Comparison of FDM and SLS printing of periodontal scaffolds using 3D models derived from CBCT scans

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INTRODUCTION

- Periodontitis is a chronic inflammation of the tissues surrounding and supporting the teeth, which includes the degeneration of periodontal ligaments, the creation of periodontal pocket and the resorption of alveolar bone.
- Periodontium is characterized as a complex tissue and, hence, designing scaffolds which mimic it represents an indisputable challenge in regenerative periodontology.
- Recent advancement in the field of tissue engineering has led to the development of bioabsorbable 3D printed scaffolds for personalized treatment against periodontitis, for the successful generation of which, the adoption of novel combinatorial technological approaches is necessary, such as the cone beam computed tomography (CBCT).

Objective :

The present study aims to shed further light in the state-of-the-art research as regards to the preparation of 3D printed periodontal scaffolds generated using CBCT data, by comparing Fused Deposition Modeling (FDM) and Selective Laser Sintering (SLS) as suitable 3D printing techniques.

MATERIALS AND METHODS

Preparation of 3D printing models

The data processed in this study was the anonymous DICOM (Digital Imaging and Communications in Medicine) data of the CBCT scan of a patient who has been diagnosed with periodontal disease. The 3D model of part of the alveolar bone and the teeth of the patient was prepared according to a previously published methodology (Verykokou et al. 2022).

SLS printing settings

The 3D printing of the developed models via SLS printer took place using polyamide 12 powder (nylon-based compound), PA12 Smooth (Sinterit, Krakow, Poland). The printing process was carried out on a Lisa desktop SLS 3D printer (Sinterit) and the models were printed with a layer height of 0.125 mm and the laser power ratio set up at 1.00.

FDM printing settings

A FlashForge Creator Pro (Zhejiang Flashforge 3D Technology Co, Zhejiang, China) FDM 3D printer was used to print the systems. A single extrusion head was utilized containing a single filament material (i.e., PLA 1.75 mm). The platform temperature was set at 45 °C and the printing temperature was set at 200 °C for all samples.

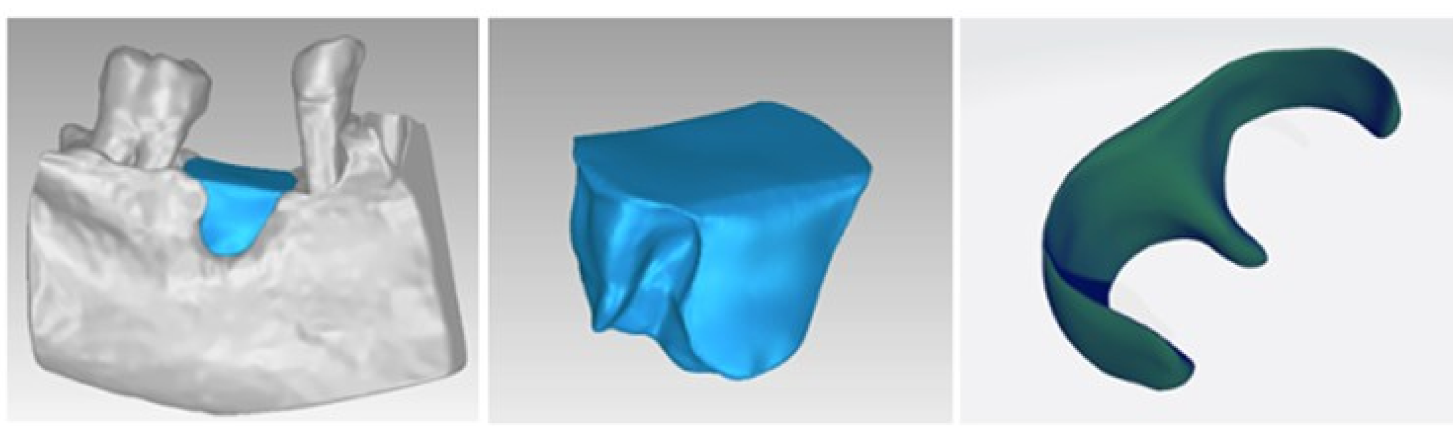

Fig 1: *3D models of the alveolar bone and the teeth (grey) and the generated scaffold A (blue) and B (green)*

CONCLUSIONS

- The 3D printing of periodontal scaffolds derived from patient's CBCT data utilizing FDM and SLS printing techniques was rendered feasible FDM printing technique is regarded as the most suitable technique as far as the required print time is concerned, since SLS printing was remarkably time-consuming. Specifically, for the SLS-printed models, the printing time of the alveolar bone was 7 h and 12 min, while the printing of scaffold took place at 3 h and 56 min.
- As for the evaluated FDM printing profiles, the standard profile was the one appearing the optimum combination of quality, printing time and required material.

