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Factors Correlating With Microsurgical Performance: A Clinical and Experimental Study

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BACKGROUND: Microsurgery is one the most complex surgical skills to master. The factors correlating with microsurgical performance, however, are poorly understood. Understanding these factors will aid in the training and assessment of microsurgeons.

METHODS: A total of 29 microsurgery fellows enrolled in a dedicated 1-year microsurgery fellowship were included in the study. For the clinical evaluations, microsurgical anastomosis performance was evaluated during multiple procedures in the operating room at the start, midpoint, and end of the fellowship by all departmental faculty using a validated microsurgical assessment tool. For the laboratory evaluations, blinded video recordings of each fellow performing an arterial femoral anastomosis in a live rat model at the start and end of the fellowship were evaluated using 3 validated microsurgical global ratings scale tools. Correlations between performance and the factors assessed by the tools were evaluated.

RESULTS: In the clinical study there were a total of 474 anastomosis evaluations; clinical performance correlated best with speed, instrument handling, and motion. In the laboratory study 58 evaluations were conducted, and performance tracked most closely with instrument handling, flow of operation, and operative steps, as well as correlating significantly inversely with time taken. The most common errors committed were unequal stitch bites, wrong grasp/damage tissue, and loose knot.

CONCLUSIONS: Speed, both subjective and objective, instrument handling, operative flow, and motion, were relevant to performance of a microsurgical anastomosis. A prospective trial is now necessary to determine whether these factors should be considered in definitions of competency in microsurgery training pathways. (J Surg Ed ▮:▮▮▮-▮▮▮. Published by Elsevier Inc on behalf of the Association of Program Directors in Surgery)

KEY WORDS: microsurgery, performance, evaluation, fellow, clinical, experimental

COMPETENCIES: Practice-based learning and improvement

BACKGROUND

Surgical skills training and assessment are central to surgical practice,[1-3] and microsurgery is one of the most complex surgical skills to master. With the implementation of duty-hour restrictions in response to concerns regarding resident fatigue, medical errors, and patient safety, concerns have been raised that trainees might not have adequate time to develop competencies in the necessary surgical skills. This has led to a shift toward competency-based training, including the Accreditation Council for Graduate Medical Education Next Accreditation System and educational milestones,[4] the Surgery Resident Skills Curriculum including simulated environment skills acquisition,[5] as well as the American Board of Surgery resident operative and clinical performance assessments.[6] This current shift toward competency-based training requires greater understanding of the development of surgical skills and learning curves both in the simulated and clinical environment. The factors correlating with microsurgical performance, however, remain poorly understood, and understanding these factors will aid in the training and assessment of microsurgeons.

Several tools have been designed for the assessment of microsurgical skills.[7-22] The tools that have demonstrated the necessary validity and reliability for use in instruction or formative assessment include the modified objective structured assessment of technical skill (mOSATS),[7-11] the structured assessment of microsurgery skills (SAMS),[12,13] and the

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University of Western Ontario Microsurgical Skills Acquisition/Assessment (UWOMSA)[14,23] tools. Although the imperial college surgical assessment device has demonstrated validity and reliability for microsurgical assessment in a number of studies,[17-20] its use remains experimental, limited by cost, practicality, and availability. The aim of this study was to use these validated assessment tools to examine the factors and errors that correlate with microsurgical performance in both the clinical and standardized laboratory environments.

METHODS

Study Population

Following institutional review board approval (PA14-0767), retrospective evaluation of prospectively collected data during a 4-year period, 2010 to 2014, for 29 microsurgery fellows at the Department of Plastic Surgery at MD Anderson Cancer Center was performed. The fellows were fully trained plastic surgeons at the start of the fellowship, having completed their residencies.

Microsurgical Technical Skill Assessment Tools

The SAMS tool was designed purposefully for assessment of microsurgical anastomosis performance. It was developed by a process of complete deconstruction and analysis of the skills and tasks involved in performing a microvascular anastomosis, and observations of clinical performances by expert microsurgeons were then done to define the essential items for a structured assessment and feedback tool. Construct and content validity has been demonstrated, as well as good interrater reliability both intraoperatively and for the rat femoral artery model.[12,13] The tool evaluates multiple domains, including planning, dexterity, visuospatial ability, operative flow, and judgement. It consists of a 25-item errors list, and a 12-component global ratings scale (GRS), including steadiness, instrument handling, tissue handling, dissection, suture placement, knot technique, steps, motion, speed, irrigation, patency test, and bleeding control, as well as summary assessment of overall performance and indicative skill for next performance.

The OSATS tool was designed for objective assessment of performance across a range of surgical skills and has demonstrated validity and reliability for multiple domains.[24,25] It has been modified in different ways for use in microsurgical assessment both in the operating room (OR) and laboratory and has demonstrated construct validity.[7-11] The items assessed include time and motion, instrument handling, respect for tissue, and flow of operation.

The UWOMSA was purposefully designed for microsurgical skills evaluation, and has demonstrated concurrent and construct validity, as well as good interrater and intrarater reliability.[14] It is composed of a GRS to assess knot tying and anastomosis, including quality of knot, efficiency, handling, preparation, suturing, and final product.

Clinical Microsurgical Skill Assessment

For the clinical assessments, all 29 fellows were assessed in the OR performing assisted hand-sewn arterial end-to-end (interrupted 0-180 suture technique with single Acland clamps) anastomoses during multiple free flap microsurgical procedures including head and neck, breast, trunk, and extremity cases by all 21 faculty members of the department of plastic surgery using the SAMS assessment tool in single-blinded fashion at the start and end of the fellowship. In total 474 evaluations of anastomosis performance were completed, with more than 16 evaluations on average for each fellow.

Laboratory Microsurgical Skill Assessment

In the laboratory assessments, all 29 fellows performed an unassisted single rat femoral arterial hand-sewn end-to-end anastomosis (interrupted suture technique with a double-approximating Acland clamp) at the start and end of the fellowship, and the performances were digitally recorded without sound. The videos could be replayed as many times as necessary. The identities of the subjects were blinded to the assessors, and the recordings were deidentified and ordered at random. As the raters were blinded to the identity of the fellows, the assessments were free of observation and expectant bias. The set-up was standardized and the assessments were double-blinded.

There were 58 performances in total. To establish validity and reliability of the ratings, assessment of 14 blinded recordings using the SAMS tool was performed by 6 experienced microsurgery raters. Once interrater reliability was established, 1 rater performed the remainder of the assessments using the SAMS, UWOMSA, and mOSATS tools. To further ensure reliability of this method, the intrarater reliability was established by randomly duplicating 10 video recordings then randomly reordering the videos. To improve the internal consistency of the scoring, each video was watched twice, and where there were discrepancies between the scores, the value from the second assessment was used, to account for experience bias. Time was measured from the point where the vessel preparation was complete and clamps were about to be applied, to the point where the patency test on the completed anastomosis was concluded. Thus, in total, 100 video recordings were evaluated, including over 80 hours of footage.

Statistical Analysis

For statistical purposes the fellow performances were considered as one homogenous group ranked by overall performance scores. Descriptive statistics were used to summarize the scores of the microsurgical tools. Spearman correlation coefficient, ρ, was calculated to measure the