A NOVEL WORKFLOW TO PRINT POLYOXYMETHYLENE DENTURE BASE

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Abstract

The advanced dentistry emphasis on the utilization of cutting-edge materials and manufacturing techniques. Recently, Polyoxymethylene (POM)- a thermoplastic polymerwas investigated as a potential material for denture base. It has exceptional mechanical, chemical, and biocompatibility qualities. Though the material is highly evaluated in literature it is used less in clinical dentistry and fewer clinical reports are available. This material was tried as interim prosthesis for a preliminary report. This pilot report details on a novel technique of fused deposition modelling in fabricating a maxillary denture with a POM denture base. It has significant advantages over other standard materials and technique. This process of creating prostheses with 3D printing is quick, effective, and offers a variety of customizing choices.

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1. Introduction

The use of a single complete denture in opposition natural teeth, fixed dental prosthesis, or any removable prosthesis is the most frequent clinical circumstances.[1]Polymethylmethacrylate (PMMA) has been widely used dentalprosthetic material. But its poor mechanical propertieshigher functional andestheticrequirements demand to explorefor newer materials,techniquesfor fabrication of prosthesis.[2-5] Many materials, novel scanning, printing and milling technique were proposed in literature for prosthetic fabrication but it had inherent limitations.[6 -10]The research foridealistic denture materials for the present needs especially for the complex clinical situations like single complete denture persisted. Among the various contemporary materials and techniques advocated, polyoxymethylene (POM) displayed favorable properties to be used as denture base materials.[11-14] POM is a thermoplastic polymer that has superior biocompatibility, better chemical resistance, and desired mechanical qualities.POM dentures can be fabricated through subtractive manufacturing, additive manufacturing, or injection molding. and its properties were superior with additive manufacturing processes. Though the POM displayed significant properties in literature clinically it was less used in the denture fabrication. Hence this clinical report was planned to fabricate the denture base with POM using fused deposition modeling (FDM).

Clinical Report

A 60-year-old female patient missing teeth in her upper arch and lower back teeth, was referred to the Department of Prosthodontics, SRM Dental College, Chennai. The patient desired to replace her old maxillary denture. A thorough case history was obtained, compiled and recorded. The patient was moderately built, appeared aware, and had no pertinent medical history. The dental history revealed the use of a single complete maxillary denture and aninterim removable partial denture in the mandibular arch. The maxillary denture had lost its stability, retention and exhibited a denture fracture in the right side's tuberosity region.

On intraoral examination it was found that the patient had a completely edentulous maxilla and partially edentulous mandible. The mandibular teeth from45-35 were presented with grade 1 mobility. Tooth 44 displayed loss of crown structure, and carious lesions were observed on teeth 32, 33, and 34. Furthermore,generalized recession and calculus were observed (Figure 1). There were no gross abnormalities found.

A comprehensive treatment approach from oral hygiene measures, restoration and management of edentulous spaces was discussed with the patient. On patient insistence for a less invasive and interim treatment,a single complete denture with a polyoxymethylene denture base for the maxillary arch was decided.The patient was educated and informed about the newer material, use and care of the POM single complete denture. The patient's consent was obtained and the POM denture was fabricated for interim use.

Procedure

The initial procedure of POM maxillary denture fabrication was similar to conventional procedure except the variations in digital workflow.[15-18] The primary impression was made with alginate and type 2 gypsum primary cast was obtained. The custom trays were fabricated, sectional border molding was done and secondary impression was made with monophasic impression material. Definitive cast was made with type 3 gypsum material. The obtained master cast wasscanned using a Dentsply Sirona inEOSX5 lab scanner. (Figure 2) The resulting digital model was analyzed and refined withthe software. The framework design was created using the InLab software of Dentsply Sirona. The model's axis was set and aligned, and the path of insertion was determined. (Figure 3)The cast block-out was achievedthrough the software (Figure 4), and the framework was designed.(Figure 5)The file was saved and transferred for further processing. The file was imported into a slicer software (PRUSA Slicer), where additional structures, such as struts and building supports, were attached.Additionally, the printing speed and temperature were programed. Printing the framework was made through Fused Deposition Modeling printerover a wooden printing bed. The printed framework was retrieved, trimmed, finished, and polished (Figure 6). The framework was verified for fitand adjustments were made as necessary.Conventional maxillomandibular relationship records, try in procedures were followed. (Figure 7). Thetry-in denture was waxed-up and processed by conventional technique. The processed denture was trimmed, finished,polished and inserted (Figure 8-10). The patientwas called for a periodicreview.

