# Polylactic Acid 3D Printed Drill Guide for Dental Implants Using CBCT

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*The aim of the present study is to describe a method for setting up a polylactic acid (PLA) 3D printed surgical guide for the minimally invasive insertion of dental implants using the CBCT (cone beam computed tomography) acquisition without occlusal contact and CAD – CAM (computer-aided design/ computer assisted manufacture) software for its design, production and testing.*

*Keywords: polylactic acid, CBCT, drill guide, flapless implant surgery, 3D printing*

Rapid 3D printing equipmenthas developed significantly during the last 20 years, [1]and PLA being a thermoplastic and biodegradable polymer which can be very well printed in 3D [2], it raises great interest in many fields, including medical applications[3]. Minimally invasive procedures for dental implant insertion [4], ororthodontic mini-implant placement[5, 6] using flapless implant surgery,have significantly simplified, thus accelerating the healing process and improving safety in terms of correct site implant insertion [7-11].

The novel aspects brought by the present study are: (i) the complete setup of the PLA guide, the 1.7 mm diameter holes which guide the pilot drill without using metal guiding tubes,(ii) its computer-aided design (CAD)with implant direction guidance bya)simulation in the CBCT software b) of occlusal surfaces of teeth delimitating the edentulous space, and c) surfaces of the same teeth facing the edentulous space, without the need of additional impression and (iii) 3D printing of the surgical guide and of the model upon which the guide is positioned in order to verify its accuracy by 3D CBCT scanning.

## Experimental part

*Materials and method*

The patient in the present study addressed a clinic in Timisoara for dental implant insertion to solve a right lateral maxillary edentation of 1st and 2nd molars as shown in the panoramic dental radiograph (fig 1, A). In order to check the palatinal-vestibular dimension of the bone, a 3D CBCT tomography was required. For visualising the occlusal surface of the teeth neighbouring the edentation, this imagistic examination was performed without occlusal contact [12, 13]. The thickness of the maxillary bone was measured in two sections: in the 1.6 molar area (fig 1, C) and in the 1.7 molar area (fig 1, D). Sufficient bone amount was found to allow the insertion of two 4 mm diameter and 10 mm length implants.

Informed consent of the patient was requested and obtained regarding the use of the radiographs for the present study. The simulation of implants in the respective areas (fig. 2 A, B, C), was performed using the Ez 3D Plus software. (Vatech, Korea). The simulated implants were elongated with 13 mm in order to exit the area of the maxillary bone, forming two cylinders (fig. 2 D, E, F).Upon implant simulation, three measurements were done: the distances between implants axis and the teeth delimitating the edentulous area and the distance between the two

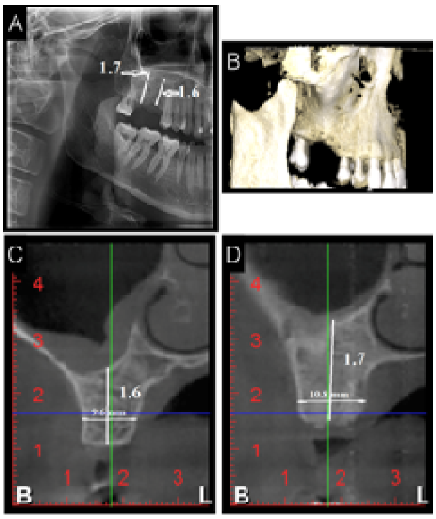


Fig 1. Panoramic dental radiograph(A), CBCT volumetric tomography in rendering view (B), 1.6 area transversal section (C), 1.7 area transversal section (D)

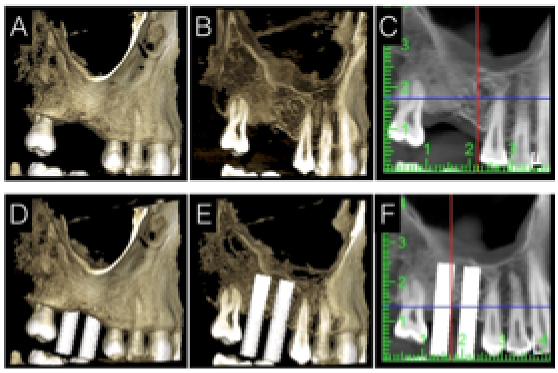


Fig 2. Rendering image of the volume before simulation (A, B) and after simulation (D, E).Multiplanar Reconstruction (MPR) image before and after simulation, respectively (C, F)

implants, which were parallel with one another (fig. 4 A).The inclination of the pilot drill which does the first hole for implant insertion will be taken over by the CAD software and it will coincide with the cylinder axis.

