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Fusion deposited starch guides for dental implant placement

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1. Introduction

Surgeons' desire to perform accurate and less invasive procedures led to the discovery of computer aided surgical planning and guided surgeries.[1] With the invention of 3D printers, the virtual planning and simulations came to life in the form of prototypes.

The fusion deposition process is the additive manufacturing technique in which the simulated models could be printed in multiple layers made up of thermoplastic substances like poly lactic acid. Poly lactic acid (PLA) is a thermoplastic polymer derived from starch that is being used commonly for prototyping. It is formed by ring opening polymerization of lactide monomer.[2] Being a biodegradable material, PLA can be used widely for prototyping. In dentistry its use is limited due to the lack of accuracy when compared to photopolymer resins. We tried to create a fusion deposited surgical guide for implant placement made up of starch.

2. Case report

We selected a 22 year old male with missing lateral incisor (Fig. 1) in the first quadrant, who insisted prosthetic rehabilitation with dental implants. With his consent, we made CBCT images of the quadrant. Digital impression of the upper and lower arches were made and superimposed on to the 3D reconstructed CBCT images with the help of an implant planning software. Digital mock up of the missing tooth was performed over the superimposed impressions (Fig. 2).

3. Surgical guide designing and fabrication

After assessment of bone width from the CBCT, we placed a virtual implant of size 3.6 × 11 (Dentium™) from the digital library. Based on the planned position of the implant, a virtual guide tube of width 3.8 was inserted in the virtual planning (Fig. 3). The 3D model of the tooth supported guide was rendered and printed using a fusion deposited manufacturing machine (FDM 3D Printer ULTIMAKER 2™). Drilling with pilot drill needs more precision, so we planned to mill multiple PMMA based sleeves with multiple diameters. Three Poly methyl methacrylate based sleeves with diameters 2.1, 2.2 and 2.25 mm were made for pilot drill. We found that the sleeve with diameter 2.25 was having passive fit with the pilot drill. Customized metallic sleeves were made with cobalt chromium metal for next sequential drills (Fig. 4).

4. Procedure

Under local anesthesia, crestal incision was placed in relation to 12 region and full thickness flap was raised bucally and palatally 2 mm away from the incision to expose the underlying bone. Surgical guide with the sleeve for the pilot drill was placed and drilling was continued in sequential pattern by changing the sleeves till the use of final drill with the diameter of 3.6 mm (Fig. 5). Implant with the diameter of 3.6 and height of 11 mm was inserted with the torque of 35Ncm.Temporisation was done with a PMMA crown.

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Fig. 1. Frontal view of the patient showing missing 12.

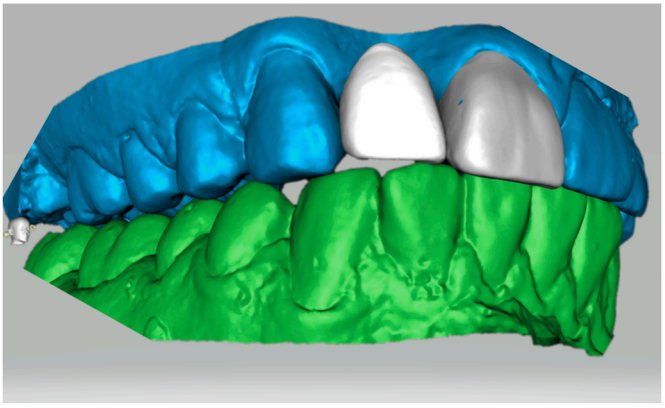

Fig. 2. Digital mock up of the missing tooth.

