Advanced Microsurgical Course – Neurosurgical Focus

Presented by

Diego A. Devia, MD.

Yelena Akelina, DVM, MS.

Microsurgery Research and Training Lab, Department of Orthopedic Surgery

Columbia University

October 2021

CURRICULUM

End-to-End Carotid Anastomosis (One-way-up Suture)

A standard anterior midline cervical approach will be used on the subjects. Proper hair removal of the rat is followed by a midline incision with a 15 scalpel. Blunt dissection using cotton tip applicators allows separation of the neck muscles - sternomastoid (SM) and sternohyoid (SH) - which provides a wide surgical exposure and an adequate way to visualize the carotid artery "pulsations" under the omohyoid muscle (OHM) which must be transected.

Transection of the OHM reveals the carotid sheath, which is incised, and the internal jugular vein, the vagus nerve, and sympathetic trunk are dissected and displaced from the common carotid artery (CCA) with the help of two straight jeweler's forceps. Generally, lidocaine solution is applied directly on the common carotid artery to reduce vasospasm. A little piece of blue rubber background is positioned behind the artery, serving 3 different purposes:

- Generates adequate contrast.
- Prevents near structures damage.
- Provides a blood-free field (i.e., a clean surgical field).

After positioning the background, a double approximator clamp will be placed with the clamp applicator, making sure there is a slack in the vessel between the clamps, so it is not too tightened. Then the carotid artery is bisected and flushed with a heparinized saline solution (20 U/ml) using an ophthalmic cannula. The next step is preparing the edges of the lumen by adventitia trimming, following three basic principles:

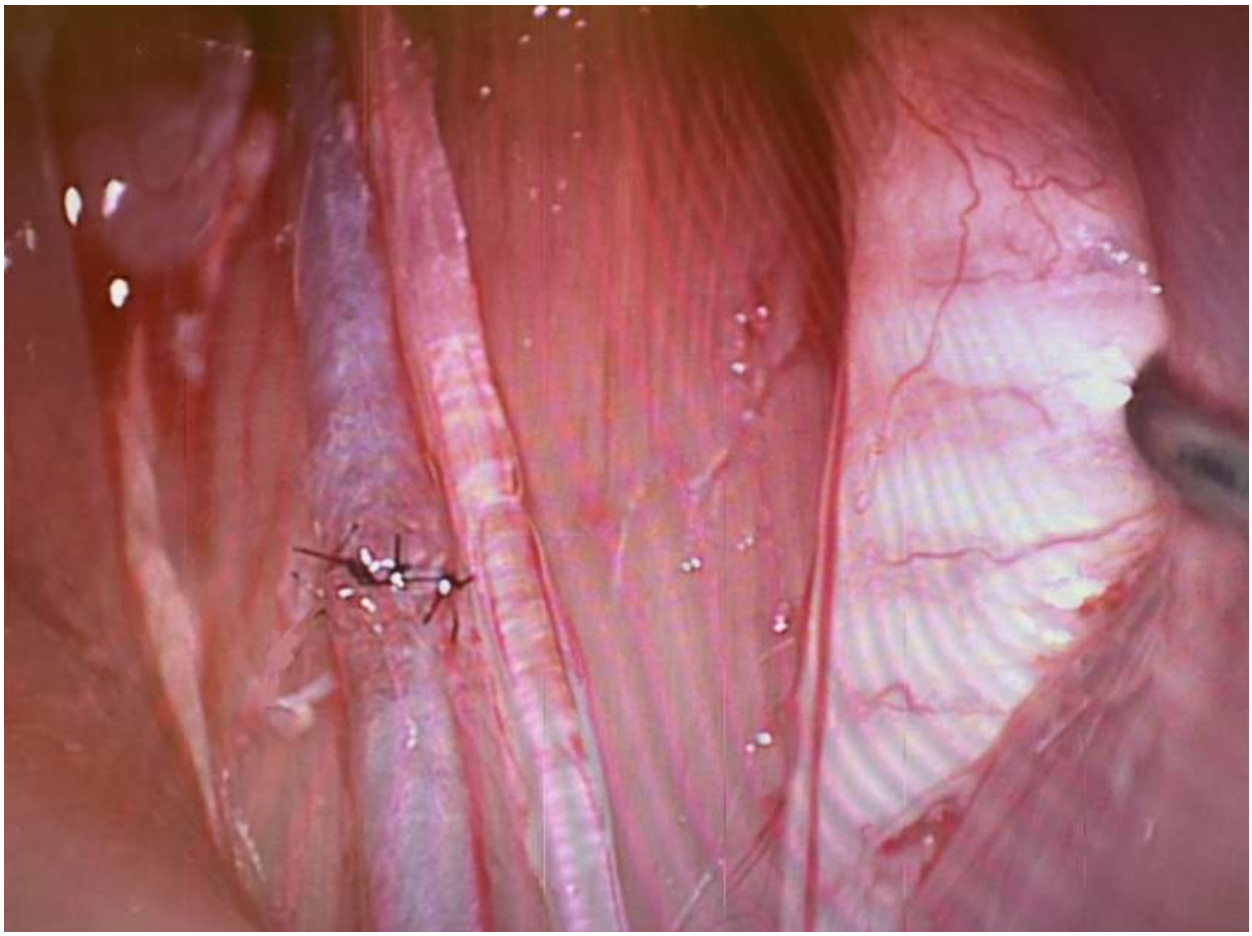
- Highest magnification.
- Vessel submerging in saline solution.
- Keeping scissors parallel.