2. Discussion

The clinical report demonstrates a unique fused deposition modelling technique for creating a POM denture base (FDM). In comparison to standard materials and processes, this approach has a number of benefits. The POM material employed in this

report has good mechanical, biocompatibility properties and ideal to fabricate denture bases.[11,12] The use of 3D printing technology in dentistry has increased in recent years.Numerous studies evaluated various materials and techniques.[13,14] The additive manufacturing process of FDM in this report involves layering the material in a specified pattern. This method has a number of advantages, including the capacity to swiftly make custom-fit dentures, reduce material wastage, and produce complex designs with great accuracy.[15,16]

The high rigidity and strength are major advantages of POM. It can be used in clinical situations of higher occlusal load or in the requirement of more retention and stability. The low water absorption and strong chemical resistance make it less prone to discoloration and stains and increases the denture durability.[11]The POM denture base was made using a digital approach.[17]It resulted in higher precision and accuracy. Digital technology allows customization and reduces production time.[18] This clinical report adapted digital technology that involves digitally designing, and fabricating using 3D printer.

POM is relatively a newer material and it is less studied clinically. Case series and more clinical studies are required to determine the effectiveness of using POM in denture base manufacturing and to compare it with other materials and techniques. In addition, the long-term durability of POM prostheses must be evaluated to replace the conventional denture base materials.

3. Conclusion

This case report highlights a novel workflow for the fabrication of a POM denture base using FDM technique. The printing approach provides a rapid and efficient method for fabricating denture with POM. It offers superior precision and customization options. Additionally, it improves treatment efficacy, patient outcomes and quality of life.

Legend

Figure 1 preoperative
Figure 2 Scanned cast
Figure 3 Axis alignment
Figure 4 Cast block-out
Figure 5 Framework design
Figure 6 POM printed denture base
Figure 7 Denture try-in with POM denture base
Figure 8 Processed denture
Figure 9 Post-operative Intra oral view
Figure 10. Post-operative – Extra oral view

4. References

Vrinda G, Preeti SK. Single complete maxillary denture with metal denture base - a case report. Int. J. of Adv. Res.2019; **7**:1632-1636.

Meenakshi A, Meena N S, Bharti V, Suganthapriya S. Special dentures. SRM J Res Dent Sci 2017;8:126-31.

Srinivasan M, Kamnoedboon P, McKenna G, Angst L, Schimmel M, Özcan M, Müller F. CAD-CAM removable complete dentures: A systematic review and meta-analysis of trueness of fit, biocompatibility, mechanical properties, surface characteristics, color stability, time-cost analysis, clinical and patient-reported outcomes. J Dent. 2021 Oct;113:103777.

Muthuvignesh N, Jei JB, Balasubramaniam MK. Materialistic meets realistic on denture Characterization – A Case Report. Arch Pharm Pract. 2022;13(3):1-4.

Joseph S, Thomas S, Mathew S, Cherackal GJ, George AK. Characterization of complete denture - 11 Case reports. SRM J Res Dent Sci 2015;6:60-4.

Abhijeet K, Mody E, Jei JB, et al. Mobile phone assisted 3D extra oral scanner for acquiring dental digital models - an innovative approach. J Evolution Med Dent Sci 2021;10(23):1815-1818.

