Impact of a Vascular Neurosurgery Simulation-Based Course on Cognitive Knowledge and Technical Skills in European Neurosurgical Trainees

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■ OBJECTIVE: **To assess microsurgical and diagnostic cerebral angiography modules and their corresponding objective assessment scales as educational tools for European neurosurgical residents at the European Association of Neurosurgical Societies Resident Vascular Neurosurgery course, which was held in Prague, Czech Republic, on September 2013. Microsurgical skills and cerebral angiography are fundamental skills in vascular neurosurgery. There is a need to develop a simulation-based curriculum focusing on these skills for neurosurgical trainees worldwide.**

■ METHODS: **The course consisted of 2 modules: microanastomosis and diagnostic cerebral angiography. In addition to an initial screening survey, each module was divided into 3 components: 1) a before didactic cognitive knowledge and technical skills testing, 2) a didactic lecture, and 3) an after didactic cognitive knowledge and technical skills testing. We compared the trainees' cognitive and technical scores from the before and after testing phases. Wilcoxon sum rank test was used to test statistical significance.**

■ RESULTS: **The knowledge test median scores increased from 63% and 68% to 80% and 88% ($P < 0.01$) on the microanastomosis and cerebral angiography modules, respectively. The practical hands-on simulation assessment median scores increased from 42% and 50% to 50.5% and 68% ($P < 0.01$) on the microanastomosis and cerebral angiography modules, respectively.**

■ CONCLUSIONS: **Our course suggests that a simulation-based vascular neurosurgery curriculum is feasible and may enhance resident knowledge and technical proficiency.**

INTRODUCTION

Increasing emphasis on quality in health care and a sobering realization of the magnitude of medical errors have fueled an interest in enhancing neurosurgical education through simulation (30). Simulation-augmented curricula have been established to enhance medical education in many areas of health care (29, 30). In addition, simulation has become a cornerstone of training in a number of nonmedical fields such as military and aerospace (29). A positive impact on learning curves has become apparent (4, 8, 22, 23, 31). The integration of simulation as a tool to enhance neurosurgical educational curricula has lagged when compared with other fields. Funding, technical limits of current simulators, the absence of validated objective assessment tools, and curricula have collectively slowed the progress (13, 29). Techniques, such as

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- Angiography
- Education
- Innovation
- Microanastomosis
- Neurosurgery
- Resident
- Simulation
- Training

Abbreviations and Acronyms
EANS: European Association of Neurosurgical Societies
NOMAT: Northwestern Objective Microanastomosis Assessment Tool
OSATS: Objective Structured Assessment of Technical Skill
PGY: Postgraduate year

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microsurgical anastomosis and cerebral angiography, are fundamental skills that every neurosurgical resident should achieve competency. Adequate access to these techniques can be challenging in some programs. To assess the potential impact of a simulation-based educational curriculum on neurosurgical residents we introduced 2 simulation modules (microanastomosis and cerebral angiography) and their corresponding objective assessment scales to European neurosurgical residents at the European Association of Neurosurgical Societies (EANS) Resident Vascular Neurosurgery course, which was held in Prague, Czech Republic, on September 2013.

METHODS

Neurosurgery residents from the European Union participated in the resident vascular simulation course held by the EANS. Residents were divided randomly into 4 groups of 4 residents each. These residents attended both the microanastomosis module and the endovascular module. We did not need Institutional Review Board approval as the article does not reflect a study but is a report of data taken from the EANS course.

Microanastomosis Module

Four surgical microscopes were used for the microanastomosis session. One 3-mm silicone-based artificial vessel was provided for each resident. The vessel was placed on a wetted filter paper in a petri dish, which was fixed under the microscope (**Figure 1**). One scissor, 1 jeweler, 1 needle holder, and one 8-0 suture per trial were provided for each resident to perform an end-to-end anastomosis with interrupted stitches.

Cerebral Angiography Module

In a separate classroom, 3 cerebral angiography simulators (Zeiss, Jena and Leica, Solms) were available for the angiography module. Custom catheters and wires, compatible with the simulators at hand, were provided and the residents were guided through the simulation by a trained technician while being monitored by a faculty member.

Course Design

The overall course started with a 30-minute introductory lecture on simulation after which 4 sessions of microanastomosis and 4 sessions of cerebral angiography ran simultaneously. Each session was scheduled for 2 hours and was attended by a group of 4 residents. Each resident attended 1 angiography session and 1 microanastomosis session. Five faculty members from the Congress of Neurological Surgeons proctored the residents during the sessions. The residents were asked to complete a survey that focused on determining their prior experience with angiography, cerebral microanastomosis, and simulation (**Supplementary Material 1**). The residents were then given 15 minutes to complete a 20-question multiple choice test to assess their knowledge on cerebral angiography and microanastomosis (depending on which session they were in). Afterward, the residents were given 20 minutes to perform the specified task in each session. In the microanastomosis session, the residents were required to anastomose a 3-mm vessel using 8-0 sutures. The residents' performance was graded based on the Northwestern Objective Microanastomosis Assessment Tool (NOMAT) (**Supplementary Material 2**). In the cerebral angiography session, the residents were required to catheterize the aortic arch, innominate artery, right common and internal carotid artery, left common and internal carotid artery, and the left vertebral artery. The residents' performance was graded based on the Congress of Neurological Surgeons Angiography Assessment Tool (**Supplementary Material 3**).

Subsequently, a faculty member in each session gave a 30-minute didactic lecture focusing on cognitive knowledge and technical nuances of the respective skill. A video on microanastomosis was shown and explained in details in the microanastomosis session. In the angiography classroom, a faculty member performed a live demonstration of cerebral angiography on a simulator. The residents were then asked to retake the 15-minute knowledge test and the 20-minute practical exercise and were consequently graded with the same scales. Wilcoxon sum rank test was used to test statistical significance for the change in performances before and after the didactic lecture.

Figure 1. Microanastomosis setting.

RESULTS

Before Module Survey

A total of 16 residents from different European countries participated in the course (**Figure 2**). Fifteen of the participating residents did not have prior exposure to simulation in their neurosurgery programs. Three residents were in their first or second postgraduate year (PGY), 3 residents were in their third or fourth PGY, and 10 residents were in their sixth or seventh PGY. Five of 16 residents had never performed a microanastomosis and the other 11 had performed less than 5 cases. Concerning cerebral angiography, 5 residents had never performed one, whereas 10 residents reported being involved in less than 10 cases.

Performance on Before and After Didactic Knowledge Tests

The residents' cognitive knowledge related to the task improved for both modules. The median percentile scores increased from 63% and 68% to 80% and 88% in the microanastomosis and cerebral angiography modules, respectively ($P < 0.01$) (**Figure 3**). The technical performance of residents assessed using the NOMAT and the Congress of Neurological Surgeons Angiography Assessment Tool scales also improved after the didactic lectures. The percentile scores of the NOMAT in the