Completion of carotid preparation is done by dilating the vessel edges with the microvessel dilator. Approximation of the vessel's ends is performed by bringing the clamps together with the angled jewelers' forceps, leaving a small gap between the artery edges.

Then suturing begins with the highest magnification, a twelve o'clock stitch with rotation technique is made first, and the one-way up technique is used for microvascular anastomosis. This

technique consists of completing the posterior wall before completing the anterior wall, precluding the need for approximator clamp flipping.

After the anastomosis is completed, the clamp is removed, always removing the low-pressure clamp first (i.e., the distal clamp), and then the high-pressure clamp (i.e., the proximal clamp). A fat pad can be positioned for hemostasis, as it is usually done with the femoral artery anastomosis. After bleeding is controlled, or in case of a clinical anastomosis, the patency is assessed with the lift and the refill tests.



Interpositional Artery Graft (Femoral Artery to Carotid Artery – Double End-to-End Anastomosis)

A standard anterior midline cervical approach will be used on the subjects. Proper hair removal of the rat is followed by a midline incision with a 15 scalpel. Blunt dissection using cotton tip applicators allows separation of the neck muscles - sternomastoid (SM) and sternohyoid (SH) - which provides a wide surgical exposure and an adequate way to visualize the carotid artery "pulsations" under the omohyoid muscle (OHM) which must be transected.

Transection of the OHM reveals the carotid sheath, which is incised, and the internal jugular vein, the vagus nerve, and sympathetic trunk are dissected and displaced from the common carotid artery (CCA) with the help of two straight jeweler's forceps. Generally, lidocaine solution is applied directly on the common carotid artery to reduce vasospasm. A little piece of blue rubber background is positioned behind the artery, serving 3 different purposes:

- Generates adequate contrast.
- Prevents near structures damage.
- Provides a blood-free field (i.e., a clean surgical field).

After positioning the background, the femoral artery graft will be prepared, following the steps learnt during the basic microsurgical course. Important steps to remember are:

- The murphy branch needs to be ligated and coagulated (allows mobilization of the femoral artery).
- The femoral artery is dissected from the inguinal ligament to the superficial epigastric artery, and then is excised and left on saline solution.

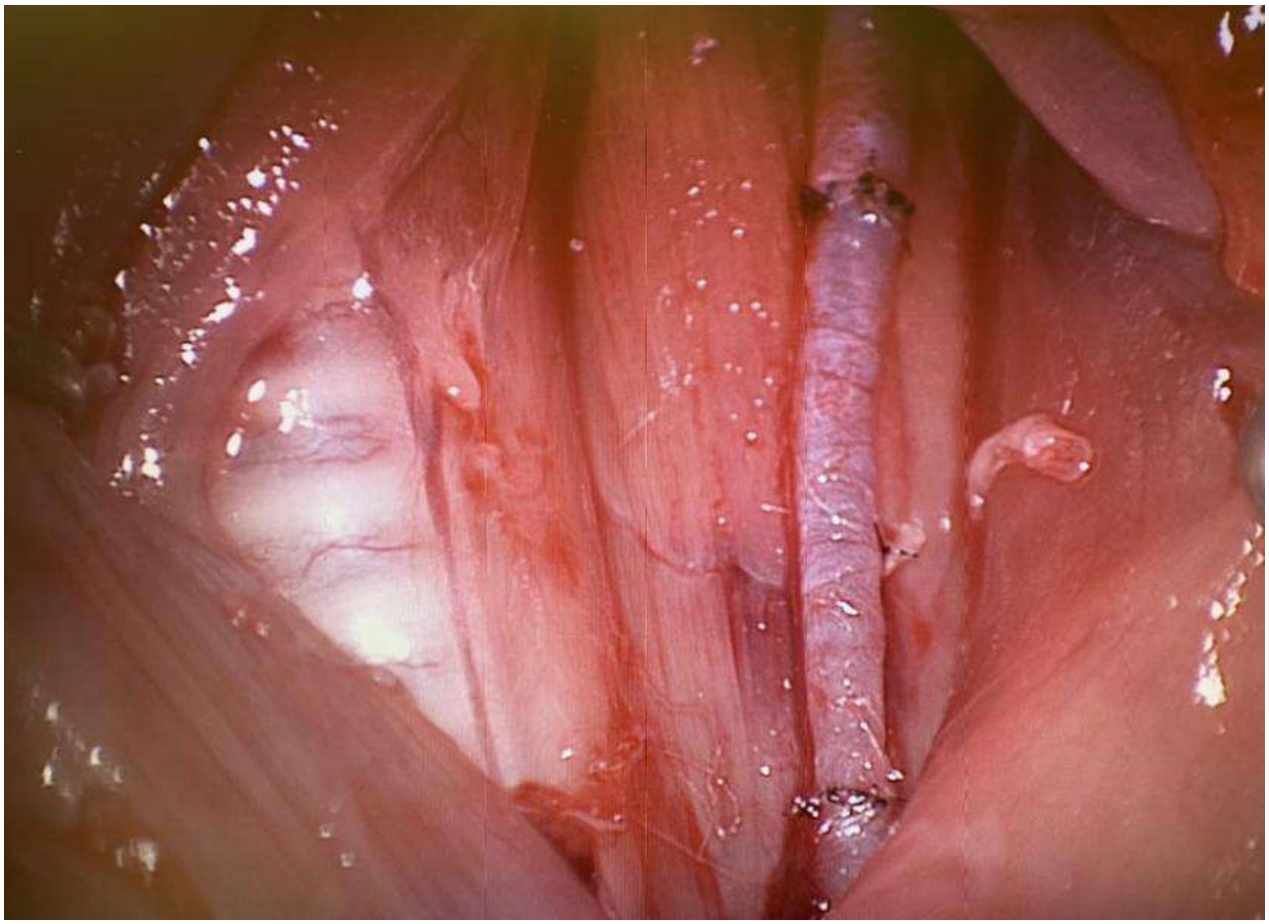
In this case we will use two single clamps, positioned as proximal and as distal as possible on the carotid artery. Then the carotid artery is bisected and flushed with a heparinized saline solution (20 U/ml) using an ophthalmic cannula. The next step is preparing the edges of the lumen by adventitia trimming, following the same three basic principles:

- Highest magnification.
- Vessel submerging in saline solution.
- Keeping scissors parallel.

