Manual dexterity

- Application of systematic early rehabilitation training in patients undergoing primary neuroanastomosis and thumb opposition reconstruction due to complete median nerve laceration due to carpal injuries
- Aging-Related Changes in Bimanual Coordination as a Screening Tool for Healthy Aging
- Harvey Cushing: France Military Hospital Surgical Unit Head and World War I U.S. Army Medical Corps Commissioner
- Association of the Brain White Matter Hyperintensity with the Cognitive Performance in Middle-Aged Population
- Predicting the long-term course: Shunt surgery results in idiopathic normal pressure hydrocephalus-a comprehensive study
- Simulation to become a better neurosurgeon. An international prospective controlled trial: The Passion study
- Focal compression of the cervical spinal cord alone does not indicate high risk of neurological deterioration in patients with a diagnosis of mild degenerative cervical myelopathy
- Even short-term training improves the skills of novice exoscope users: a prospective laboratory experiment

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Manual dexterity refers to the ability to use one's hands and fingers with skill and coordination to perform complex tasks.

Importance

In the case of a neurosurgeon, manual dexterity is of utmost importance as they are required to perform intricate surgeries on the brain, spinal cord, and nerves. They must have excellent fine motor skills, a steady hand, and precise movements to perform delicate procedures in tight spaces.

Neurosurgeons often use specialized surgical instruments, including microscopes and endoscopes, to visualize and operate on the nervous system. They must be able to manipulate these instruments with great accuracy and control to minimize the risk of complications and maximize the chances of a successful outcome.

To develop and maintain their manual dexterity, neurosurgeons often engage in specialized training and practice. This may involve using surgical simulators, performing mock surgeries on cadavers, or participating in continuing education courses to refine their skills.

Certain studies have linked fatigue and sleep deprivation to worsened surgical dexterity. There are, to date, no reviews of this topic in published surgical literature. It therefore seems prudent to evaluate such behaviors and provide the neurosurgical community with the most current evidence on the topic so that learners and those responsible for their training may understand the potential consequences of their decisions on procedural dexterity and performance [1].

Omnidirectional articulated instruments enhance dexterity.

Evaluation

Conway et al. developed two novel individuation scores and tested them against a previously developed score using a commercially available instrumented glove and data collected from 20 healthy adults. Participants performed individuation for each finger of each hand as well as the whole hand open-close at two study visits separated by several weeks. Using the three individuation scores, intra-class correlation coefficients (ICC) and minimal detectable changes (MDC) were calculated. Individuation scores were further correlated with subjective assessments to assess validity.

They found that each score emphasized different aspects of individuation performance while generating scores on the same scale (0 [poor] to 1 [ideal]). These scores were repeatable, but the quality of the metrics varied by both equation and finger of interest. For example, index finger intra-class correlation coefficients (ICC's) were 0.90 (< 0.0001), 0.77 (< 0.001), and 0.83 ($p < 0.0001$), while pinky finger ICC's were 0.96 ($p < 0.0001$), 0.88 ($p < 0.0001$), and 0.81 ($p < 0.001$) for each score. Similarly, MDCs also varied by both finger and equation. In particular, thumb MDCs were 0.068, 0.14, and 0.045, while index MDCs were 0.041, 0.066, and 0.078. Furthermore, objective measurements correlated with subjective assessments of finger individuation quality for all three equations ($\rho = -0.45$, $p < 0.0001$; $\rho = -0.53$, $p < 0.0001$; $\rho = -0.40$, $p < 0.0001$).

They provide a set of normative values for three separate finger individuation scores in healthy adults with a commercially available instrumented glove. Each score emphasizes a different aspect of finger individuation performance and may be more uniquely applicable to certain clinical scenarios. They hope for this platform to be used within and across centers wishing to share objective data in the physiological study of hand dexterity. In sum, this work represents the first healthy participant data set for this platform and may inform future translational applications in motor physiology and rehabilitation labs, orthopedic hand and neurosurgery clinics, and even operating rooms [2)]

Endoscopic training

Findings suggest that three dimensional endoscopy modality provides improved surgical dexterity by affording the surgeon with depth perception when manipulating tissue and maneuvering the endoscope in the endonasal corridor [3)].

Junior residents and expert surgeons performed standardized motor tasks under microscopic and endoscopic visualization. Demerits for inaccuracy and time needed to complete the tasks were used to compare the surgeons' performance with the microscope and the endoscope. The participants also performed a motor task under direct vision using different instruments to evaluate whether the shape of the instrument had any impact on the surgical fidelity.

For the junior residents, the number of demerits accrued was lower with the microscope than with the endoscope, and the time needed to complete the tasks was also lower with the microscope. There was no difference in the number of demerits between the microscopic and the endoscopic experts, but the microscopic expert completed the task in a shorter time. There was no difference in demerits or performance time when comparing a short, straight instrument and a longer, bayoneted one.