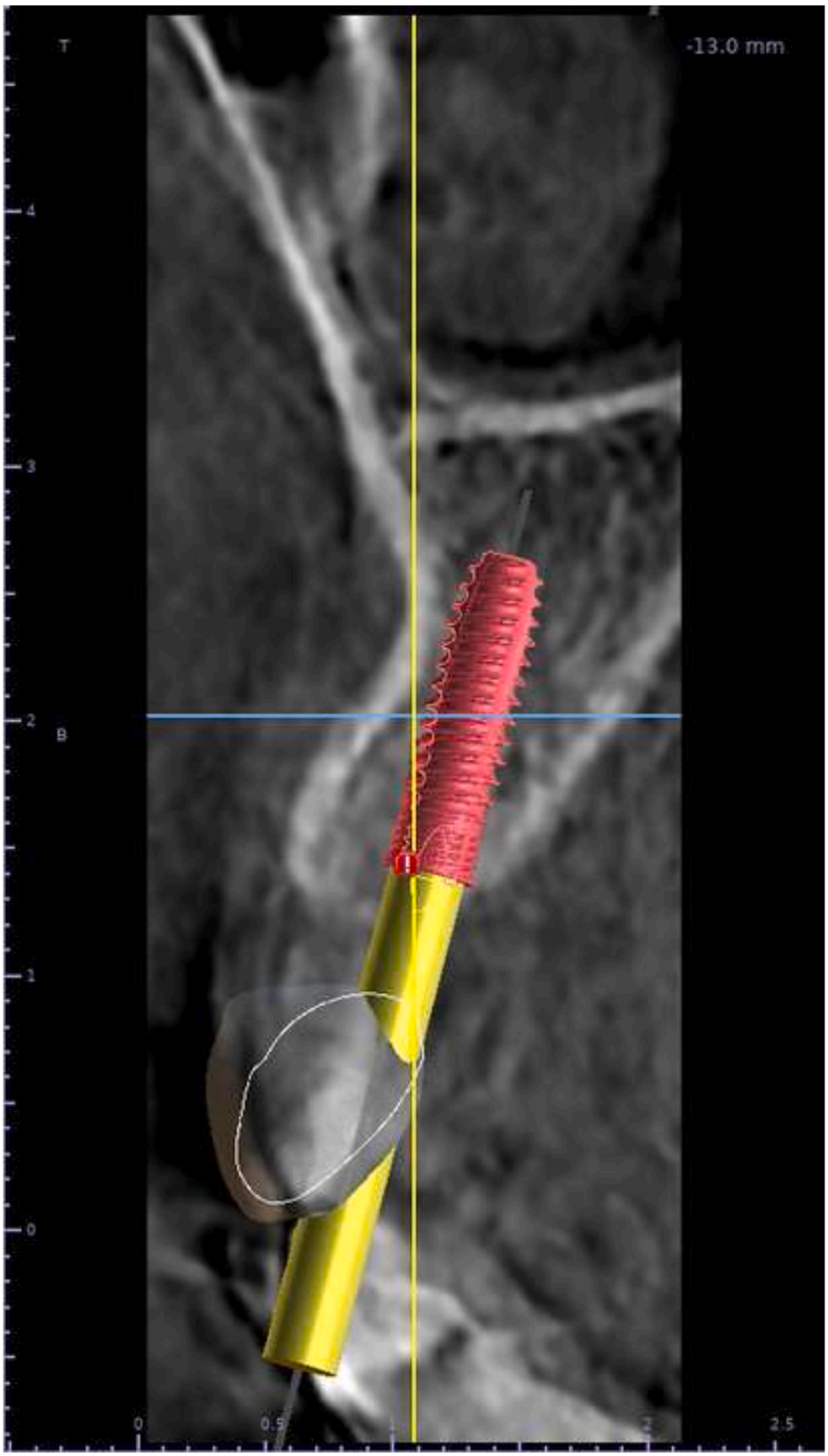

Fig. 3. Cross section of the virtual planning.

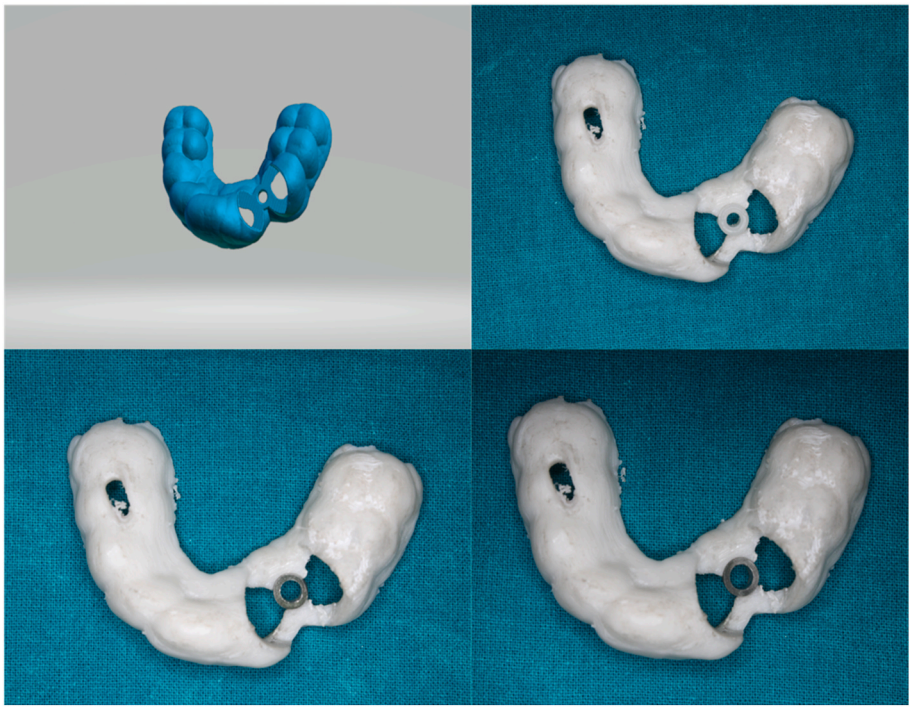

Fig. 4. Design and printed model of the guide with various sleeves.

