This lecture presents one of the most often vascular surgical procedures – carotid endarterectomy. This type of surgery is performed to prevent stroke caused by atherosclerotic plaque at the common carotid artery bifurcation and, most important, internal carotid artery. Before we will discuss the anatomy of this region, it is necessary to mention that typical symptoms that lead to the diagnosis of carotid artery’s partial or total occlusion include:

- Episodes of dizziness
- Loss of function in the hand or leg opposite the side of the lesion
- Episodic loss of vision in one eye
- Transient aphasia (see explanation of this condition below)
- Confusion with temporary loss of consciousness

From all symptoms that were mentioned above I will spend a little bit more time to explain transient aphasia because the meanings of others are obvious.

25 percent of stroke victims suffer from a serious loss of speech and language comprehension. The affliction is commonly known as aphasia, and it is frustrating for patients and caregivers alike. It is estimated that more than 1 million Americans suffer from some form of aphasia, which can result from a stroke, brain tumor, seizure, Alzheimer’s disease or head trauma.

“Aphasia is a very specific condition that deals with disorder of language,” said Michael Frankel, associate professor of neurology at the School of Medicine and chief of neurology at Grady Hospital. “The easiest way to explain it is that a person can’t express what he wants to say or cannot find the right words, or that someone else finds it difficult to understand what the person is saying.

“It all depends, of course, on how much of the brain is damaged,” Frankel continued. “Damage usually occurs on the left side of the brain for people who are right-handed. Left-handers are also more likely to have language function located in the left hemisphere of the brain, but some have it on the right side of the brain.”

Frankel noted, however, a difference between aphasia and another disorder known as dysarthria, which is characterized as a problem of articulation. Both conditions can occur from stroke individually or in tandem.
A patient with aphasia, for example, may not be able to understand or express what she wants to say. A person with dysarthria, on the other hand, understands everything and can express what she wants to say, but when she tries to use muscles in the mouth and throat to speak, it becomes difficult to coordinate them correctly, resulting in slurred speech.

If a stroke is the cause of aphasia, speech therapy can help treat it, said Frankel. Some aphasia patients, however, do not undergo speech therapy but nevertheless show signs of improvement. Frankel said it is important to recognize aphasia as a symptom of stroke since difficulty speaking can often be a warning sign. A person can exhibit signs of aphasia prior to suffering a stroke.

“If a person has five minutes of difficulty speaking where the words don’t come out, or they come out mixed up, that may be a warning sign of a stroke—even if it lasts just a few minutes,” Frankel said.

The warning signs of stroke also include sudden weakness on one side of the body or sudden numbness. This is often a sign of a transient ischemic attack, signifying that something is wrong with the blood vessels in the brain. At this stage it is often possible to introduce treatment to intervene and prevent another stroke from occurring. A stroke occurs when part of the brain is deprived of oxygen and affected nerve cells die. The brain cells that are killed cannot operate. The result is weakness, paralysis, or difficulty speaking, like aphasia.

There is no known cure for aphasia. According to the National Aphasia Association, 66 percent of aphasia cases result from stroke. Some patients are fortunate to recover completely within the first few hours or days. This is known as transient aphasia.

If aphasia symptoms persist beyond the first two to three months after a stroke, a complete recovery is unlikely. Recovery is a slow process that usually requires a minimum of a year of treatment including helping the individual and family understand and adjust to long-term deficits.

Surgical treatment of patients with significant carotid disease has started in late 70th. Significant is defined as symptomatic carotid stenosis of greater than 75% or asymptomatic carotid stenosis of greater than 90%.

Surgical Anatomy

The common carotid arteries differ in position, and relations at their origin. The right carotid artery arises from innominate artery, behind the right sterno-clavicular articulation; the left – from the highest part of the arch of the aorta. The left carotid artery is therefore longer. Both arteries ascend obliquely outward from the arch of aorta to the head. Roots, directions and position of right and left carotid arteries are different, but in the neck, the
two common carotid arteries resemble each other so closely, that one description will apply to both. All nuances of the anatomy we will demonstrate on example of the right carotid artery.
The common carotid artery is contained in a sheath, derived from the deep cervical fascia, which also encloses the Internal Jugular Vein (IJV) and Pneumo-gastric (Vagus) nerve. The IJV is lying on the outer (lateral) side of the artery, and Vagus nerve between the artery and vein, posteriorly to both of them (Pic.1, vagus nerve isn’t shown on the picture)).

![Pic.1]

The common carotid artery is a long vessel without any branches previous to its bifurcation. During the bifurcation the common carotid artery creates two major branches: **External and Internal Carotid Arteries**. The external carotid artery (ECA) takes a slightly curved course upwards and forwards (anteriorly). It is rapidly diminishes in size in its course up the neck, owing
to the number of the branches given off from it. The ECA gives off eight (8) branches and I will indicate just two of them that are most important from surgical technology point. They are:

- Superior Thyroid artery
- Lingual artery
- Facial artery (External Maxillary artery)

Those are anterior branches and Superior Thyroid artery is the first one. You have to remember that Superior Thyroid artery together with Internal and External Carotid arteries have to be controlled (looped or clamped) during the surgery.