Vasudevan K. Stereolithographic apparatus(SLA) 3D Printer: An Innovative approach towards the future of Prosthodontics. J Indian Prosthodont Soc. 2020 Dec;20(Suppl 1):S8.

Koppolu SK, Manoharan P S. Shifting focus from subtractive to additive technology in digital prosthodontics. SRM J Res Dent Sci 2022;13:74-5.

Palanivel J, D. David, Srinivasan D, et al. Artificial intelligence - creating the future in orthodontics - a review. J Evolution Med Dent Sci 2021;10(28):2108-2113.

Tyagi R, Kalra N, Khatri A, Kulood M K, Garg N. Three-dimensional printing: Fine-tuning of the face of pediatric dentistry. SRM J Res Dent Sci 2022;13:25-31.

Schierz O, Schmohl L, Hahnel S, Rauch A. Polyoxymethylene as material for removable partial dentures—A literature review and illustrating case report. J Clin Med 2021, 10, 1458.

Turner JW, Radford DR, Sherriff M. Flexural properties and surface finishing of acetal resin denture clasps. J Prosthodont 1999;8:188–195.

Chung YJ, Park JM, Kim TH, Ahn JS, Cha HS, Lee JH. 3D Printing of Resin Material for Denture Artificial Teeth: Chipping and Indirect Tensile

Fracture Resistance. Materials (Basel). 2018 Sep 21;11(10):1798.

Kim T.H., Varjao F. 3D printed complete dentures. *Quintessence Dent. Technol.* 2016;39:141–149.

Tian Y, Chen C, Xu X, Wang J, Hou X, Li K, Lu X, Shi H, Lee ES, Jiang HB. A Review of 3D Printing in Dentistry: Technologies, Affecting Factors, and Applications. Scanning. 2021 Jul 17;2021:9950131.

Barazanchi A., Li K. C., Al-Amleh B., Lyons K., Waddell J. N. Additive technology: update on current materials and applications in dentistry. *Journal of Prosthodontics.* 2017;26(2):156–163.

Wagner SA, Kreyer R. Digitally Fabricated Removable Complete Denture Clinical Workflows using Additive Manufacturing Techniques. J Prosthodont. 2021 May;30(S2):133-138.

Goodacre BJ, Goodacre CJ. Additive Manufacturing for Complete Denture Fabrication: A Narrative Review. J Prosthodont. 2022 Mar;31(S1):47-51.

