Short Communication:

Microsurgical Training Curriculum for Neurosurgery Residents in Southern Iran

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ABSTRACT

Cerebrovascular diseases comprise a major subspecialty in neurological surgery. Current education curriculums lack the necessary training modalities for teaching the microvascular techniques, to neurosurgery residents. We have included a 1-month micro-lab and animal lab rotation for senior residents, which can be added to their current educational program. Necessary equipment for this rotation includes an operating microscope Zeiss S8, microsurgical instruments, and animal anesthesia equipment are used to perform revascularization techniques on the aorta of a rat model (average-sized Sprague-Dawley weighing 200-250 gram). This rotation was included in previous curriculums as micro-lab. Evaluation of microvascular surgical skills following the addition of animal models to this skill lab is suggested to be considered as a part of OSCE in board certification in future studies. The addition of animal models to micro-lab rotations, provides a better understanding of tissue consistency while dealing with a microvascular surgery procedure, for neurological surgery residents.

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Highlights

● Cerebrovascular incidents are among the most common conditions, which a neurological surgery resident should learn to tackle during a residency training program.

● Microvascular surgery has a steep learning curve and the necessary skills are usually not achieved during the residency program.

● Learning and practicing the necessary microsurgical revascularization techniques in animal labs should be considered as a preliminary step in the neurological surgery residency curriculum.

Plain Language Summary

Cerebrovascular incidents are among the most common conditions that neurosurgeons deal with in their clinical practice. Surgery on small-diameter brain vessels requires precise albeit fast technical skills and is usually performed via a microscope. Learning such skills during the residency program should follow a stepwise protocol. Animal labs are the optimal places where neurological surgery residents can acquire such skills on rats prior to practice in operating rooms.

1. Introduction

Cerebrovascular diseases are among the most common conditions worldwide leading to a significant portion of mortality and morbidity. The clinical presentations can range from a Transient Ischemic Attach (TIA) with full recovery early after the event to hemorrhagic strokes such as that seen with Intracranial and Subarachnoid Hemorrhage (ICH and SAH). Cerebrovascular pathologies such as extracranial and intracranial arterial stenosis, aneurysms, and arteriovenous malformation comprise a major portion of the diseases that a certified neurosurgeon would encounter in his/her practice.

Almost half a century ago, microsurgery was introduced to the neurosurgical practice [1], which revolutionized the surgical techniques and improved the long-term results for revascularization surgeries. However, training in microvascular surgery has faced 2 major obstacles; first, the less exposure of residents to the management of different surgical cases considering the increased number of trainees, and second, popularity and further use of endovascular techniques [2].

Training of microvascular anastomosis techniques comprises the major part of surgical skills, necessary for revascularization surgeries. Training can be performed in several stages based on the experience of trainees. This should mainly start with various models of artificial materials that simulate tissues. In the next stage, the trainee should practice the microsurgical skills on the animal model. Further experienced trainees would work with live animal models, which provide the most relevant simulation due to the presence of blood flow. According to similar educational curriculums, such a training program has the merits of high face and construct validity.

Mastering the microsurgical anastomosis techniques along its steep learning curve [3] requires rehearsal and practice to refine necessary skills especially for bypass grafts when time is of the essence and brain tissue is endangered with reduced perfusion.

Rat model in microsurgical training

The live rat animal model remains an indispensable model for many training microsurgical courses worldwide [4]. The use of this model in microsurgery training stretches back to the early 1960s when pioneers such as Lee identified the need for low-cost surgical models that could meet the clinical needs of the day. He and subsequent researchers went on to develop organ transplant models in the rat to help address the current immunological issues at that time [5].

The fact that the abdominal aorta of an average-sized rat measures 3 to 5 mm in diameter almost equal to the diameter of the human Middle Cerebral Artery (MCA) makes it a perfect tissue for simulation of training anastomosis techniques. We use the basic principles of microsurgery for end to end, end to side, and side to side vascular anastomosis.

Surgical micro-lab

We have integrated the 3-month micro-lab rotation as a mandatory course for trainees in the 4th year of neurosurgical residency at Shiraz medical school. The micro-lab has become actively involved in the educational curriculum with the collaboration of "Neurosurgery Department" [6, 7] and "Center of Contemporary and Experimental Medicine" (Both affiliated with Shiraz University of Medical Sciences, Shiraz, Iran) since 2009.

Equipment: The micro-lab is equipped with a Zeiss S8 microscope, a standard flexible table, bipolar electrocautery, and micro-instruments such as micro-forceps, needle holders, and micro scissors.