Completion of carotid preparation is done by dilating the vessel edges with the microvessel dilator. Then suturing begins with the highest magnification, a twelve o'clock stitch with rotation

technique is made on the proximal anastomosis (End-to-End) and then on the distal anastomosis (End-to-End). After this a six o'clock stitch is performed as well on both anastomoses. Next, 3 stitches are done on the frontal wall (again on both anastomoses), followed by flipping both clamps and suturing the back wall (3 stitches too).

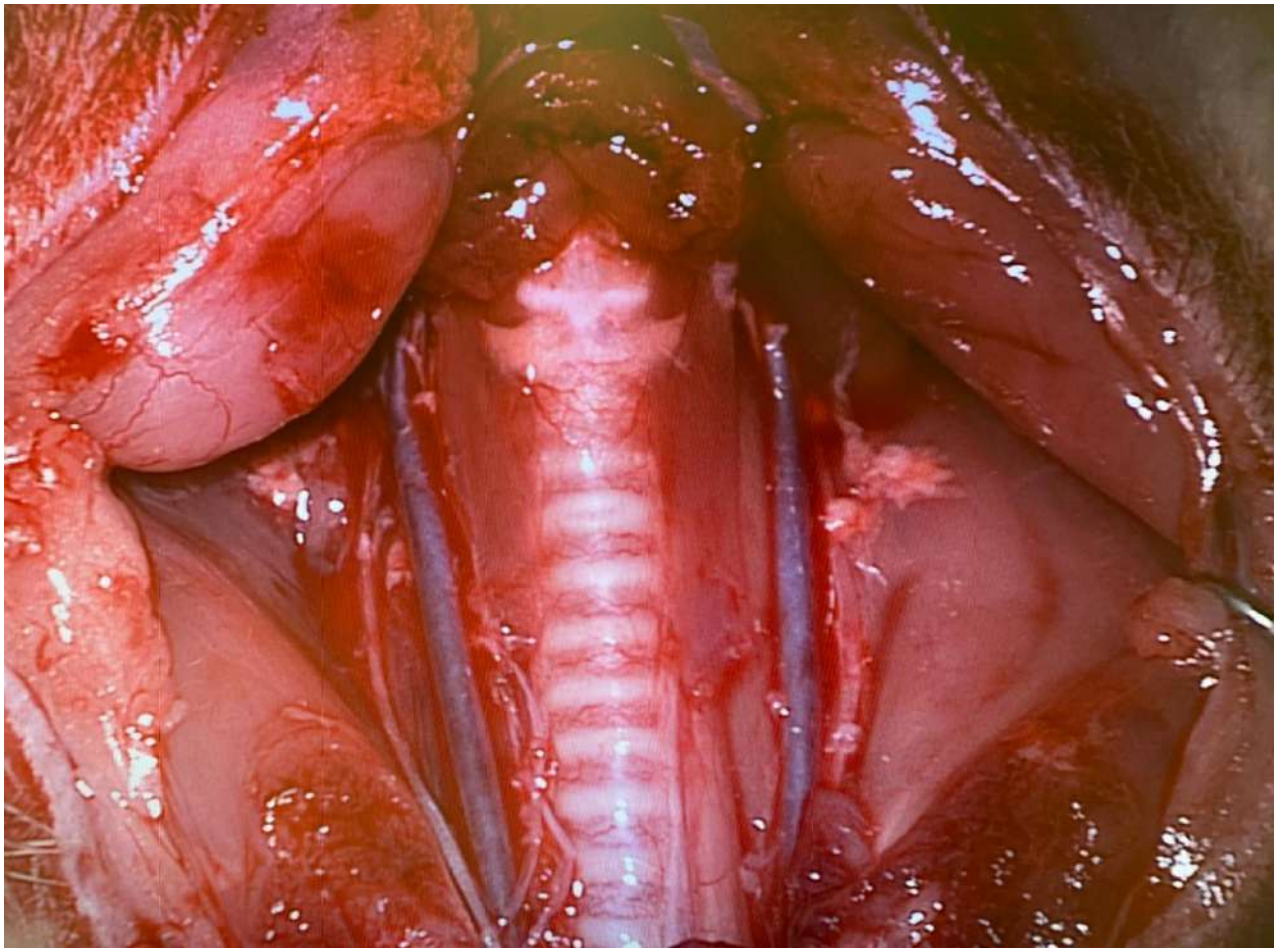
After both anastomoses are completed, the clamps are removed, always removing the low-pressure clamp first (i.e., the distal clamp), and then the high-pressure clamp (i.e., the proximal clamp). A fat pad can be positioned for hemostasis, as explained before. After bleeding is controlled, or in case of a clinical anastomosis, the patency is assessed with the lift and the refill tests.