Figure 1 preoperative

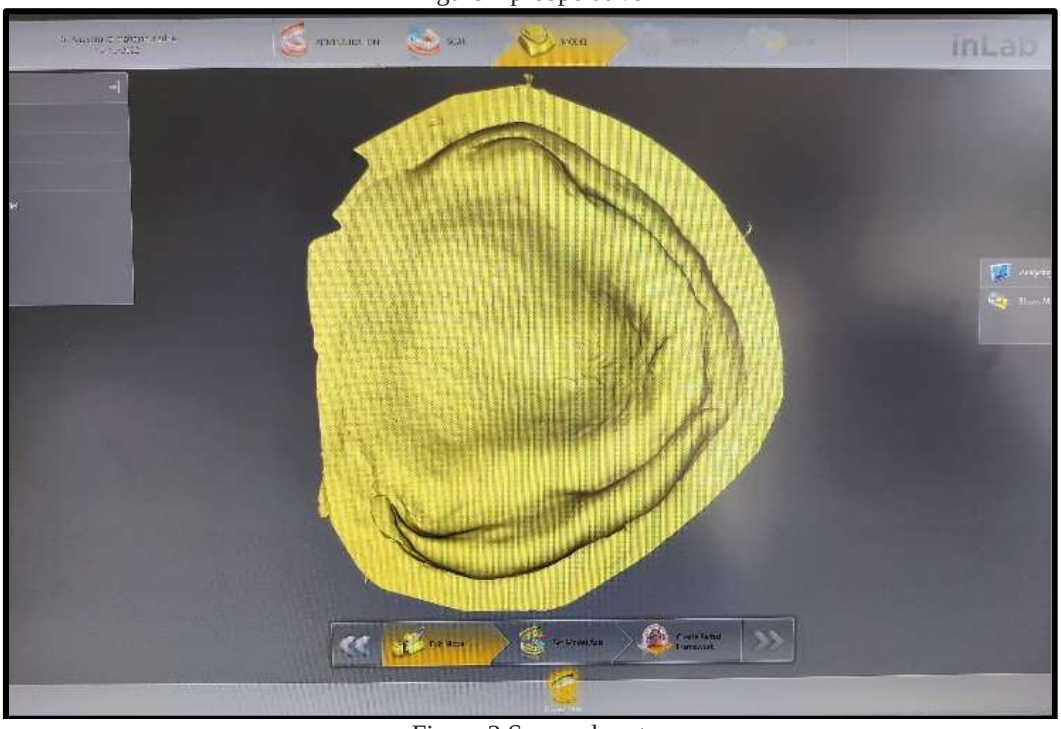

Figure 2 Scanned cast

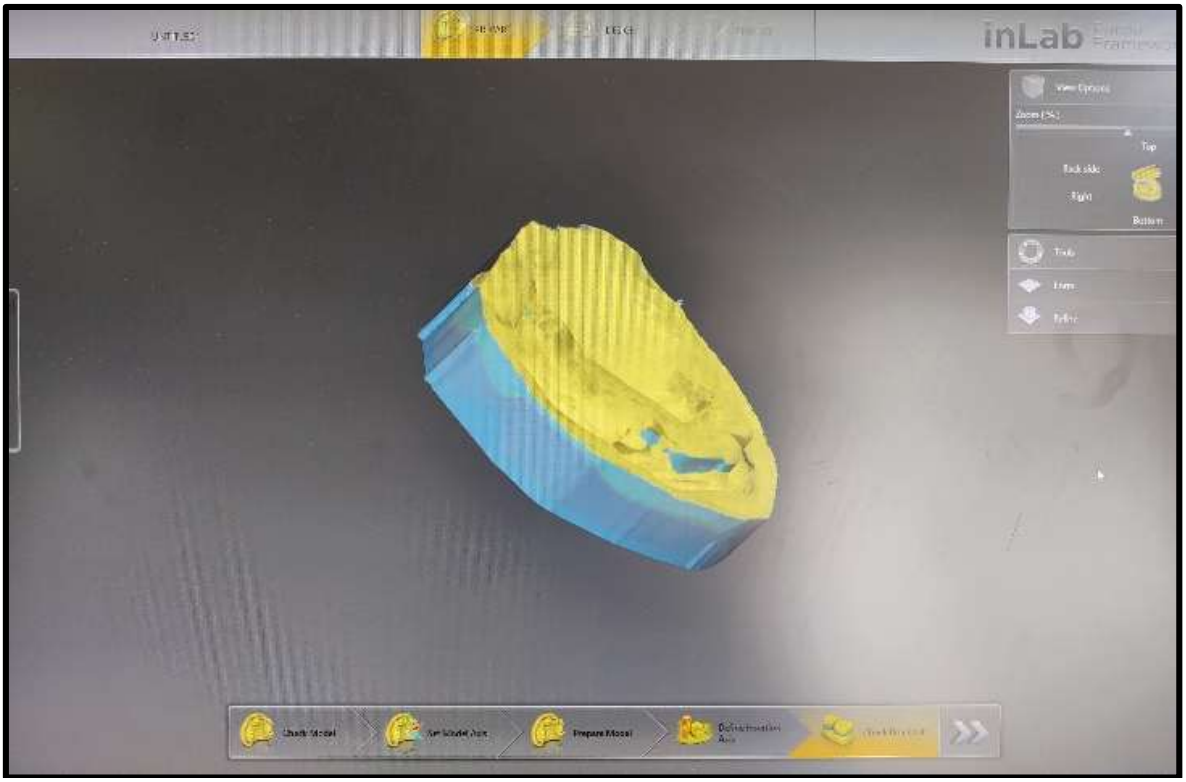

Figure 3Axis alignment

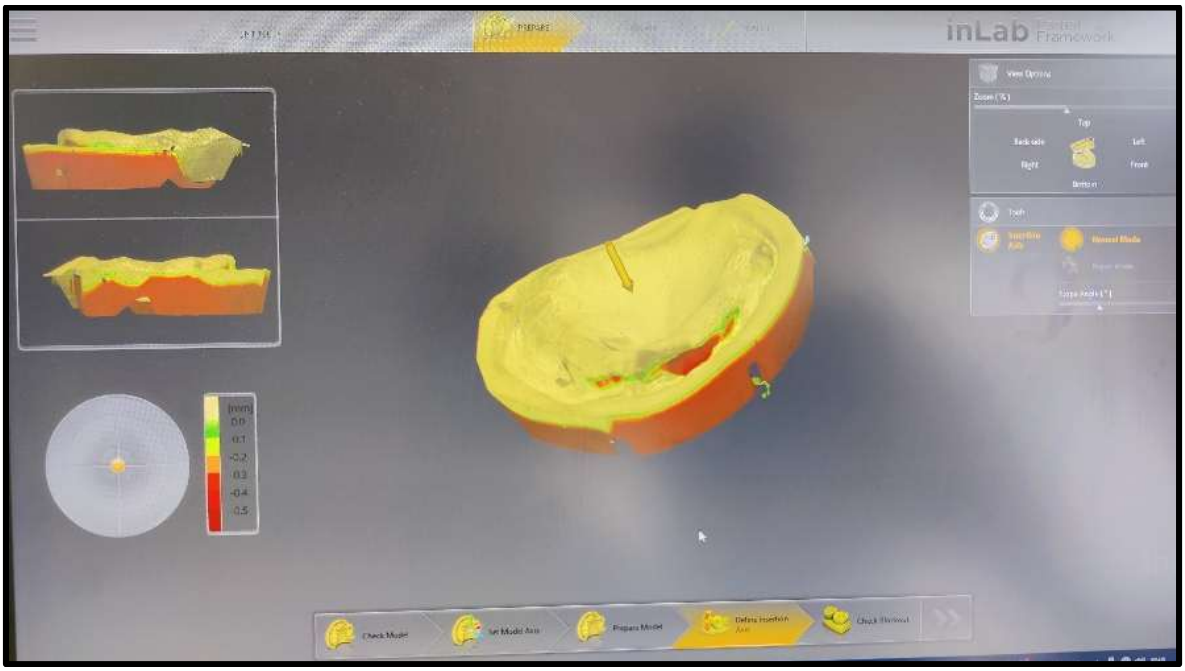

