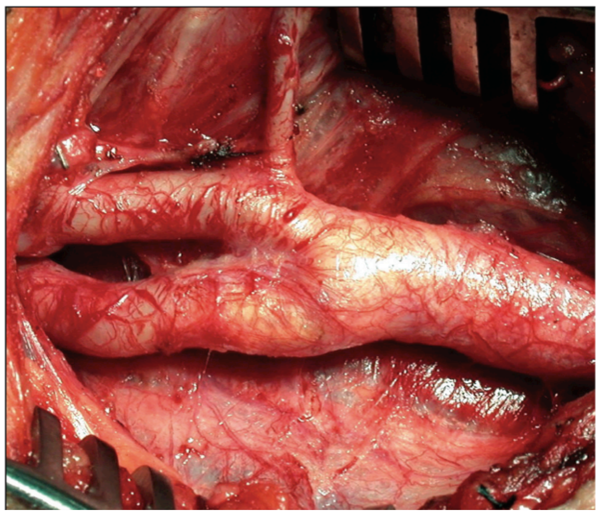

Figure 2: Intra-operative photograph showing right carotid bifurcation.

The accessory nerve is found deep to the sternomastoid muscle lateral to the internal jugular vein. Injury to this nerve, which supplies the trapezius muscle, can lead to a shoulder drop and difficulty in arm abduction. The vagus nerve is within the carotid sheath and, it lies posterior to the internal carotid and then courses lateral to the common carotid. The nerve may course anterior to the carotid, especially proximally in the neck. The major disability associated with injury to the vagus in the neck is vocal cord paresis because of the recurrent laryngeal nerve fibers that are traveling with the vagus in the neck. The hypoglossal nerve emerges between the internal jugular vein and internal carotid artery. The nerve loops anterior to the branches of the external carotid artery superficial to the carotid sheath, usually just superior to the carotid bifurcation. Injury to The hypoglossal nerve can cause significant speech and eating difficulties. Traveling with the hypoglossal nerve are fibers from C1 that form the superior root of the ansa cervicalis. The ansa fibers normally diverge from the hypoglossal nerve as it crosses the internal carotid and descend superficial to the internal and common carotid arteries. The superior root is joined by the inferior root, which emerges from between the internal jugular and common carotid. The nerve can be spared if possible, however, division of the inferior or superior root is sometimes necessary to obtain adequate mobilization of the hypoglossal nerve or exposure of the carotid and does not result in significant disability. ***(Scott-Conner et al, 2009)*** **(Figure 3)**

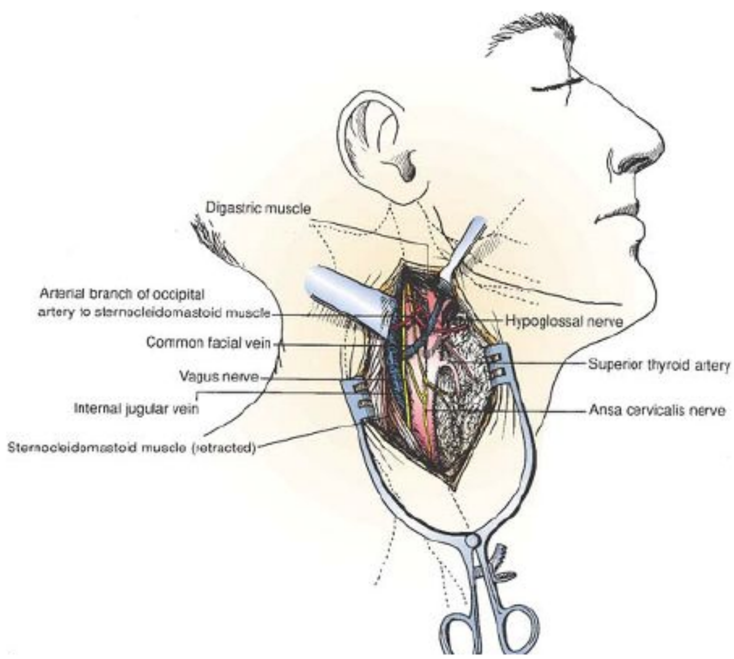

Figure 3: Relations of the Carotid sheath. ***(Scott-Conner et al, 2009)***

The glossopharyngeal nerve parallels the course of the hypoglossal but is much more superior; its inferior extent is rarely below the angle of the mandible. It may, however, be encountered in very high dissections of the internal carotid. The superior laryngeal nerve is usually medial to the carotid sheath. Dissection of the external carotid and its branches should stay close to the vessels to avoid injury to the superior laryngeal. Injury to the superior laryngeal may cause voice fatigue. The marginal mandibular branch of the facial nerve normally parallels the ramus of the mandible but can extend as much as 2.5 cm inferior to the mandible. Injury to this nerve can lead to a significant cosmetic and functional impairment, with drooping of the corner of the mouth and drooling. This nerve can be injured by high dissection or by placement of mechanical retractors against the mandible. ***(Scott-Conner et al, 2009)***

Epidemiology of Extracranial Cerebrovascular Disease and Stroke

When considered separately from other cardiovascular diseases, stroke is the third-leading cause of death in industrialized nations, behind heart disease and cancer, and a leading cause of long-term disability ***(Casper et al, 2010)***.

A large number of strokes go unreported. The prevalence of silent cerebral infarction between ages 55 and 64 years is approximately 11%, increasing to 22% between ages 65 and 69, 28% between ages 70 and 74, 32% between ages 75 and 79, 40% between ages 80 and 85, and 43% beyond age 85 ***(Rosamond et al, 2007)***.

Approximately 88% of all strokes are ischemic, 9% are intracerebral hemorrhages, and 3% are subarachnoid hemorrhages ***(Rosamond et al, 2008)***.

In the Framingham Heart Study population, the prevalence of >50% carotid stenosis was 7% in women and 9% in men ranging in age from 66 to 93 years ***(Fine-Edelstein et al, 1994)***. In the Cardiovascular Health Study of subjects older than 65 years, 7% of men and 5% of women had moderate (50% to 74%) carotid stenosis; severe (75% to 100%) stenosis was detected in 2.3% of men and 1.1% of women ***(O'Leary et al, 1992)***. In NOMASS, a population-based study of people older than 40 years of age who lived in northern Manhattan, New York, 62% had carotid plaque thickness of 0.9 mm by sonography, and 39% had minimal or no (0.0 to 0.9 mm) carotid plaque ***(Sacco et al, 1997)***.