Side-to-Side Carotid Arteries Anastomosis

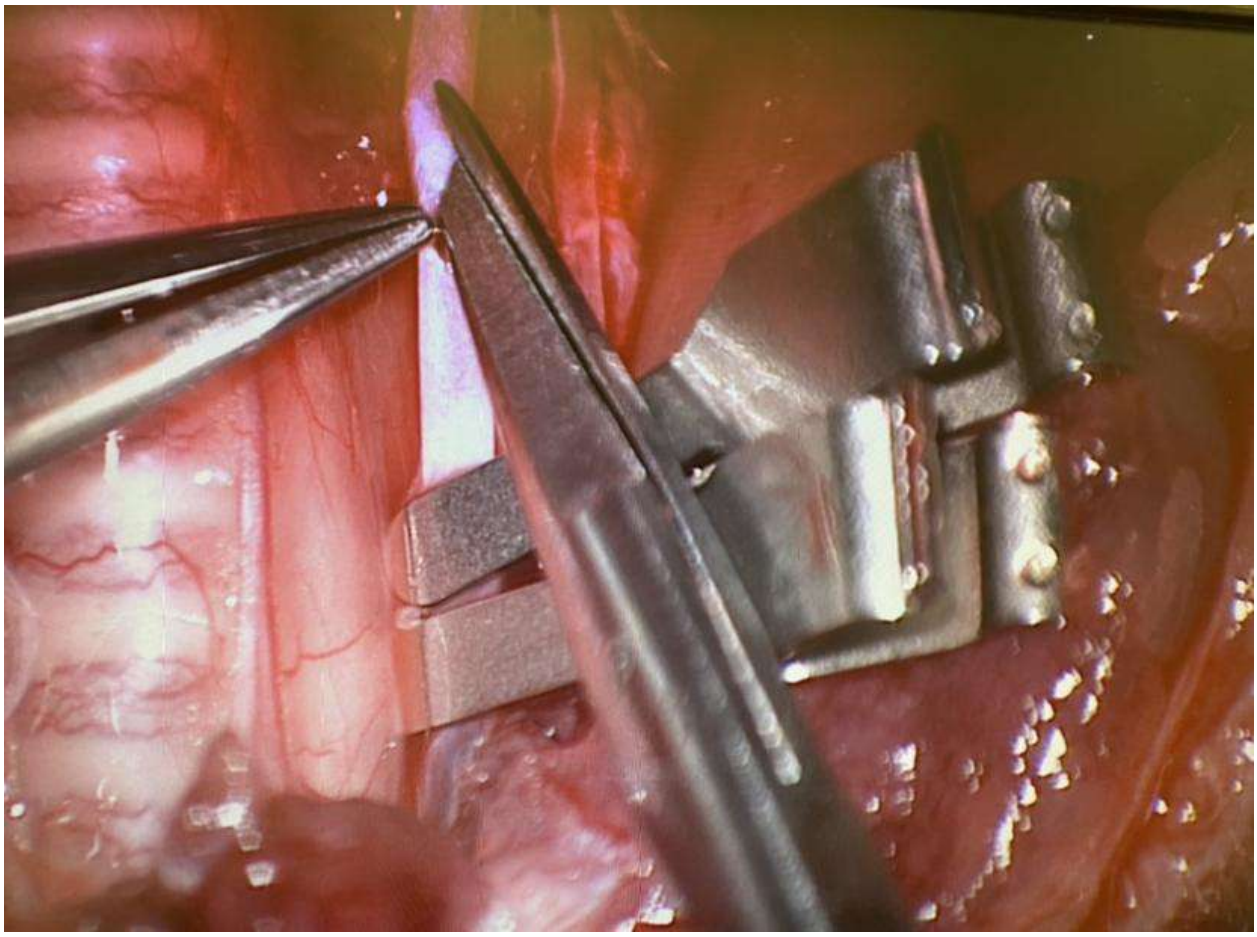
A standard anterior midline cervical approach does not provide adequate exposure for performing this procedure, so an anterior cervico-thoracic approach will be used on the subjects. Proper hair removal of the rat is followed by a midline incision with a 15 scalpel. Blunt dissection using cotton tip applicators allows separation of the neck muscles (on both sides) - sternomastoid (SM) and sternohyoid (SH) – permitting visualization of the carotid artery “pulsations” under the omohyoid muscle (OHM) which must be transected. Then the sternoclavicular joints are dissected, and the first two ribs are exposed on their medial half. An induced costochondral separation of the first two ribs is added bilaterally as part of the technique to gain more space and dissect both common carotid arteries (CCAs) more proximally to their origin, which serves as a maneuver for an easier CCAs approximation.

