A Hybrid Dental Model Concept Utilizing Fused Deposition Modeling and Digital Light Processing 3D Printing

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Three-dimensional (3D) printing is a leading technique in digital dentistry. Crowns and partial dentures, surgical guides, and dentures are now being produced through 3D printing.1 This printing technology not only shortens the fabrication time for dental restorations, but also improves the quality. There are many methods of 3D printing. Among them, digital light processing (DLP) printing is widely used in dental prosthesis fabrication and has proved to be an accurate and economical technique.2

However, DLP printers produce shrinkage depending on the material and polymerization method.2 The error increases as the size of the printout varies.3 Although the accuracy of single-crown or three-unit crown and partial denture prostheses has been reportedly good,4 when making full-arch dental models, dental casts with a low overlap rate with the origin file have sometimes been found.

To overcome this problem, a technique combining the use of DLP and fused deposition modeling (FDM) 3D printing is proposed. Owing to material characteristics, FDM accuracy of the full-arch dental model is supposed to be higher than that of DLP; however, due to the surface roughness of the FDM method, the crown preparation’s die for the dental prosthesis is sometimes not accurate. Therefore, a new hybrid dental model that combines FDM (for the full dental model) and DLP (for the specific die) is proposed.

TECHNIQUE

A crown-only preparation die was designed using dental computer-aided design (CAD) software (DentalCAD, exocad) (Fig 1). Subsequently, the die was separated from the whole model with an Exocad model builder. The diameter of the die was set...
The new hybrid dental model combined with the die and the whole model printed using DLP were evaluated for accuracy using the root mean square (RMS) value based on superimposition with a matching software (Geomagic Control X 2017, 3D Systems) (Fig 3). The formula for calculating the RMS value was as follows:

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RMS = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (O_i - C_i)^2}
\]

\(O_i\) denotes the data point of the original model, \(C_i\) the data point of the compared model, and \(n\) the number of all measuring points.

The RMS values were compared between the two groups (\(n = 10\)) of dental models using a statistical analysis program (SPSS statistics 23, IBM). The mean ± standard deviation values were 56.09 ± 0.011 µm and 75.82 ± 0.004 µm for the hybrid and DLP models, respectively. In the one-way analysis of variance, the hybrid model showed a significantly higher accuracy (\(P < .001\)).

RESULTS/DISCUSSION

This paper introduced a hybrid dental model made using FDM and DLP 3D printing. Currently, many dentists use oral scanners to transfer oral information to an STL file and send it to the laboratory. Although technicians can fabricate a dental prosthesis without using dental models, a dental model output is essential to check for correct occlusion and to fabricate complicated prostheses. Therefore, the demand for accurate dental models will continue to increase in the future.

This hybrid model requires two different printers and their calibration to achieve the desired results. However, the present authors hope that this concept of printing dental models will be widely used in the future to fabricate more accurate dental models.
CONCLUSIONS

In this technique, a new hybrid dental model using FDM and DLP 3D printing for full-arch tooth models was introduced. This technique would enable more precise dental prosthesis fabrication and verification.

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REFERENCES


Discrepancy Between Patient Satisfaction and Biologic Complication Rate in Patients Rehabilitated with Overdentures and Not Participating in a Structured Maintenance Program After 7 to 12 Years of Loading

There is a lack of studies reporting the long-term prevalence of peri-implant diseases in patients rehabilitated with overdentures and not receiving maintenance, which is a common situation. The aim of this cross-sectional study was to evaluate the patient satisfaction and rate of biologic complications in patients rehabilitated at least 7 years prior with mandibular/maxillary overdentures, who, for personal or economic reasons, decided not to participate in a structured supportive maintenance program. Each of the patients filled out a health and dental history and a visual analog scale (VAS)–based satisfaction questionnaire. Additionally, the patients received a clinical examination and panoramic radiograph. The prevalence of peri-implant diseases and the patient satisfaction were reported. Moreover, presumed risk indicators of peri-implant diseases and implant loss were tested through univariate analyses and multivariate, time-adjusted logistic regression. A total of 52 patients who received 63 overdentures on 252 implants were included. The included patients showed a high degree of satisfaction (mean VAS = 6.3; standard deviation [SD] = 2.1) and very low discomfort rates and reported that they would repeat the type of rehabilitation (mean VAS = 6.99; SD = 2.6). The prevalence of peri-implantitis was 30.8% at the patient level and 19.4% at the implant level, while 23.1% of patients experienced implant loss at any time. A clear tendency toward an increased prevalence of biologic complications after the eighth year of loading was noted. In the time-adjusted regression analyses, bone-level implants were associated with a higher prevalence of recession with no/minimal inflammation (OR = 3.37; 95% CI = 1.16 to 9.77; \(P = .025\)), while the maxillary arch was associated with both severe peri-implantitis (OR = 4.18; 95% CI = 1.03 to 16.97; \(P = .046\)) and implant loss (OR = 9.27; 95% CI = 3.41 to 25.14; \(P = .000\)). Despite high levels of satisfaction, patients rehabilitated with overdentures not participating in a structured support program showed high rates of biologic complications. For this reason, they should be strongly motivated at the time of prosthesis delivery to participate in a structured maintenance program.