Establishing an Asynchronous Curriculum for Vascular Anastomosis for Neurosurgical Residents

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Background

Mastery of advanced microsurgical bypass techniques is a critical milestone for senior neurosurgical residents preparing for independent practice. However, opportunities for deliberate practice of open vascular anastomosis are increasingly limited by duty-hour restrictions, heightened patient safety concerns, and declining operative volumes of complex open vascular cases.

Traditional apprenticeship-based training models often fail to provide sufficient repetition, structured feedback, or objective assessment of technical progression. These constraints highlight the need for reproducible, scalable, and feedback-driven training models that can be completed outside of the operating room.

Objective

To develop and implement a graduated, asynchronous, video-based curriculum to teach and refine vascular anastomosis skills in senior neurosurgical residents, and to evaluate changes in technical performance before and after curriculum completion.

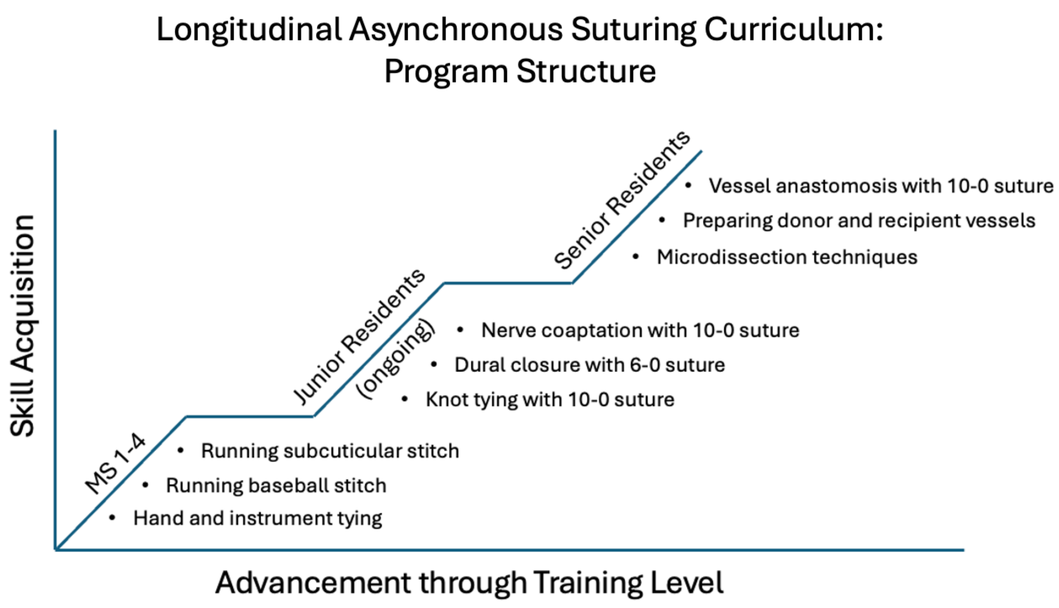

Figure 1. Overview of the asynchronous, graduated surgical skills curriculum for medical students, junior neurosurgical residents, and senior neurosurgical residents, illustrating sequential task progression, required photo and video submissions, and asynchronous mentor feedback.

Curriculum Design

- We developed a longitudinal, asynchronous microsurgical curriculum conducted over four months, designed to promote deliberate practice and progressive skill acquisition (Table 1)
- Entry into program requires completion of the pre-curriculum assessment and training
  - Ensures residents are adequately prepared for the curriculum
- Key design features include:
  - Sequential task progression with advancement contingent on feedback
  - Independent task completion outside of the operating room
- Required submission of:
  - High-resolution photographs of completed tasks
  - Short video clips (≤3 minutes) capturing critical steps (needle handling, suture placement, knot tying)
- Asynchronous, task-specific feedback provided by expert neurovascular faculty, emphasizing:
  - Suture technique and spacing
  - Vessel handling and orientation
  - Efficiency, ergonomics, and economy of motion
- This structure allows for individualized feedback without requiring synchronous faculty availability.

Pre-Curriculum

Participants included senior neurosurgical residents.

Prior to curriculum enrollment:

- Residents completed an entrance task demonstrating proficiency in knot tying using 10-0 nylon around adjacent gauze strands, as assessed by faculty
- Participants attended an in-person instructional session with senior neurovascular faculty
- Complete structured pre-test, including:
  - Timed knot tying
  - End-to-side anastomosis on a 2-mm synthetic biovessel

Table 1. Vascular anastomosis curriculum for senior neurosurgical residents

Month	Task
1	Preparation of the donor and recipient vessels (chicken femoral artery)
2	Placement of heel and toe stitches
3	Placement of additional anchoring stitches
4	Completion of a full end-to-side anastomosis of synthetic biovessels

Outcome Assessment

Upon curriculum completion, residents undergo a structured post-test identical in format to the pre-test.

Evaluation metrics include:

- Knot-tying efficiency
- Quality and completion time of end-to-side anastomosis

Primary analysis compares pre-curriculum and post-curriculum performance, allowing objective assessment of skill acquisition.

Expected Outcomes

This curriculum is designed to:

- Provide reproducible vascular skills training independent of operative case volume
- Enable meaningful expert feedback without requiring synchronous faculty presence
- Improve technical readiness for independent practice in senior residents

If successful, this framework is scalable and adaptable to:

- Other surgical techniques (Figure 1)
- Additional neurosurgical subspecialties
- Broader surgical education contexts

Conclusions

A structured, asynchronous curriculum offers a feasible and effective approach to teaching advanced vascular anastomosis skills outside of the operating room. This model supports deliberate practice, individualized feedback, and objective assessment, addressing key limitations of traditional surgical training paradigms. Adoption of similar curricula may help bridge gaps in operative exposure while maintaining high standards of technical competency.

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