Microneurosurgery

Neurosurgery with operating microscope.

Gazi Yasargil collaborated with Raymond Madiford Peardon Donaghy at the University of Vermont in developing microneurosurgery.

Microneurosurgical technique and anatomical knowledge require extensive laboratory training before mastering these skills.

There are diverse training models based on synthetic materials, anesthetized animals, cadaver animals, or human cadaver.

Fresh chicken wings

The main brachial artery was cannulated, and water was infused at 140 mm Hg followed by anatomical neurovascular dissection. Multiple microsurgical training exercises were performed under microscope vision including terminoterminal, laterоterminal, laterolateral vascular anastomosis, and nerve anastomosis. Different complexity aneurysms were created using venous patches, clipping, rupture, and vascular reconstruction techniques were performed.

This novel training model is inexpensive, easily obtainable, and no live animals are required. The diameter and characteristics of arteries and veins used are similar to those of the human brain. Great microsurgical technique progress may be obtained.

The infused chicken wing artery model presents a realistic microvascular training method [1)].

Human cadaver models

Human cadaver models are especially beneficial because they are the closest to live surgery with the greatest disadvantage of lacking hemodynamic factors.

Aboud et al. developed the “brain infusion model” to provide a simple but realistic training method minimizing animal use or needs for special facilities, and prepared human cadaver for surgical procedures in the following manner: the carotid arteries (CAs) and vertebral arteries (VAs) in the neck were cannulated, as were the internal jugular veins (JVs) on both sides. Two tubes were introduced into the spinal canal and each one was advanced into one of the cerebellopontine angle cisterns. A CA, VA, or both were then connected to a reservoir containing light red fluid and a pressure of 80 to 120 mm Hg and a pulse rate of 60 beats/minute were established using a pump. The JV on the side currently being dissected was connected to a reservoir containing dark red fluid and kept at a pressure between 20 and 40 mm Hg. The remaining vessels were clamped in the neck. The cisternal tubes were connected to a reservoir of clear fluid that was regulated by an adjustable flow. Nine trainees have tested this model on eight specimens by practicing a variety of surgical procedures and maneuvers, including craniotomies; hemostasis; cisternal and vascular dissection; vascular anastomosis and repair; establishment of arterial bypasses; aneurysm creation, dissection, and clipping; management of an aneurysm rupture; intraparenchymal resection such as amygdalohippocampectomy; ventricular endoscopy and third ventriculostomy; cavernous sinus and skull base approaches; and resection of artificial tumors in the basal cisterns.

This model mimics the normal human anatomy and dynamic vascular filling found in real surgery and presents it from the training perspective, allowing a wide range of skill development and repeated practice. It provides an alternative model to laboratory animals. It is inexpensive and readily available, and has great value for the acquisition and refinement of surgical skills that are not only specific to neurosurgery, but are applicable to other surgical disciplines [2)]

Olabe et al. cannulated carotids and vertebral arteries with plastic tubes and fixed with suture. Water was flushed through the tubings until the whole arterial vasculature was observed as clean. The cannulated specimens were fixed with formaldehyde. Tap water infusion at a flow rate of 10 L/h was infused through the arterial tubings controlled with a drip regulator filling the arterial tree and leaking into the interstitial and cisternal space.

Multiple microneurosurgical procedures were performed by 4 trainees. Cisternal and vascular dissection was executed in a very realistic fashion. Bypass anastomosis was created as well as aneurysm simulation with venous pouches. Vessel and aneurysm clipping and rupture situations were emulated and solution techniques were trained. [3)].

1)
Olabe J, Olabe J. Microsurgical training on an in vitro chicken wing infusion model. Surg Neurol. 2009 Dec;72(6):695-9. doi: 10.1016/j.surneu.2008.12.008. Epub 2009 Mar 29. PubMed PMID: 19329164.
2)
Aboud E, Al-Mefty O, Yaşargil MG. New laboratory model for neurosurgical training that simulates live surgery. J Neurosurg. 2002 Dec;97(6):1367-72. PubMed PMID: 12507135.
3)
Olabe J, Olabe J, Sancho V. Human cadaver brain infusion model for neurosurgical training. Surg Neurol. 2009 Dec;72(6):700-2. doi: 10.1016/j.surneu.2009.02.028. Epub 2009 Aug 6. PubMed PMID: 19664809.