

Seminar Presentation: Critical Analysis  
Validation of a Task-Specific Scoring System for a Microvascular Surgery Simulation Model

Nimmons, G., Chang, K., Funk, G., Shonka, D., & Pagedar, N. (2012). Validation of a Task-Specific Scoring System for a Microvascular Surgery Simulation Model. *The Laryngoscope*, 122(10), 2164-2168.

The paper discussed in this seminar describes a study that evaluated the effect of surgical experience on the ability to perform a microvascular anastomosis. This study is extremely relevant to our own, given that the procedures and evaluation techniques used to evaluate both manual and robot-assisted microvascular anastomosis. Micro-scale surgery requires a very technically advanced skill set, given that the vessels have a diameter of only 2-3 mm. Procedures on this scale force a high level of eye-microscope-hand coordination and dexterous handling of the delicate tissues using fine, fluid motions. By implementing and refining a cooperatively controlled, steady-hand robot, namely the Robotic ENT Microsurgery System (REMS), it is possible to eliminate hand tremor, which is the most detrimental when operating at such a small scale. However, it is necessary to determine an accurate and objective method to simulate and evaluate the procedures before concluding the efficacy of a robotic microsurgery system.

The motivation for the study described in this paper is to validate a method to objectively evaluate microvascular procedures and validate the use of an available and cost-effective model for the anastomosis. The study was organized using 20 subjects of varying experience level, including 1<sup>st</sup> to 5<sup>th</sup> year residents, surgical fellows, and attending physicians; experience was self-reported by the subjects on a 1-5 scale, with increasingly experienced subjects rating themselves higher on the scale.

With a subject base established, the next step was to develop a method to objectively evaluate performance, specifically, a version of the Objective Structured Analysis of Technical Skill (OSATS) checklist, customized for the procedure at hand. Beginning with the OSATS for

urologic vasovasostomy, experienced microvascular surgeons updated the checklist with relevant criteria. The updated criteria, shown in Tables I and II of the paper, consists of evaluations for task specific scores (TSS) and a global rating scale (GRS). Task specific criteria evaluate proficiency at different skills needed in the procedure, such as loading the needle, ability to pass the needle through the tissue, and tying clean knots, all with reasonable dexterity. The global criteria deal with the general ability to perform the procedure, such as smoothness of the operation, handling of instruments and tissue, and the overall result. Using these criteria, it is possible to quantitatively score each subject's performance in the procedure.

The final part of the method described in this paper is the use of the chicken thigh model for the microvasculature. Traditional methods used for microvascular involve live mice; however, it was necessary to find another biologic model that is easier to obtain and more cost effective while still providing accurate structures upon which to operate. To meet this need, the ischiatic neurovascular bundle of a chicken thigh was used. The vasculature was separated from the bundle and skeletonized to remove all attached fat and tissue. This model provides an accurate representation of the vasculature present in a free flap, specifically of the vessel diameter and tissue properties.

Using the methods described above, each subject performed the procedure and was evaluated, producing results that supported the hypotheses. It was observed that with increased experience, mean task specific scores increased and the standard deviation of the scores of each group decreased. Broken down by each criteria of the TSS, it was seen that all groups performed well at loading the needle, holding it without wobble, and tying knots with appropriate tension. The greatest difference in task specific skills was seen in the passing of the needle through the tissue at the correct angle, with a well sized bite of tissue, and with proper tissue handling. For

these criteria, there was a clear improvement in score with increased experience. Similar results were observed for the global criteria, with the increasingly experienced subjects outperforming the other.

Overall, this paper was strong in its detailed description of the methods used in the experiment. The methods were completely described, with sufficient justification to design choices, such as the use of the chicken thigh model. Also, the extensive analysis of the results, both statistically and qualitatively, provided an in-depth explanation of what was observed. The only shortcoming of the procedure was the subjectivity in assigning the subjects based on experience. Since experience was self-reported, there was no uniform method of judging experience among the subjects. In spite of this, a general trend of increased classified experience level (rated 1 to 5) was observed with increasing experience level, as expected. Thus, this paper effectively detailed the study and offered in-depth analysis of the results, achieving the goal of validating the OSATS as a scoring system and the chicken thigh as an accurate model for microvascular anastomosis.

This paper is extremely relevant to our own project since it provides a detailed procedure very similar to what we are performing for our user trials. Having validated the chicken thigh as a viable model of the microvasculature in a free flap, we too can use this model to evaluate free-hand and robot-assisted anastomoses. Perhaps the biggest takeaway from this paper is the OSATS criteria used to evaluate the procedures; this quantitative scoring method will be applied to our own trials in order to compare the free-hand and robot-assisted procedures. Based on the first few trials, it is expected that task specific scores will be relatively low for all subjects, due to how inexperienced our subjects are with this specialized task. However, it is expected that the global scores will show improvement from the free-hand to the robotic trials. Criteria such as tissue and

instrument handling, economy of motion, and smoothness of motion are key areas where the REMS is intended to improve by eliminating hand tremor. Even preliminary qualitative analysis of the completed trials shows improved tissue and instrument handling in the robot-assisted procedures. It is predicted that the OSATS scores will further support this hypothesis.

In summary, the paper discussed provides a detailed framework for quantitatively evaluating microvascular procedures. Using the OSATS criteria described and the validated chicken thigh model, it will be possible to analyze the benefits of the REMS in microvascular anastomosis.