Title: Repeatability and Reproducibility: A Study to Analyze the Precision of Assessing Tooth Preparations

Authors:
Kimberly Deranek, Assistant Professor, Nova Southeastern University, H. Wayne Huizenga College of Business and Entrepreneurship, kderanek@nova.edu, 954-262-5151
Steve Kramer, Associate Professor, Nova Southeastern University, H. Wayne Huizenga College of Business and Entrepreneurship, steve.kramer@nova.edu, 954-262-5002
Sharon Siegel, Professor and Chair, Nova Southeastern University College of Dental Medicine, scsiegel@nova.edu, 954-262-7379

Abstract:
Key components of tooth preparation for indirect dental restorations (crowns) include adequate tooth reduction and smooth surface finish. Tooth preparations have been traditionally assessed and grades awarded through visual inspection, and the judgement and expertise of faculty. Because of subjectivity and potential inconsistencies, faculty utilize tools to calibrate the scoring process whenever possible. This becomes important as National Board Dental Examinations are considering using CAD/CAM (computer-assisted design and computer-assisted manufacturing) scanners and software for assessing indirect restoration preparations for licensure. The purpose of this research is to assess the intra-observer repeatability and the inter-observer reproducibility quality outcome measures for tooth preparations to evaluate scoring process consistency.

Material and Methods: Onlay and crown preparations were scored across six dimensions: occlusal reduction, anatomic form, finish line, axial reduction/internal box form, path of draw, and preparation finish using a standardized scoring rubric. Quality outcome standards associated with a (double blind) sample of 50 teeth produced by third-year dental students as part of a CAD/CAM course were assessed and grades assigned (for each dimension per tooth, three times each, randomly sequenced) by two faculty members. Preparation depth (axial reduction) was evaluated using standardized depth dimensions (2 mm) with a periodontal probe and rounded angles were assessed using an explorer. A standardized depth gauge was used to measure occlusal clearance/reduction (2mm functional cusp (fc), 1.5mm non-fc). An ordinal measurement system was used to evaluate each tooth with a letter grade (A through F). Statistical analysis was done using Kendall’s Coefficient of Concordance (W) ranging from 0 to 1. A coefficient value of 1 indicates perfect agreement while a coefficient of 0 indicates the agreement is random.

Results: Research revealed a significant difference in evaluator repeatability and reproducibility levels across dimensions. Faculty members’ intra-observer repeatability was highest for repeated measurement of occlusal reduction, axial reduction, and finish of prep, though in all instances measures could only be classified as marginally acceptable (W=0.7 to <0.9). Measures in the other three categories were deemed unacceptable (W<0.7). Reproducibility was found to be generally weaker than repeatability across dimensions. Reproducibility measures were deemed marginally acceptable in one dimension (W=0.7 to <0.9) and unacceptable (W<0.7) across the remaining five dimensions.

Conclusion: Despite the expertise and diligence of the faculty members, the study revealed a significant level of inconsistency associated with visual grading tooth preparations using a grading rubric even with calibrated tools. Our findings yield important details of grading variance associated with the grading dimensions both within and between evaluators. The results suggest that visual inspection as a grade measurement system is insufficient for assessing student tooth preparations and that a more objective measuring system through the use of CAD/CAM preparation scanning may be more repeatable and reproducible. Further research is needed.