Learning curve

In neurosurgery, the learning process represents one of the critical topics in the development of a neurosurgeon, where there is often no standardized learning program. The learning curve is defined by plotting proficiency as a function of time, or the number of repetitions.

A learning curve is a graphical representation of the increase of learning (vertical axis) with experience (horizontal axis).

Understanding the variation of learning curves of experts and trainees for a given surgical procedure is important in implementing formative learning paradigms to accelerate mastery. Study objectives were to use artificial intelligence (AI)-derived metrics to determine the learning curves of participants in 4 groups with different expertise levels who performed a series of identical virtual reality (VR) subpial resection tasks and to identify learning curve differences among the 4 groups.

A total of 50 individuals participated, 14 neurosurgeons, 4 neurosurgical fellows and 10 senior residents (seniors), 10 junior residents (juniors), and 12 medical students. All participants performed 5 repetitions of a subpial tumor resection on the NeuroVR (CAE Healthcare) platform, and 6 priori-derived metrics selected using the K-nearest neighbors machine learning algorithm were used to assess participant learning curves. Group learning curves were plotted over the 5 trials for each metric. A mixed, repeated-measures ANOVA was performed between the first and fifth trials. For significant interactions ($p < 0.05$), post hoc Tukey's HSD analysis was conducted to determine the location of the significance.

Overall, 5 of the 6 metrics assessed had a significant interaction ($p < 0.05$). The 4 groups, neurosurgeons, seniors, juniors, and medical students, showed an improvement between the first and fifth trial on at least one of the 6 metrics evaluated.

Learning curves generated using AI-derived metrics provided novel insights into technical skill acquisition, based on expertise level, during repeated VR-simulated subpial tumor resections, which will allow educators to develop more focused formative educational paradigms for neurosurgical trainees [1)]

Patients operated by an experienced resident or certified surgeon reported a favorable outcome more often than patients operated by an inexperienced resident (adjusted OR 3.23 and adjusted OR 3.16, respectively). In addition, a negative association was found between surgeon's years of experience and postoperative Symptom Severity Scale and Functional Status Scale scores.

Outcome after carpal tunnel release seems to be dependent on surgical experience, and there is a learning curve in residents [2)].

Neurointerventionalists can overcome the right transradial learning curve and achieve high success rates and low crossover rates after performing 30-50 cases [3)].

The records of 223 consecutive patients who underwent percutaneous endoscopic decompression by a single surgeon for their lumbar canal and lateral recess stenosis were reviewed. Patients were stratified into group 1 (n=100) and group 2 (n=123), depending on their case number. After the 100th case, the procedural time reached a plateau and subsequent patients were assigned to the second group. Demographics and surgical outcomes, including operative times, change in dural sac dimensions, length of hospital stay, and intraoperative complication rates were compared between the 2 groups. Postoperative clinical outcomes, including the visual analogue scale (VAS), the Oswestry Disability Index (ODI) and reoperation rates were compared between the 2 groups (group 1, n=90; group 2, n=110) by follow-up evaluation.

RESULTS: Procedural times were greater in group 1 than group 2 (group 1, 105.26 minutes; group 2, 67.65 minutes; $p<0.05$) and they had higher complication rates (group 1, 16% [16 of 100]; group 2, 8.3% [8 of 123]; $p<0.05$). The length of hospitalization, postoperative improvement in VAS and ODI, and reoperation rates were not different between the groups. In both groups, stenotic spinal canals were effectively decompressed.

CONCLUSION: Continued surgical experience was associated with a reduction in operative times and less intraoperative complications. Although the learning curve was steep and additional surgical experience may be needed to overcome the learning curve, percutaneous full endoscopic lumbar decompression is a safe, clinically-feasible, and effective surgical technique and can be adopted as the primary treatment for lumbar canal and lateral recess stenosis [4].

The learning curve in MISS is complex and difficult to measure, therefore operating times, conversion to open procedures, VAS and periods of hospital length of stay are used. While assessing complications as a measure of the learning curve, it was noted that nearly all the complications were documented before, and became minimum after the 30th consecutive case. As surgical experience increases, perioperative parameters (operative time, length of hospitalization) improve. The downside of MISS is starting unfamiliar procedures without tactile sensation, working in a narrow restricted surgical field and using endoscopes via 2D imaging. Appropriate instruments, a trained team and an adept radiographer are important assets for a smooth transition during the learning period. Structured training with cadavers and lots of practice, preferably while working under the guidance of experienced surgeons, is helpful. The learning curve can be shortened when a proficient surgeon gains relevant knowledge, understands 3D anatomy, and has surgical aptitude along with manual dexterity [5].

Robotic pedicle screw placement learning curve

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