The Internal Carotid artery (ICA) that rises from bifurcation of the common carotid artery is going upward and posteriorly from ECA. It supplies the anterior part of the brain and the eye. ICA enters the canal in the temporal bone and forms multiple branches inside the skull. **The cervical (neck) portion of the ICA gives off NO branches.**

Another important nerve structure that has to be recognized and preserved during surgery is Hypoglossal nerve (which brings supply to tongue’s muscles).

Others segments of surgical anatomy of this region we will talk about during surgery discussion.
**Carotid Endarterectomy**

The patient is positioned with the neck extended and the head turned away from the side of the surgery. The incision is made along the anterior border of the sternocleidomastoid muscle (Pic.2).

**Pic.2**

Using electrocautery, the surgeon cauterizes superficial vessels and incises the platysma muscle in the line of the incision. **Dull Weitlaner**, Beckman retractor, or Gelpi retractor is placed for wound exposure. Dull Weitlaner is the best choice from this group of retractors. Common facial veil is usually obstructing approach to the artery and has to be dissected, clamped, cut, and ligated with free tie or, if necessary, suture ligated. Common carotid artery is gently mobilized. As we have mentioned above, common carotid artery, vagus nerve and internal jugular vein have common sheath, which has to be opened prior to artery dissection. Tissue in this area should be manipulated as little as possible to prevent separation of the atherosclerotic plaque inside the vessel. A vessel loop is placed around the common carotid artery 1-2 cm below bifurcation (Pic.3).
As dissection continues superiorly, the hypoglossal nerve must be identified and preserved. Finding first descendent hypoglossal nerve can assist in locating the main trunk of hypoglossal nerve.

The dissection of the external carotid artery and its first branch – superior thyroid artery are performed next. Both arteries must be looped with vessel loop for ECA and 2-0 silk ligature for superior thyroid artery. The dissection of the internal carotid artery is completed last. Special attention must be paid to another nerve that positioned in this area – **carotid body (or sinus)**, which regulates arterial blood pressure. This nerve positioned right in bifurcation “fork”, between external and internal carotid arteries. Sometimes additional injection of the local anesthetic must be used
for carotid body nerve blockage. Additional loop applied for internal carotid
artery control.

A small moist gauze is placed in the wound for 3-5 minutes; heparin is given
via a central line and adequate anticoagulation confirmed by the activated
clotting time.

The preselected (by the surgeon) vascular clamps are applied to the common
carotid artery and internal carotid artery. The ECA and superior thyroid
artery are controlled by gentle traction on the vessel loops.

A longitudinal incision is then made through the adventitia on the
anteriolateral surface of the carotid artery. The length of this incision is
extended inferiorly into the common carotid artery below any obvious
localized plaque. The incision extends superiorly into the internal carotid
artery to appoint immediately beyond the bifurcation (pic.4).

At that point, a temporary bypass shunt is inserted. Two different
modifications of shunt are commonly used: Javid shunt and Carotid balloons
shunt (Pic.5, picture shows insertion of the shunt into the left carotid
arteries). Javid shunt is a simple modification, easy to use and doesn’t
require more than 1, 5 min for its insertion. Shunt first must be inserted into
the internal carotid artery to ensure backflow. It is very important to have air and debris cleared by the backflow of the
blood from the internal carotid artery before gently inserting the shunt into
common carotid artery.
The shunt bypass is now in place, providing circulation to the internal
carotid artery and to the cerebral circulation.
Using a small blunt dissector (Freer Elevator), the plaque is mobilized from the adventitia. When the common carotid artery plaque (atheroma) is completely mobilized at this level, a fine right-angled clamp is passed around it, and, using an 11-scalpel blade, the atheroma is divided (Pic.6).

The dissection is continued superiorly until the external carotid artery is encountered. With gentle retraction laterally, the external carotid plaque is removed. While applying gentle traction, the external carotid clamp can be removed momentarily. This maneuver usually enables the specimen to be removed completely (when the vessel wall partially everts) from within external carotid and superior thyroid arteries.

Blunt dissection is continued into internal carotid artery. Usually, the plaque thins out as the dissection proceeds superiorly. The vessel wall also partially everts, making the dissection easier. Eventually, the thin normal intima “fractures”, and the specimen is removed (pic.7).
The vessel wall is then carefully inspected, and any loose strips of atheroma that remain are carefully peeled away. The internal carotid artery is closely inspected to ensure that there is no loose flap superiorly. If there is any concern about a distal intimal flap or the possibility of dissection, the intima on the level of ‘fracture’ is “tacked” to the adventitia with 7/0 monofilament suture passed from the internal aspect of the plaque through the adventitia and secured external to the vessel. The internal carotid artery clamp is again momentarily released to provide retrograde flushing of the vessels. Finally, the wall of the dissected artery is dried with gauze “peanut” and again inspected to ensure that there is no loose debris (Pic.8).
The arteriotomy is closed with a double 6/0 monofilament suture. The last few remaining loops of this suture are left loose; bypass shunt is removed, and the clamp on the internal carotid artery again released momentarily to fill the vessel (Pic.9). This clamp is reapplied and the external carotid artery clamp removed. Common carotid artery clamp is released, and the suture is pulled taut. The last – internal carotid artery clamp is realized.
If concern exist that direct closure may narrow the lumen of the internal carotid artery, a small patch of saphenous vein, bovine pericardium, or synthetic can be used. A 6/0 monofilament suture is utilized.