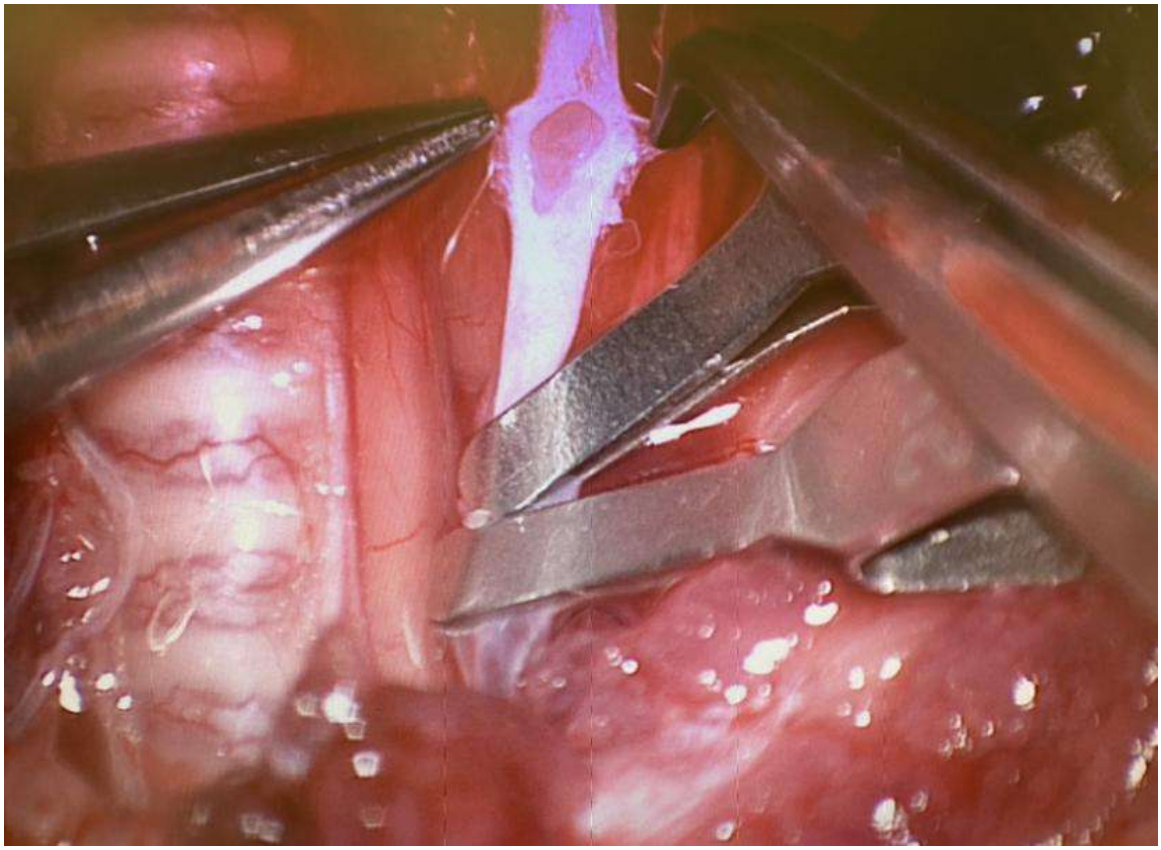
Both carotid sheaths are incised, and the internal jugular veins, the vagus nerves, and sympathetic trunks are dissected and displaced from the CCAs with the help of two straight jeweler’s forceps.



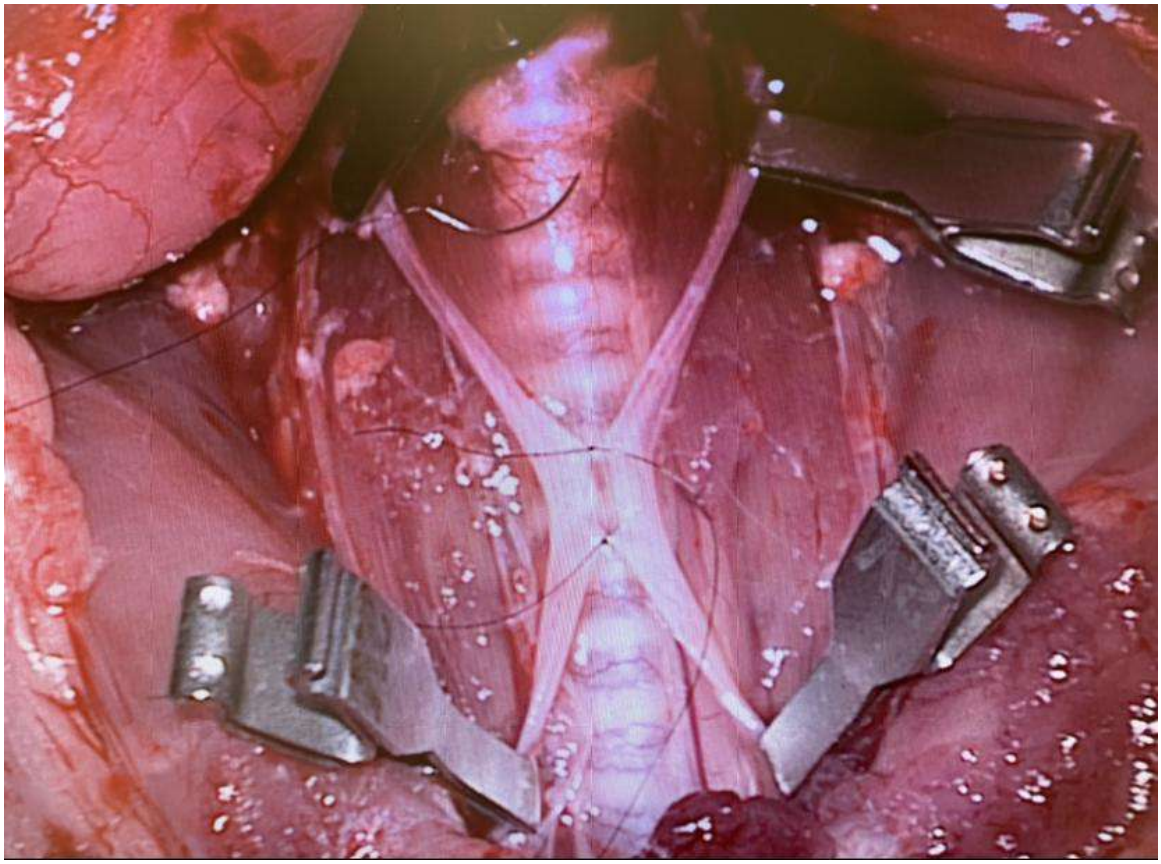
Generally, lidocaine solution is applied directly on the common carotid arteries to reduce vasospasm. Four (#4) single clamps are positioned: 1 proximal and 1 distal on each CCA.