Figure 4 Cast block-out

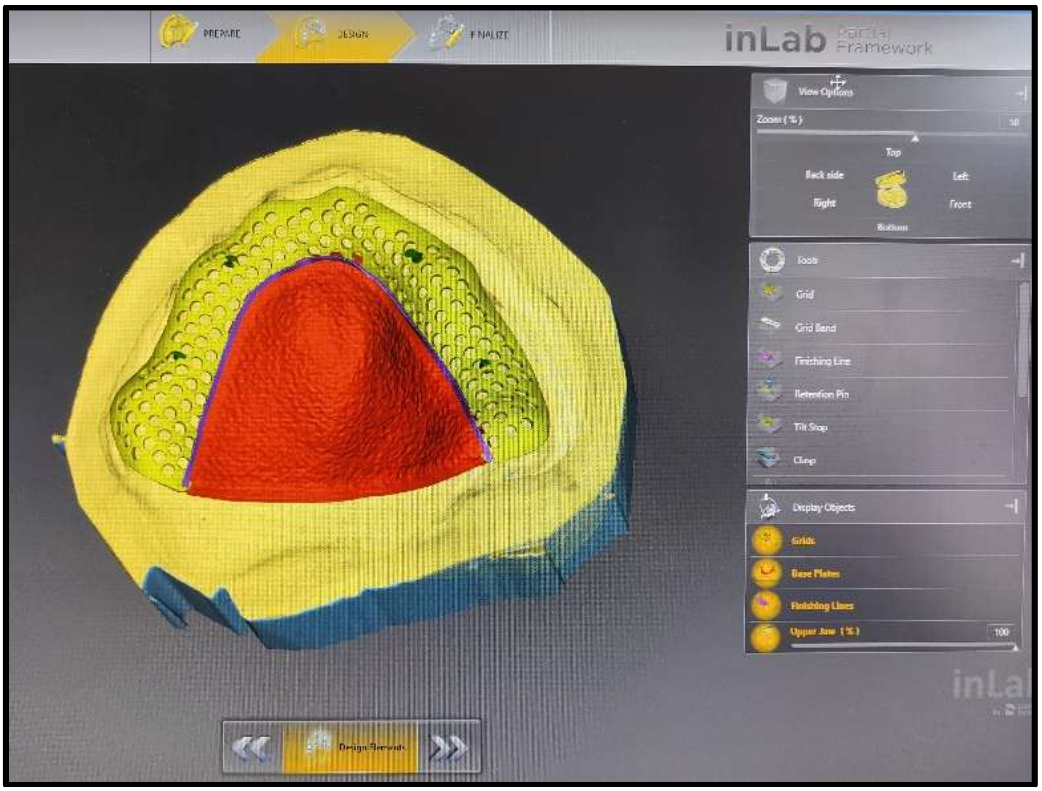

Figure 5 Framework design

Figure 6 POM printed denture base

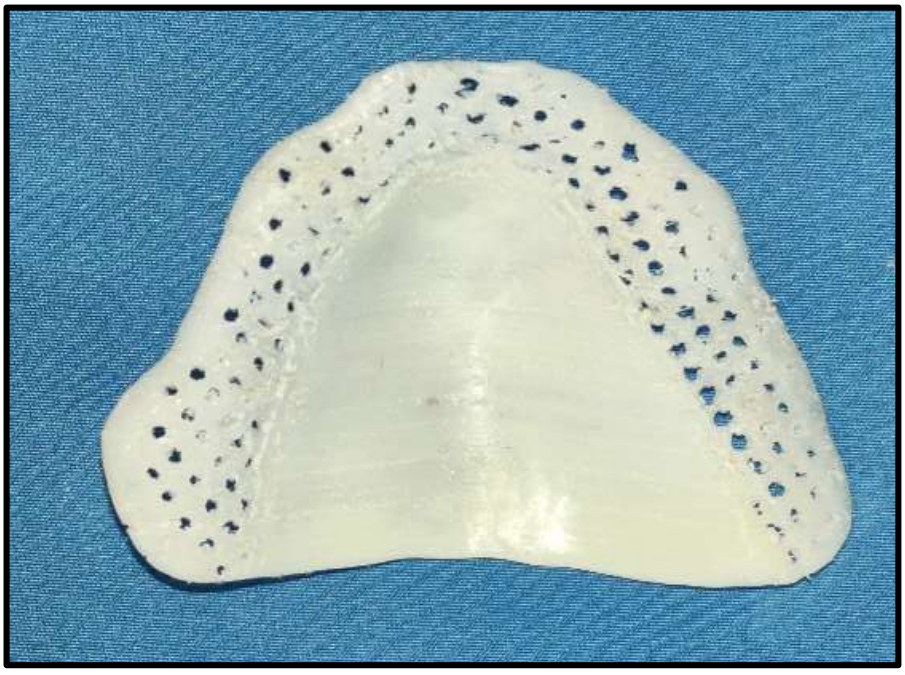

Figure 7 Denture try-in with POM denture base

Figure 8 Processed denture

Figure 9 Post-operative Intra oral view

Figure 10. Post-operative – Extra oral view