Rev Estomatol. 2022;30(1):e11947. DOI: 10.25100/re.v30i1.11947

EDITORIAL

3D Printing in Dental Science

Impresión 3D en la Ciencia Odontológica

Edison Andrés Cruz Olivo Olivo [1]

OPEN ACCSESS

[1] Universidad del Valle, Faculty of Health, School of Dentistry, Department of Periodontology, Cali, Colombia.

Citation
Cruz-Olivo E.A. 3D printing in dental science. *Rev Estomatol.* 2022 February;30(1):e11947. DOI: 10.25100/re.v30i1.11947

Received: January 7th 2022
Evaluated: January 09th 2022
Accepted: January 20th 2022
Publised: February 07th 2022

Correspondencia
Edison Andrés Cruz Olivo. Universidad del Valle. Calle 4b # 36b-00 Edificio 132. Email: andres.cruz@correounivalle.edu.co

ABSTRACT

3D printing is a technology that describes a manufacturing process previously planned and designed in a computer to create an object [1,2]. This technology was introduced in dentistry by Chuck Hull since 1986 and allowed the automation and thus improved dental workflow [2]. Technologies used in 3D printing involves: Stereolithography (SLA), bioprinting, fused deposition modeling (FDM), selective laser sintering (SLS), and PolyJet printing. We can choose one of them depending on the clinical use and material, need of accuracy among others. To 3D printing you need to use a scanner with an integrated software in order to capture the 3D images of the object being scanned. Those 3D images are stored in Standard Tessellation Language (STL) file 3. But what "Tessellation" means? Tessellation is the covering process of a surface, using one or more geometric shapes, with no overlaps and no gaps. It means that the object scanned is copied in detail with high reliability and then can be printed.

KEY WORDS
3D printing; CAD-CAM; digitalization; intraoral scanner; prototyping; digital dentistry.

RESUMEN

La impresión 3D es una tecnología que describe un proceso de fabricación previamente planificado y diseñado en un computador para crear un objeto. Esta tecnología fue introducida en odontología por Chuck Hull desde 1986 y permitió la automatización y, por lo tanto, mejoró el flujo de trabajo del consultorio. Las tecnologías utilizadas en la impresión 3D incluyen: estereolitografía (SLA), bioimpresión, modelado por deposición fundida (FDM), sinterización selectiva por láser (SLS) e impresión PolyJet. Podemos elegir uno de ellos dependiendo del uso clínico y material, necesidad de precisión entre otros. Para la impresión 3D, debe usar un escáner con un software integrado para capturar las imágenes 3D del objeto que se escanea. Esas imágenes 3D se almacenan en el archivo de Lenguaje estándar de teselado (STL). Pero, ¿qué significa "Teselado"? El teselado es el proceso de recubrimiento de una superficie, utilizando una o más formas geométricas, sin superposiciones ni espacios. Significa que el objeto escaneado se copia en detalle con alta confiabilidad y luego se puede imprimir.

PALABRAS CLAVE
Impresión 3D; CAD-CAM; digitalización; escáner intraoral; creación prototipos; odontología digital.

3D printing is a technology that describes a manufacturing process previously planned and designed in a computer to create an object [1,2]. This technology was introduced in dentistry by Chuck Hull since 1986 and allowed the automation and thus improved dental workflow [2]. Technologies used in 3D printing involves: Stereolithography (SLA), bioprinting, fused deposition modeling (FDM), selective laser sintering (SLS), and PolyJet printing. We can choose one of them depending on the clinical use and material, need of accuracy among others.

To 3D printing you need to use a scanner with an integrated software in order to capture the 3D images of the object being scanned. Those 3D images are stored in Standard Tessellation Language (STL) file [3]. But what "Tessellation" means? Tessellation is the covering process of a surface, using one or more geometric shapes, with no overlaps and no gaps. It means that the object scanned is copied in detail with high reliability and then can be printed.

Before printing, the software cuts the STL file into multiple horizontal layers and creates the G-code for the machine command for the printer. Thus, the resolution of the printer is determined by its layer thickness (z-axis) which represents the vertical accuracy of 3D printer [1]. There are two approaches used to fabricate 3D objects: subtractive approach (milling); additive approach (layered manufacturing) [4] . The first, normally use a small model or block to machining it and is indicated to fabricate ceramic crowns in dentistry. The last, can produce complex structures and thus is suitable for reproduce the anatomy of different structures of oral cavity [4].

Explained that, different clinical applications have been used since 1990s in prosthodontics, periodontics, orthodontics, endodontics and maxillofacial oral surgery for diagnosis, surgery planning and simulation, treatment planning, both student and patient education among others. For instance, an oral surgeon (periodontist, endodontist, maxillofacial surgeon, oral pathologist), can get an overview of anatomical structures (bone defects, fractures) before performing the surgery. This helps the clinician in the design and printing of a customized barrier titanium mesh (in case of a customized guided bone regeneration).

In addition, 3D printing is used to fabricate stereolithographic implants drilling guides (IDG) to reduce the improper placement of dental implants, avoid anatomical structures damage (i.e. nerve lesion, sinus floor perforation among others). These guides can also be designed to cut bone when implants for overdenture need to be paralleled and at the same level, and can be named cutting guides. In addition, cutting guides are useful when harvesting bone from mandible when autogenous bone graft is needed in guide bone regeneration. This drilling and cutting guides can be supported and/or anchored either over teeth, supported mucosa or alveolar ridge. Moreover, there is evidence that customized dental implants are printed in cases where guided bone regeneration and conventional implants cannot be used [5].