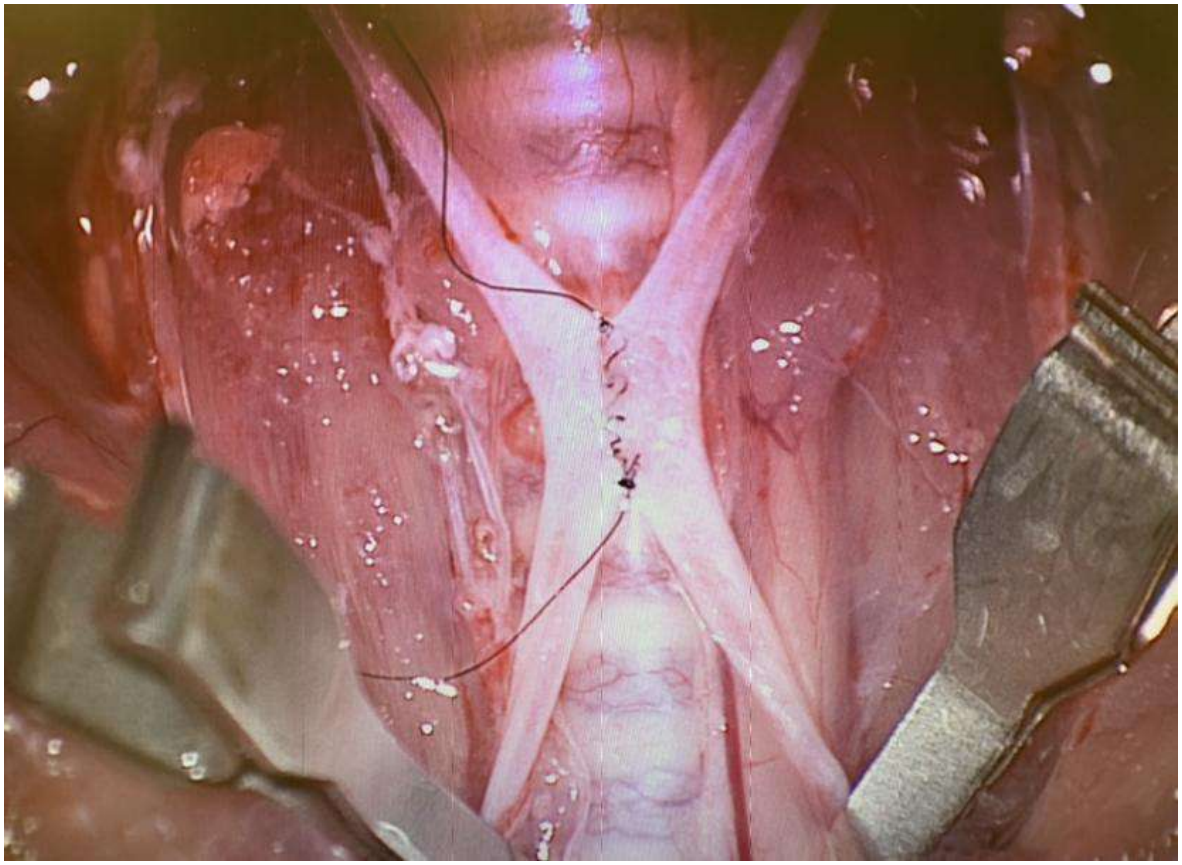
The CCAs preparation begins with adventitia removal, followed by arteriotomies in front of each other. These arteriotomies are performed by elevating the artery using an adventitia remnant that is left intact on purpose. A little cut is done with the microscissors, and through this little hole the microscissors are inserted in the vessel and a longer cut is accomplished (approximately 2 or 3 times the vessel's diameter, i.e., 2 or 3 mm long).

