DIMENSIONAL ACCURACY OF DIGITAL MODELS OBTAINED BY DIRECT IMPRESSION SCANNING AND GYPSUM MODEL DIGITIZATION

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Abstract

The rapid integration of CAD/CAM technologies into prosthetic dentistry has significantly transformed clinical and laboratory workflows. One of the most debated issues in digital prosthodontics is whether direct scanning of dental impressions can provide dimensional accuracy comparable to traditional gypsum model digitization, which is still considered the reference standard for high-precision restorations.

Keywords: digital dentistry, impression scanning, CAD/CAM, A-silicone, gypsum models, laser scanning, dimensional accuracy.

Objective:

The aim of this study was to perform a comparative evaluation of the dimensional accuracy of digital models obtained through three different digitization approaches: direct laser scanning of A-silicone impressions, and indirect scanning of Type IV and Type V gypsum models routinely used in fixed prosthetic dentistry. The study sought to determine whether direct impression scanning can provide accuracy comparable to conventional gypsum-based digitization for high-precision prosthetic applications.

Materials and Methods:

Standardized one-step, double-layer impressions were fabricated using addition-cured silicone materials (Hydrorise Putty and Hydrorise Light, Zhermack, Italy) under controlled laboratory conditions to minimize operator-dependent variability. A calibrated

Johanssen gauge block with a certified reference distance of 7.000 mm served as the master experimental model, ensuring high metrological reliability.

Digitalization was carried out using a Zirkonzahn S600 laser scanner. For direct scanning of A-silicone impressions, an anti-glare scanning spray was applied to reduce surface reflectivity and improve optical data acquisition. In contrast, gypsum models cast from the impressions using Type IV (Elite Rock) and Type V (Elite Master) dental stones were scanned without any surface pretreatment.

Each digital model was scanned multiple times, and linear measurements were performed repeatedly to assess reproducibility. Dimensional deviations from the reference value were calculated, and the obtained data were analyzed using variational statistical methods to determine mean values, standard deviations, and accuracy trends among the tested groups.

Results:

Digital models derived from Type IV gypsum exhibited the highest dimensional accuracy, with a mean measured distance of 6.916 ± 0.015 mm. Type V gypsum models demonstrated slightly lower accuracy (6.890 ± 0.019 mm), although still within clinically acceptable limits for fixed prosthodontic procedures.

The greatest dimensional deviation was observed in digital models obtained by direct scanning of A-silicone impressions (6.885 ± 0.012 mm). These inaccuracies were primarily attributed to optical limitations related to the elastic and reflective surface properties of the impression material, as well as potential thickness variability and uneven distribution of the anti-glare spray layer. Despite these deviations, the reproducibility of measurements within each group remained relatively high.

Conclusion: While direct laser scanning of dental impressions offers notable advantages in terms of workflow simplification, time efficiency, and elimination of intermediate laboratory steps, the present findings indicate that gypsum-based

digitization—particularly using Type IV super-gypsum—continues to provide superior dimensional accuracy for precision-dependent fixed prosthetic restorations. At the current stage of technological development, indirect scanning of gypsum models remains the gold standard for high-accuracy digital prosthodontics. Future advancements in impression material formulations and optical scanning technologies may enhance the reliability of direct impression digitization and facilitate a fully digital prosthetic workflow.

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