Rat Model: An average-sized Sprague-Dawley weighing 200-250 gram

Anesthesia and preparation: The rats are anesthetized with an injection of a cocktail [(Ketamine (75-95 mg/kg) and Xylazine (5-8 mg/kg)] intraperitoneally. They were constantly monitored for the depth of anesthesia throughout the procedure. The rats' abdomen area is prepared by standard methods and is fixed to a table by fishhooks.

Procedure: A vertical incision is made on the abdomen from the xiphoid down to 4cm. The dissection begins under magnification by microscope under 5 power of magnification using 2 micro-forceps when the peritoneum is entered. After displacing the viscera laterally, the abdominal aorta and inferior vena cava are exposed (Figure 1).

2. Training Course Details

The trainee is requested to make the first suture using micro-instruments; then with a gentle rotation of lumen, the second suture is made opposite to the first. The 3rd and 4th sutures were made between the first 2. Four more sutures were also applied between the previous 4, to make 8 knots overall. Then the clamps were released to evaluate the anastomosis after the restoration of blood flow. Doppler ultrasonography is also used to evaluate the optimal flow rate. Same procedures are also practiced for end-to-side and side-to-side anastomosis with or without venous patch grafts.
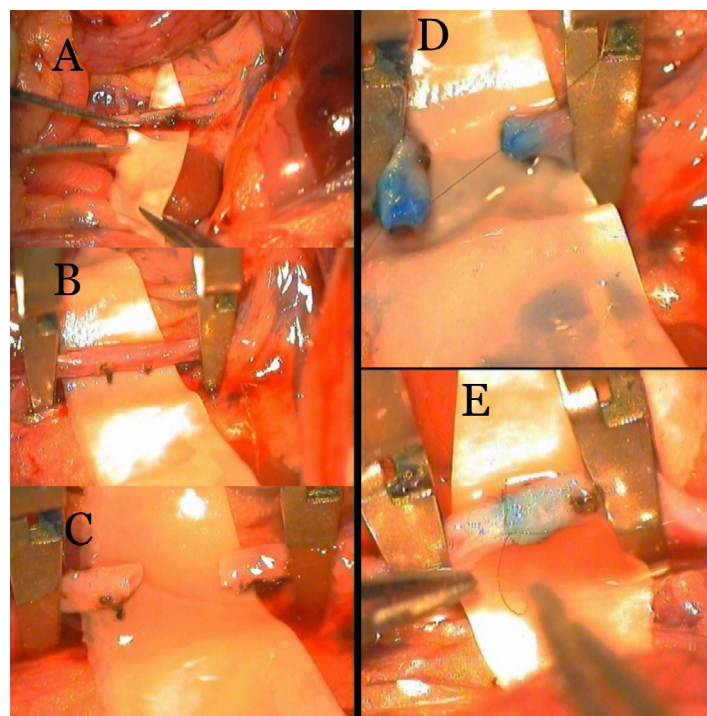

Figure 1. Steps of re-vascularization procedure performed by each trainee

A. A strip of latex glove is placed under the abdominal aorta for better visualization; B. We proceed with gentle removal of the peri-adventitia tissues to expose the lumen and at this stage, 2 vascular bulldog clamps are applied above and below the desired segment of anastomosis; and C: Then the lumen is sharply incised; D: Methylene blue is also applied to both arterial stumps to improve visualization; E: End-to-End anastomosis is then carried out using Ethilon Sutures USP 10-0 which possess 3.8 mm round needles, in a simple separate fashion.

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3. Discussion

With the increased number of neurological surgery residents and the wide-spread use of endovascular techniques, many trainees do not gain sufficient exposure to learn the vascular anastomosis techniques in operating rooms. Despite the advancements in endovascular procedures over the recent decades, the number of surgical bypass surgeries has remained constant. The main reasons for this fact are that surgical bypasses provide better patency rates in terms of durability and flow rate and less chance of developing re-stenosis and necessity of re-operation. Also, endovascular techniques are not suitable for several conditions or they may be costlier with similar clinical outcomes.

Interdisciplinary micro-lab, such as the one designed at our department, makes it possible for neurosurgical trainees to learn the microsurgical skills for vascular anastomosis on simulated animal models, along WITH its steep learning curve.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors contributions

Conception and design: Abdolkarim Rahmanian; Data Collection: Mohammad Eisaei; Data analysis and interpretation: Mohammad Eisaei; Drafting the article: Nima Derakhshan; Critically revising the article: Nader Tanideh, Omid Koohi-Hosseinabadi; Reviewing submitted version of manuscript: Nima Derakhshan, Abdolkarim Rahmanian; Approving the final version of the manuscript: All authors.

Conflict of interest

The authors declared no conflict of interest.

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