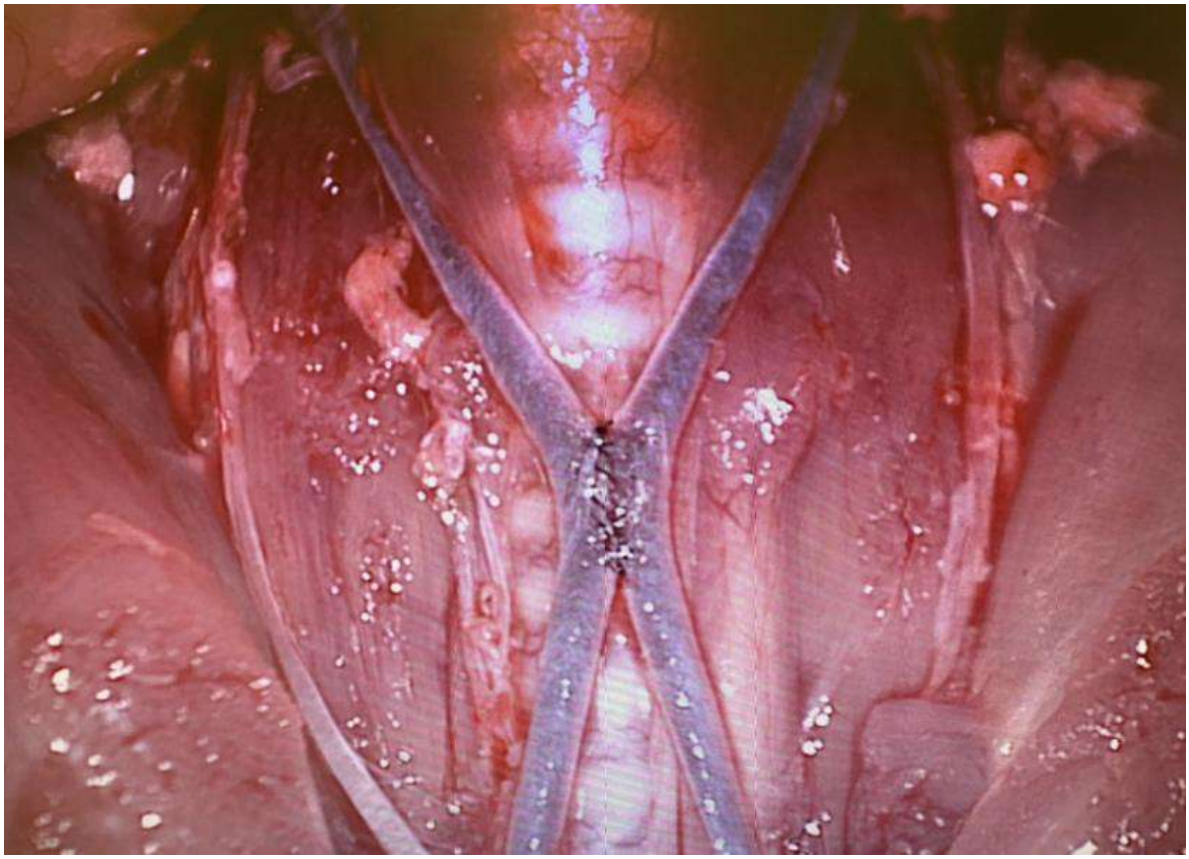




After positioning the background, both CCAs are approximated with the apical sutures. Both apical sutures must keep the appropriate length of the thread (not too long to avoid tangling), as this will be used for the back and front running sutures. If you are right-handed the back wall will be completed first, starting from the right, using a continuous suture with approximately 8 loops. Then it is secured to the shorter tail of the front wall suture thread. Finally, the anastomosis is completed by suturing the front wall starting from the left and using the long tail of the front wall suture thread, securing it by knotting it with the shorter tail of the back wall suture thread which was left intact.







After the anastomosis is completed, the clamps are removed, always removing the low-pressure clamps first (i.e., the distal clamps), and then the high-pressure clamps (i.e., the proximal clamps). A fat pad can be positioned for hemostasis. After bleeding is controlled, or in case of a clinical anastomosis, the patency is assessed with the lift and the refill tests.

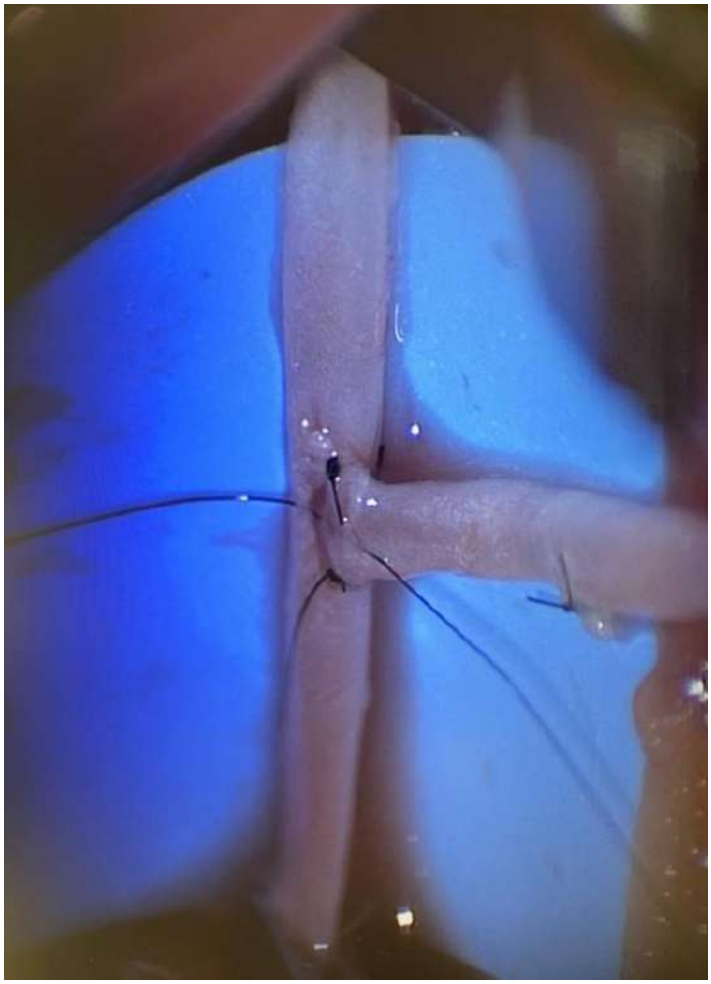
Interpositional Artery Graft (Femoral Artery Between both Carotid Arteries) – Interpositional Bypass Simulation (Double End-to-Side Anastomosis)