The 3D DICOM (Digital Imaging and Communications in Medicine) file obtained by CBCT scanning was exported using the same software in an STL(STereoLithography) filein order to achieve the CAD design (fig 3, A). The platform of programmes developed for this purpose included the following software: NetFabb (Autodesk, United States), SketchUp (Trimble, United States), FreeCad and Blender (Free and Open Source Software). With the aid of a Symme3D Multifunctional Delta Platform (Symme3D, Romania) type printer, the model( f ig 3, B),the

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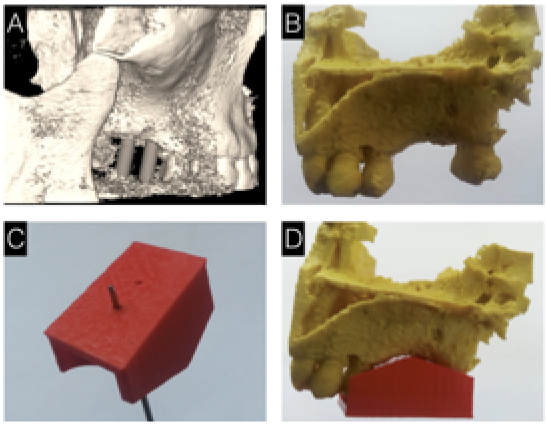


Fig 3. Photo STL file (A), Model(B), Surgical guide (C), Model plussurgical guide (D)

PLA(Symme3D, Romania) surgical guide ( fig 3, C) were printed. The guide was then placed over the model (fig 3, D).

## Results and discussions

In order to verify the guide placed over the model, it was scanned with a CBCT Paxi 3D tomograph (Vatech, Korea). A panoramic section of the acquired volume was performed (fig 4, B), identical with the one in which implants were simulated (fig 4, A). The measured distances were identical: 3.9 mm between the axis and teeth and 6.3 mmbetween implants.The results of these measurements show that the procedure we followed to produce the PLA surgical guide for dental implant insertion is precise with no dimensional deviation from implant simulation to the finalisation of the surgical guide.

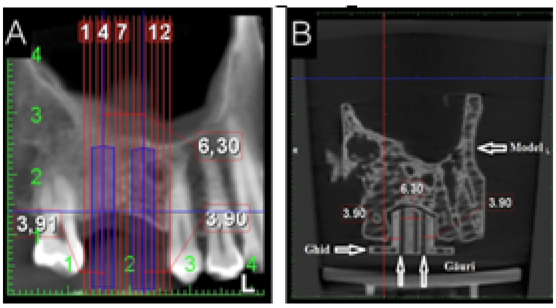


Fig 4. Panoramic section of implant simulation (A), Panoramic section of themodel plus surgical guide (B).

As shown in the study [8]surgical guides can also be produced in dental practices equipped with a 3D printer. We must state that great accent is set on opening the possibility to achieve such surgical guides with CAD-CAM and CBCTsoftware[14].By combining tridimensional scanning techniques with CAD-CAM software and 3D stereolithographic printing using thermoplastic material (TPM) surgical guides for dental implants can be printed even within a single session. [15].(TPM) are also used in the manufacture of other medical devices[16]. Deviations caused by CBCT image transfer to CAD-CAM software in our study are neglectable, this aspect being also shown in other studies.[17].

## Conclusions

Using the method described in the present study, PLA 3D printing for the production of dental implants insertion guides may offer both safety and predictability. Moreover, the devices created for clinicians aid their work and increase the quality of medical procedures.

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