Motion Analysis as a Tool for the Evaluation of Oculoplastic Surgical Skill

Evaluation of Oculoplastic Surgical Skill

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Objective: To evaluate motion analysis as a discriminator of ophthalmic plastic surgical skill between surgeons of varying experience.

Methods: Thirty subjects were divided into 3 groups based on surgical experience: novice (<5 performed procedures; n=10), intermediate (5-100 procedures; n=10), and expert (>100 procedures; n=10). Detailed 3-dimensional motion data from surgeons performing 2 oculoplastic surgical tasks on a wet laboratory skills board were obtained using the Qualisys motion capture system. The first task was a deep 3-1-1 suture. The second was skin closure with a continuous suture. The main outcome measures were time, overall path length, and total number of movements. Kruskal-Wallis analysis was performed to evaluate statistical significance.

Results: Highly significant differences were found during the skin closure task between all groups for mean time (P=.002), overall path length (P=.002), and number of movements (P=.001). For the deep stitch, highly significant differences were also found for time (P<.001), path length (P<.001), and number of movements (P<.001).

Conclusions: Motion analysis, using this technology, was able to differentiate between surgeons of varying experience performing oculoplastic tasks, thus demonstrating construct validity. This technique may be useful in the objective quantitative measurement of oculoplastic skill, with potential applications for training and research.

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PARTICIPANTS

Thirty subjects were divided into 3 groups (n=10 each) based on surgical experience: novice (<5 performed procedures), intermediate (5-100 performed procedures), and expert (>100 performed procedures). All subjects were given standardized instruction prior to the tasks, and an independent expert observer was present to ensure correct task completion in all cases.

SIMULATED SURGICAL TASKS

The first task was the insertion of a deep 3-1-1 suture using 6-0 polyglactin (Vicryl; Ethicon, Somerville, New Jersey). It had to be placed around a metallic hook surrounded by a plastic cylinder (Figure, A). The suture needle was passed through the hook and then tied to the metallic frame (rim) with 3 throws on the first knot with 2 subsequent single throws to lock it. The loose ends of the suture were cut. The location of this deep stitch made the manipulation of the instruments more challenging. The second task involved the insertion of a continuous skin suture using 6-0 polypropylene (Prolene; Ethicon) in a preformed skin wound (Figure, A). The task commenced with a 3-1-1 knot placed beyond the skin wound to anchor the suture. The needle was then passed subcutaneously and regrasped inside the wound edges after which 3 subcutaneous bites were performed bringing the skin edges together. The needle was then passed from inside the wound edges and brought up through the skin (parallel to the wound), allowing a final 3-1-1 knot to be applied to secure the distal end of the continuous skin closure task.

For both tasks, a standardized wet laboratory environment was used for all surgeons undergoing testing, with the same instruments, surgical skills board (Royal College of Ophthalmologists, London, England) (Figure, A), and unmounted sutures being provided to all subjects. Subjects were allowed time to familiarize themselves with the environment, but once testing commenced, they were required to complete each task a single time without stopping or restarting.

Statistical analysis was performed using the Kruskal-Wallis test on SPSS (version 14; SPSS Inc, Chicago, Illinois). Statistical significance was set at 0.05. A nonparametric test was chosen because of the sample sizes in each cohort.

RESULTS

Summaries of path length, number of movements, and time are presented in the Table. The results demonstrate significant differences in path length, number of movements, and time taken to complete both surgical tasks, with more experienced surgeons demonstrating greater efficiency in completing the given tasks.

Highly statistically significant differences were found between the 3 grades of surgeons for both tasks. For the placement of the deep suture (task 1) (Table), the greater the degree of experience, the shorter the path length (Kruskal-Wallis, $P < .001$), the lesser the number of hand movements (Kruskal-Wallis, $P < .001$), and the shorter the time taken (Kruskal-Wallis, $P < .001$). For the placement of the subcutaneous skin closure (task 2) (Table), the greater the degree of experience, the shorter the path length (Kruskal-Wallis, $P = .002$), the...
lesser the number of hand movements (Kruskal-Wallis, \( P = .001 \)), and the shorter the time taken (Kruskal-Wallis, \( P = .002 \)).

### Table. Summary of Results for Deep Suture and Skin Closure Tasks

<table>
<thead>
<tr>
<th></th>
<th>Deep Suture (Task 1)</th>
<th>Skin Closure (Task 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median (Range)</td>
</tr>
<tr>
<td>Time, min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novice</td>
<td>2.36 (2.01)</td>
<td>1.73 (6.28)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1.53 (0.36)</td>
<td>1.49 (1.03)</td>
</tr>
<tr>
<td>Expert</td>
<td>0.68 (0.20)</td>
<td>0.67 (0.58)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&lt; .001 )</td>
</tr>
<tr>
<td>Path Length, m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novice</td>
<td>9.75 (6.81)</td>
<td>7.80 (20.16)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>4.82 (1.29)</td>
<td>4.69 (4.39)</td>
</tr>
<tr>
<td>Expert</td>
<td>1.68 (0.68)</td>
<td>1.52 (1.78)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&lt; .001 )</td>
</tr>
<tr>
<td>No. of Movements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novice</td>
<td>14114 (12.031)</td>
<td>10343 (37.528)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>9126 (2137)</td>
<td>8885 (6146)</td>
</tr>
<tr>
<td>Expert</td>
<td>3627 (976)</td>
<td>3604 (2846)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&lt; .001 )</td>
</tr>
</tbody>
</table>

\( ^{a} \text{Kruskal-Wallis test.} \)

The surgical tasks selected evaluated specific components of technical competence in a wet laboratory environment and thus have inherent limitations. These tasks, however, were selected to represent core oculoplastic skills that residents should be familiar with and to be of different complexity. This tool has the potential for providing structured objective feedback on surgical performance that may be used to monitor progress and target further tuition and thus be a useful adjunct to current systems of evaluation.

Further research on the practical implementation of this method is required, including its potential to evaluate live surgery. Motion analysis, using a different technology, has been successfully applied to corneal suturing under the microscope.\(^6\) It is encouraging that this form of motion tracking technology, which to our knowledge has not been used for surgical evaluation previously and is more sensitive than other similar tools, was successfully adapted to oculoplastic surgery. You can escape bad teaching but not bad assessment. Good assessment procedures are fundamental for promotion, certification, and licensure. No single method can comprehensively assess the surgical skills of residents in training. Our results offer encouragement that as further research takes place in this field, motion analysis will prove to be a useful modality in accomplishing the current goal of more objective surgical evaluation.

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