For junior residents, surgical fidelity is higher with the microscope than with the endoscope. This difference vanishes with experience, but a slower speed of execution is observed with endoscopic visualization, both in junior and expert surgeons [4].

In neurosurgery, for example, the simultaneous use of 2 instruments through the same endoscopic shaft remains a difficult feat. It is, however, very challenging to manufacture steerable instruments of the requisite small diameter.

Dewaele et al. present a new technique to produce such instruments by means of laser cutting. Only 3 coaxial tubes are used. The middle tube has a cutting pattern that allows the steering forces to be transmitted from the proximal to the distal end. In this way the steering part is concealed in the wall of the tube. Large diameter articulated instruments such as for laparoscopy might benefit from the excellent tip stability provided by the same economical technology. Method. Coaxial nitinol tubes are laser-cut with a Rofin Stent Cutter in a specific pattern. The 3 tubes are assembled by sliding them over one another, forming a single composite tube. In a surgical simulator, the neurosurgical microinstruments and laparoscopic needle drivers were evaluated on surgical convenience. Results. Simultaneous use of 2 neurosurgical instruments (1.5 mm diameter) through the same endoscopic shaft proved to be very intuitive. The tip of the steerable laparoscopic instruments (10 mm diameter) could resist a lateral force of more than 20 N. The angle of motion for either instrument was at least 70° in any direction. Conclusions. A new design for steerable endoscopic instruments is presented. It allows the construction in a range from microinstruments to 10-mm laparoscopic devices with excellent tip stability [5].

Cerebrovascular anastomosis

Cerebrovascular anastomosis (for example in the management of Moyamoya disease or complex aneurysms) is a rarely performed but essential procedure in neurosurgery. Because of the complexity of this technique and the infrequent clinical opportunities to maintain skills relevant to this surgery, laboratory training is important to develop a consistent and competent performance of cerebrovascular anastomosis. We reviewed the literature pertaining to the training practices surrounding cerebrovascular anastomosis in order to understand the ways in which trainees should best develop these skills. A wide variety of training methods have been described. These may be classified into five general categories, according to training materials used, being synthetic material, living animal, animal carcass, human cadaver, and computer simulation. Ideally, a novice begins training with non-biological material. After gaining sufficient dexterity, the trainee will be able to practice using biological materials followed by high fidelity models prior to actual surgery. Unfortunately, the effectiveness of each model has generally, only been judged subjectively. Objective quantification methods are necessary to accelerate the acquisition of competence [6].

1)

Quintana LM. How to Be a Neurosurgeon with Good Hands. World Neurosurg. 2016 May;89:686-8. doi: 10.1016/j.wneu.2015.11.005. Epub 2015 Dec 1. PubMed PMID: 26608385.

2)

Conway BJ, Taquet L, Boerger TF, Young SC, Krucoff KB, Schmit BD, Krucoff MO. Quantitative assessments of finger individuation with an instrumented glove. J Neuroeng Rehabil. 2023 Apr 20;20(1):48. doi: 10.1186/s12984-023-01173-0. PMID: 37081513.

3)

Zaidi HA, Zehri A, Smith TR, Nakaji P, Laws ER Jr. Efficacy of Three-Dimensional Endoscopy for Ventral Skull Base Pathology: A systematic review of the literature. World Neurosurg. 2015 Oct 10. pii: S1878-8750(15)01346-7. doi: 10.1016/j.wneu.2015.10.004. [Epub ahead of print] Review. PubMed PMID: 26463398.

4)

Cote M, Kalra R, Wilson T, Orlandi RR, Couldwell WT. Surgical fidelity: comparing the microscope and the endoscope. Acta Neurochir (Wien). 2013 Dec;155(12):2299-303. PubMed PMID: 24122091

5)

Dewaele F, Kalmar AF, De Ryck F, Lumen N, Williams L, Baert E, Vereecke H, Kalala Okito JP, Mabilde C, Blanckaert B, Keereman V, Leybaert L, Van Nieuwenhove Y, Caemaert J, Van Roost D. A Novel Design for Steerable Instruments Based on Laser-Cut Nitinol. Surg Innov. 2014 Feb 7. [Epub ahead of print] PubMed PMID: 24510935.

6)

Higurashi M, Qian Y, Zecca M, Park YK, Umezu M, Morgan MK. Surgical training technology for cerebrovascular anastomosis. J Clin Neurosci. 2013 Oct 3. pii: S0967-5868(13)00513-4. doi: 10.1016/j.jocn.2013.07.029. [Epub ahead of print] PubMed PMID: 24326254.