Objective Assessment of Dental Anatomy
Using Surface Scanning Technology and 3D Image Analysis

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Background & Rationale

- Dental students traditionally learn dental anatomy by making teeth out of wax to match human dentition on a plastic typodont.
- Student wax-ups are graded visually by trained dental school faculty.
- Dental students sometimes receive different feedback on the same project depending on the time and person grading.
- This traditional evaluation of wax-ups is time consuming, labor intensive, and subjective.

Rationale: New technology and research using intra-oral scanners provides an objective method for evaluation.

Methods

Goal of Study: Design a useful protocol for virtual evaluation and objective grading of student dental anatomy projects.

Hypothesis: Virtual evaluation provides more accurate and precise grading results than traditional visual grading.

Approach:
1. Scan ideal reference model and scan student wax-up (figure 4).
2. Import .STL models into CloudCompare software (figure 5).
3. Align models and measure differences between them (figure 6).
4. Grade the wax-up projects traditionally and virtually (figures 2 & 7).

Results

Intra-rater Reliability (Precision):

<table>
<thead>
<tr>
<th>Grader</th>
<th>Change</th>
<th>t-test p-value</th>
<th>Significant Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>-0.05%</td>
<td>0.45577</td>
<td>NA</td>
</tr>
<tr>
<td>102</td>
<td>0.56%</td>
<td>0.30365</td>
<td>no</td>
</tr>
<tr>
<td>103</td>
<td>-4.65%</td>
<td>0.00328</td>
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</tr>
<tr>
<td>104</td>
<td>3.17%</td>
<td>0.00194</td>
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</tr>
<tr>
<td>105</td>
<td>-1.53%</td>
<td>0.04009</td>
<td>yes</td>
</tr>
</tbody>
</table>

Inter-rater Reliability (Accuracy):

- Faculty Graders Intraclass Correlation Coefficient (ICC) = 0.332 (poor)
- Digital Graders Intraclass Correlation Coefficient (ICC) = 0.866 (excellent)

Conclusions

- Traditional visual inspection lacks precision.
- Virtual evaluation is more accurate than traditional visual grading.
- Virtual evaluation is faster, less labor intensive, and more objective than visual grading.
- New CloudCompare technique facilitates student self-assessment, enhanced teaching tools for faculty, and an improved protocol for grading dental anatomy projects.

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