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Idle time: an underdeveloped performance metric for assessing surgical skill

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Simulation

Abstract

BACKGROUND: The aim of this study was to evaluate validity evidence using idle time as a performance measure in open surgical skills assessment.

METHODS: This pilot study tested psychomotor planning skills of surgical attendings (n = 6), residents (n = 4) and medical students (n = 5) during suturing tasks of varying difficulty. Performance data were collected with a motion tracking system. Participants' hand movements were analyzed for idle time, total operative time, and path length. We hypothesized that there will be shorter idle times for more experienced individuals and on the easier tasks.

RESULTS: A total of 365 idle periods were identified across all participants. Attendings had fewer idle periods during 3 specific procedure steps ($P < .001$). All participants had longer idle time on friable tissue ($P < .005$).

CONCLUSIONS: Using an experimental model, idle time was found to correlate with experience and motor planning when operating on increasingly difficult tissue types. Further work exploring idle time as a valid psychomotor measure is warranted.

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Objective measures of technical surgical skills are needed for accurate feedback and competency evaluations.[1] Current assessments of technical skills include observer-generated task-specific checklists and global rating scales,[2–5] and technology-based performance measures.[6–9] Observer-based scoring metrics are readily accessible and inexpensive. Although commonly used to assess trainees, observer-based scoring metrics remain subject to bias[10] and can be time consuming. In contrast, although technology-based performance measures are more expensive, they provide a unique and unparalleled opportunity for automated and objective assessment methods. Further integration of technology into surgical skills assessment is critical for developing objective performance measures and providing an explicit path to surgical mastery.

The movement of motor skills acquisition outside the operating room and into the simulation environment permits the incorporation of technology-based metrics. Specifically, motion tracking technology allows for the objective measurement of motor behavior. Prior research on psychomotor skills assessment in open surgery has employed an electromagnetic tracking device called the Imperial College Surgical Assessment Device.[11–15] This work demonstrated evidence of construct validity with relationships among number of hand movements and experience level,[13] final product scores,[14] and observer-based global rating scores.[12,13]

The majority of studies evaluating motor behavior in surgical skills focus on metrics regarding hand movements including path length and the amount of time to complete the procedure.[11–15] These metrics represent a subset of surgical skills performance and technical skills metrics available with motion tracking technology. Although the prior work on motor movement provides a strong foundation for understanding surgical performance, there is a paucity of research on those instances where there is no movement—idle time. Idle time is characterized by a lack of movement of both hands and may represent periods of motor planning or decision making that can be used to differentiate performance.[16] Additionally, as individuals progress through stages of motor learning, there is a rapid reduction in the cognitive processes associated with difficult motor planning and a convergence on more rapid automaticity.[17] This is expected to translate into less idle time during a task performed by more experienced individuals who have had more practice.

Our work involves development and implementation of decision-based simulators with a variety of anatomical presentations that provide a range of task complexity.[18–21] The variable tissue simulator was developed to present suturing tasks of varying levels of difficulty based on the materials presented. The first aim of this pilot study was to evaluate idle time as a potential surgical performance metric. We hypothesize that there will be shorter idle times for more experienced individuals and on the easier tasks. The second aim of this pilot study was to assess the ability of the variable tissue simulator to differentiate psychomotor performance based on experience and task difficulty. We hypothesize that the time and path length to complete the suturing task will be shorter for more experienced individuals and on less difficult tasks.

Methods

Setting and participants

The study participants (n = 15) were medical students (n = 5), surgery residents (n = 4), and attending surgeons (n = 6) at a Midwestern academic hospital. Participants were recruited through departmental list serves and participation was voluntary and based on availability. Participants performed a simulated suturing task on the variable tissue simulator in a single setting. Performance data were collected with video recordings and an optical motion tracking system. There were no time restrictions on the suturing task and feedback was not provided.

Study approval was granted by the University of Wisconsin Health Sciences Institutional Review Board and written informed consent was obtained from all participants.

Surveys

Before performing the suturing task, participants completed a survey that collected demographic information including the level of training, surgical specialty, and handedness. Following the suturing task, participants responded to a question asking if the motion tracking system interfered with their ability to perform the task (5-point Likert scale: 1 = strongly disagree, 5 = strongly agree).

Variable tissue simulator

The variable tissue simulator was designed to present a simulated suturing task that induced decision making by varying the materials and difficulty of the suturing task. The simulator was composed of a board with simulated materials held in place by clips. In this study, 3 different simulated tissue types were presented: foam (dense connective tissue), rubber balloons (artery), and tissue paper (friable tissue) (Fig. 1). The suturing task was to place 3 interrupted instrument-tied sutures on 2 opposing pieces of material. 3-0 Prolene suture was provided along with a needle driver, surgical forceps and suture scissors. The development of the variable tissue simulator was guided by prior cognitive task analysis with 2 expert surgeons.[22]