RESULTS

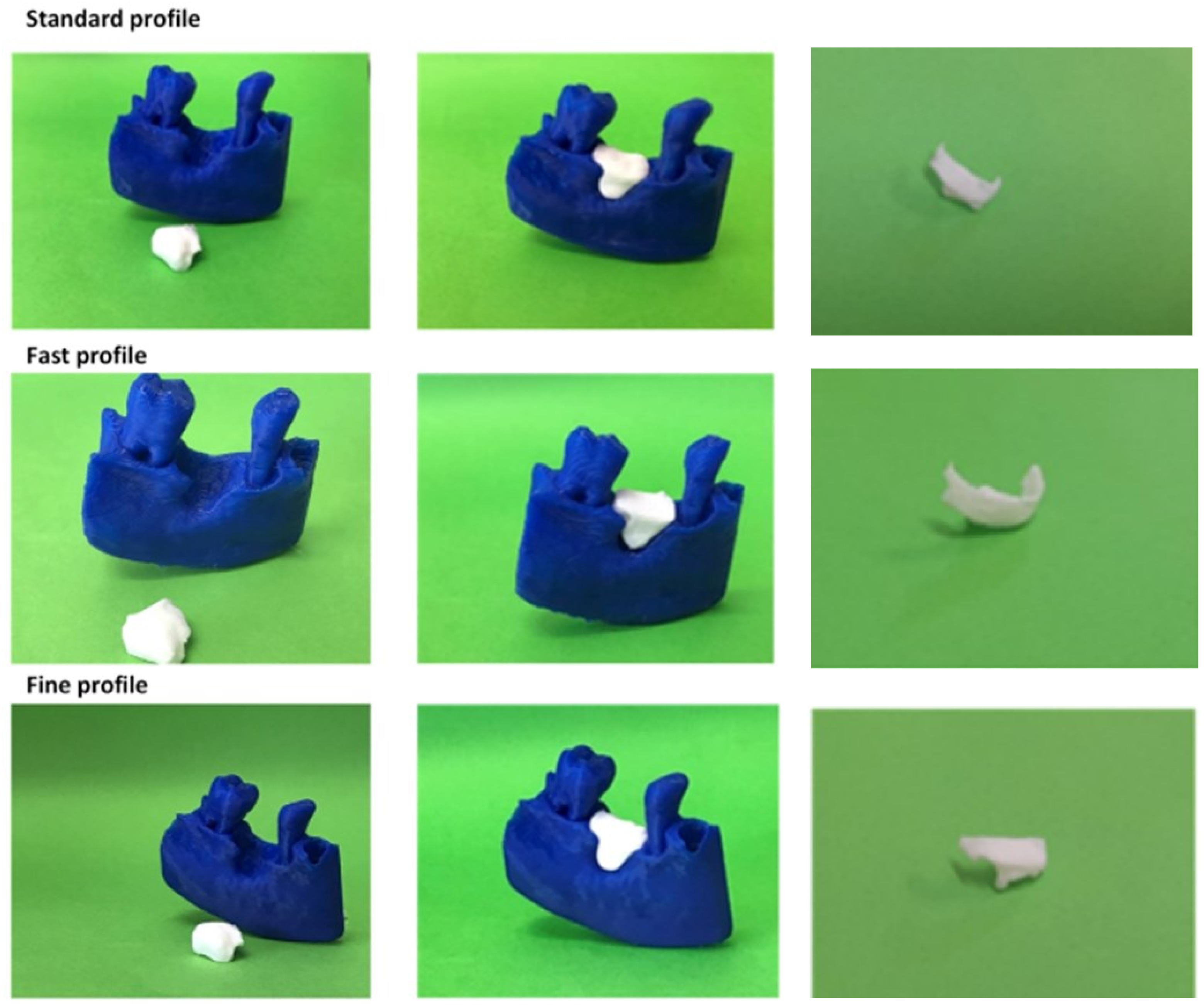

Fig 2: *Images of the 3 different 3D printing profiles scaffolds derived from FDM 3D printing*

Table 1: *Print time and material required at FDM printing, at each examined profile.*

		Profiles		
		Standard	**Fine**	**Fast**
Alveovar bone	Print time	1 h 15 min	1h 58 min	42 min
	Material (gr/m)	2.98	3.43	2.98
Scaffold A	Print time	6 min	10 min	4 min
	Material (gr/m)	3.05	3.00	2.98
Scaffold B	Print time	4 min	6 min	3 min
	Material (gr/m)	3.11	3.00	3.11

Fig 3: *Images of the SLS 3D printed scaffolds*

REFERENCES

Verykokou S.; Ioannidis C.; Angelopoulos C. Evaluation of 3D Modeling Workflows Using Dental CBCT Data for Periodontal Regenerative Treatment. Journal of Personalized Medicine, 12(9) (2022).

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