INFLUENCE OF IMPRESSION MATERIAL AND SCANNING METHOD ON THE ACCURACY OF CAD/CAM DENTAL MODELS

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Abstract

Accuracy of digital dental models is a critical determinant of marginal fit, occlusal precision, and long-term success of fixed prosthetic restorations. Both the physical properties of impression materials and the optical characteristics of scanning methods play a decisive role in the fidelity of CAD/CAM-generated models.

Keywords: CAD/CAM dentistry, digital impressions, scanning accuracy, prosthetic workflow, dental materials.

Objective

This study aimed to evaluate the influence of impression material properties and scanning methodology on the dimensional accuracy of digital models used in contemporary prosthetic dentistry. Special attention was given to determining whether direct scanning of elastomeric impressions can achieve accuracy comparable to that of **digitally scanned gypsum models in precision-oriented CAD/CAM workflows.**

Materials and Methods

A standardized in vitro experimental design was implemented using a calibrated Johanssen gauge block with a certified reference distance of 7.000 mm. Digital models were generated through three distinct digitization pathways: (1) direct laser scanning of A-silicone impressions, (2) scanning of Type IV super-gypsum models, and (3) scanning of Type V resin-reinforced gypsum models obtained from the same impressions.

Prior to experimental measurements, the intrinsic accuracy of the laser scanner was verified using reference standards to exclude systemic measurement bias. Each specimen was scanned multiple times under identical conditions, and linear measurements were repeated to assess precision and reproducibility. The resulting dimensional deviations were statistically processed to calculate mean values, standard deviations, and consistency of measurements across the different material–scanning combinations.

Results

Preliminary validation confirmed a mean intrinsic scanner error of 8 μm, indicating high methodological reliability and negligible instrumental influence on the results. Among the tested groups, digital models derived from Type IV super-gypsum exhibited the highest dimensional fidelity to the reference distance.

Direct laser scanning of A-silicone impressions consistently resulted in underestimation of the true dimension, reflecting systematic deviations associated with the optical properties of elastomeric materials. Type V resin-reinforced gypsum models demonstrated intermediate accuracy, which may be attributed to resin modification influencing setting expansion and microstructural uniformity.

Discussion

Direct impression scanning offers clear advantages in terms of workflow simplification, reduced clinical and laboratory stages, and time efficiency. However, its current accuracy remains limited by the reflective and elastic nature of A-silicone materials, as well as by the necessity for surface opacification using scanning sprays, which may introduce an additional source of dimensional error.

In contrast, gypsum models—particularly Type IV super-gypsum—provide a matte, optically stable surface and exhibit predictable dimensional behavior after setting. These characteristics make gypsum casts more compatible with existing laser scanning

technologies, thereby ensuring higher reliability in precision-demanding prosthetic applications.

Conclusion

The dimensional accuracy of CAD/CAM-based dental models is strongly influenced by both the properties of the impression material and the chosen scanning strategy. While direct scanning of impressions represents a promising step toward fully digital prosthetic workflows, current technological limitations restrict its precision. Until non-reflective impression materials or more advanced optical scanning systems become widely available, indirect digitization via scanning of gypsum models—particularly Type IV super-gypsum—should be regarded as the method of choice for high-accuracy prosthetic restorations..

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