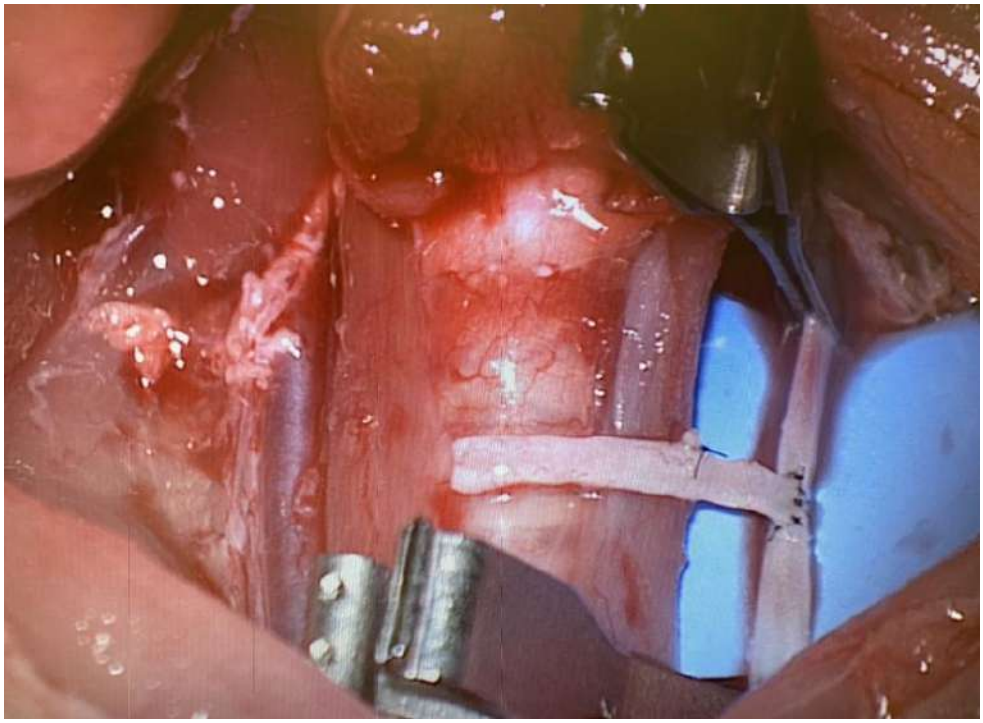
A standard anterior midline cervical approach will be used on the subjects. Proper hair removal of the rat is followed by a midline incision with a 15 scalpel. Blunt dissection using cotton tip applicators allows separation of the neck muscles (on both sides) - sternomastoid (SM) and sternohyoid (SH) – permitting visualization of the carotid artery "pulsations" under the omohyoid muscle (OHM) which must be transected. Both carotid sheaths are incised, and the internal jugular veins, the vagus nerves, and sympathetic trunks are dissected and displaced from the CCAs with the help of two straight jeweler's forceps.

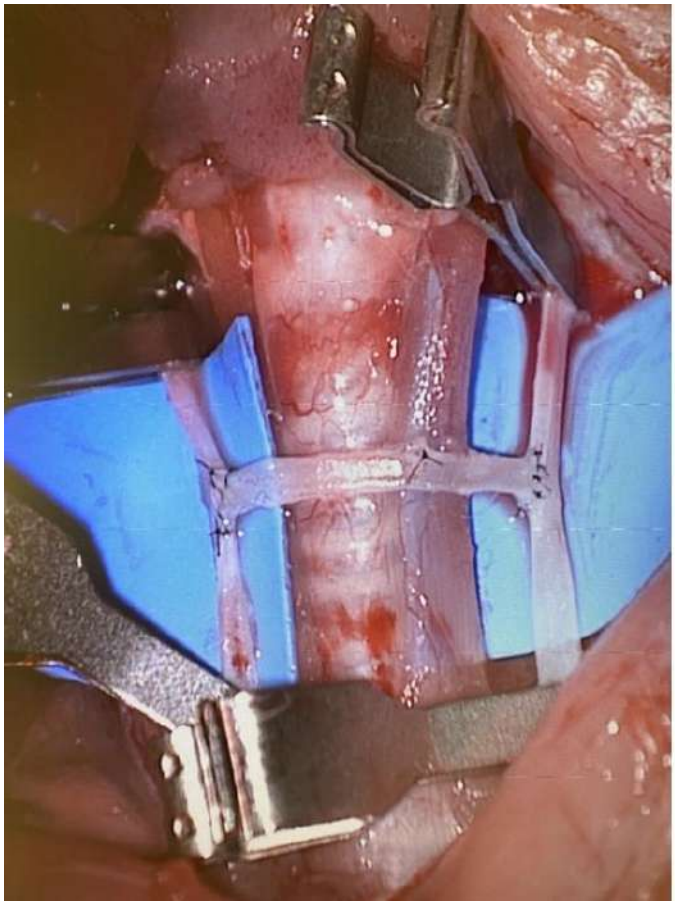
Then the femoral artery graft will be prepared, following the steps learnt during the basic microsurgical course. Important steps to remember are:

- The murphy branch needs to be ligated and coagulated (allows mobilization of the femoral artery).
- The femoral artery is dissected from the inguinal ligament to the superficial epigastric artery, and then is excised and left on saline solution.

Four (#4) single clamps are positioned: 1 proximal and 1 distal on each CCA. The CCAs preparation begins with adventitia removal, followed by arteriotomies in front of each other (1-1.5 mm of diameter), and the femoral artery is positioned between both CCAs through bilateral End-to-Side anastomoses. The first anastomosis (doesn't matter which side is performed first) is usually easier as the femoral artery can be flipped for back wall suturing; with the second side it is recommended to use the one-way-up suture technique. A twelve o'clock stitch with rotation technique is made first, and then the posterior wall is sutured before completing the anterior wall.







After the anastomosis is completed, the clamps are removed, always removing the low-pressure clamps first (i.e., the distal clamps), and then the high-pressure clamps (i.e., the proximal clamps). A fat pad can be positioned for hemostasis. After bleeding is controlled, or in case of a clinical anastomosis, the patency is assessed with the lift and the refill tests.