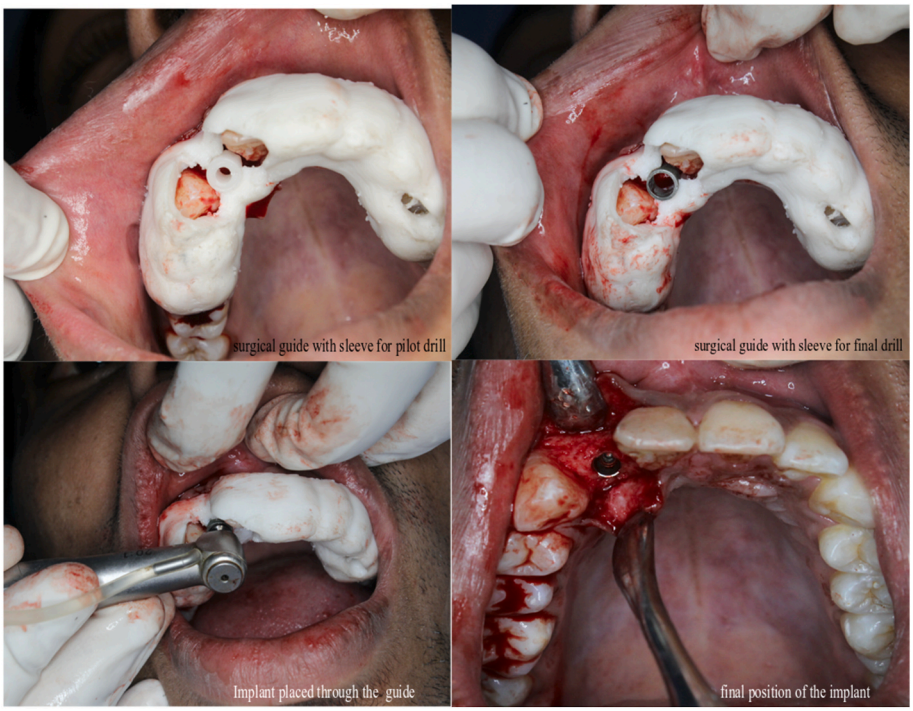

Fig. 5. Sequential Drilling and Implant placement through the guide.

5. Discussion

The concept of using PLA for surgical guides is not new. In 2007 David et al. used a block type guide made up of PLA for implant placement.[3] A recent in vitro study shows that accuracy of starch based guides are comparable with photopolymer guides.[4] Clinically most of the surgeons still prefer photopolymers due to higher precision and faster production. In the future non degradable resin based prints can be a threat to the environment. We can use the biodegradable starch filaments for prototyping to prevent the threat. As a small step, recently we made a locator guide with starch for surgical removal of an impacted maxillary premolar.[5]

6. Conclusion

PLA can be a best replacement for photopolymer resins. It is biodegradable and economical also.

Sources of finding

Nil.

Declaration of competing interest

Nil.

References

1 Marchack CB. CAD/CAM-guided implant surgery and fabrication of an immediately loaded prosthesis for a partially edentulous patient. *J Prosthet Dent*. 2007 Jun 1;97(6): 389–394.
2 Armentano I, Bitinis N, Fortunati E, et al. Multifunctional nanostructured PLA materials for packaging and tissue engineering. *Prog Polym Sci*. 2013;38:1720–1747.
3 David OT, Szuhanek C, Tuce RA, David AP, Leretter M. Polylactic acid 3D printed drill guide for dental implants using CBCT. *Rev. Chim.-Bucharest.* 2017 Feb 1;68:341–342.
4 Juneja M, Thakur N, Kumar D, Gupta A, Bajwa B, Jindal P. Accuracy in dental surgical guide fabrication using different 3-D printing techniques. *Addit Manuf*. 2018 Aug 1;22: 243–255.
5 Adersh GA, Kumar LS, Kurien NM, Tharakan M, Rahim SN. 3D printed locator guides"; Fusion deposited starch guides for surgical removal of impacted maxillary teeth. *Journal of Oral Biology and Craniofacial Research*. 2021 Apr 1;11(2):113–117.