In orthognatic surgery, 3D printed models are used to perform orthognathic surgical planning and prediction by means of a virtual planning in a scanner software. Moreover, in digital orthodontics, this technology use 3D printed models for diagnosis and construction of aligners, production and bonding of customized brackets and thus, and reducing orthodontic treatment time [6].

Workflow in restorative dentistry have been improved by 3D printing technology. For instance, 3D printed Temporal crowns have shown better results compared with analogue made temporal crowns in terms of proximal and marginal fitting [7]. Moreover, 3D printed frameworks for removable prosthetic denture have shown to reduce manual errors in it preparation at the laboratory, reducing the time of workflow. In addition, zirconia crowns have been printed using different methods, for instance a crown can be printed from a zirconia powder and inkjet printing or through milling system from a fully dense ceramics. Both methods have shown to be effective in printing zirconia crowns with required size, shape, morphology with adequate physical and strength properties [8].

Root canal treatment in teeth with calcified pulp now are handle using narrow files and drills introduced in 3D printed templates. Moreover, apical surgery with osteotomy and root resection is aided by 3D printed surgical guides previously planned and designed, thus reducing root and periapical damage such as perforations, and making endodontic treatment more quick than hand-driven (analogue) endodontic treatment [9].

This overview of the applications of 3D printing technology allows us to explain, why dental industry is the target of many companies around the world, focused on the development of new 3D printers, materials and new clinical and laboratory applications. And it is a fact that nowadays, dentist, dental students, laboratory technicians and patients are getting more digital. Therefore, digital dentistry is the current and future of dental science [10].

If you are interested in getting to know more about this technology, and to start working with it, the following companies shares the market place in digital dentistry: 3D Systems, 3Shape, Asiga, Autodesk, BEGO, Carima, DENDTIS, DeltaMed, Dental Wings, DWS, EOS, Envision TEC, Formlabs, Prodways, Stratasys, Structo, Valplast, Vertex Dental, Z3Dlab among others.

However, all technologies have limitations that need to be overcome. 3D printing materials must be hard and though enough to resist long-term use in oral cavity. Moreover, when they will be use in surgery, 3D materials should be capable to sterilize to reduce risks of infection (i.e. drilling and cutting guides). Until this technology evolves, the equipment and materials can be expensive and thus not available for massive use among dentist around the world [11].

As mentioned before, this technology will continue

evolving and thus, it is necessary to educate and update the dental team (dentist, specialist, dental assistant, laboratory technicians) and include further topics of CAD-CAM, 3D printing subjects in dental curriculums at universities programs of dental science. Moreover, a new trend of research line is now open and waiting to be explored by researchers once 3D printing can be applied in all fields of dental science (periodontics, endodontics, orthodontics, restorative and prosthetic dentistry, oral and maxillofacial surgery, oral pathology among others).

On behalf of the Editorial Team thank you for your time to read this Editorial. We are compromised in enhancing the quality and timeliness of our Journal for the publication of your research. Remember that articles published in Revista Estomatologia are summarized and indexed in the following indexes, repositories and catalogs: ICMJE, DOAJ, EBSCO - Fuente Académica, REDIB, LILACs, BIREME, LATINDEX, SHERPA/RoMEO, GALE - Informe Academico, Dialnet, ROAD and Google Schoolar and thus we invite you to publish your articles in our journal.

Conflict of interest statement

The author declare that there is no conflict of interest related to the companies mentioned on this editorial.

References

1. Kessler A, Hickel R, Reymus M. 3D printing in dentistry-state of the art. Operative dentistry. 2020;45(1):30-40. Doi: https://doi.org/10.2341/18-229-L

2. Jawahar A, Maragathavalli G. Applications of 3D printing in dentistry-a review. Journal of Pharmaceutical Sciences and Research. 2019 May 1;11(5):1670-5.

3. Chander NG. An overview on 3D printing in prosthodontics. The Journal of the Indian Prosthodontic Society. 2020 Apr;20(2):121. Doi: https://doi.org/10.4103/jips.jips_78_20

4. Liu Q, Leu MC, Schmitt SM. Rapid prototyping in dentistry: technology and application. The international journal of advanced manufacturing technology. 2006 Jun;29(3):317-35. Doi: https://doi.org/10.1007/s00170-005-2523-2

5. Osman RB, van der Veen AJ, Huiberts D, Wismeijer D, Alharbi N. 3D-printing zirconia implants; a dream or a reality? An in-vitro study evaluating the dimensional accuracy, surface topography and mechanical properties of printed zirconia implant and discs. Journal of the mechanical behavior of biomedical materials. 2017 Nov 1;75:521-8. Doi: https://doi.org/10.1016/j.jmbbm.2017.08.018

6. Nayar S, Bhuminathan S, Bhat WM. Rapid prototyping and stereolithography in dentistry. Journal of pharmacy & bioallied sciences. 2015 Apr;7(Suppl 1):S216.Doi: https://doi.org/10.4103/0975-7406.155913

7. Mai HN, Lee KB, Lee DH. Fit of interim crowns fabricated usingphotopolymer-jetting 3D printing. The Journal of prostheticdentistry. 2017 Aug 1;118(2):208-15. Doi: https://doi.org/10.1016/j.prosdent.2016.10.030

8. Krastl G, Zehnder MS, Connert T, Weiger T, Weiger R, Kühl S. Guided endodontics: a novel treatment approach for teeth with pulp canal calcification and apical pathology. Dental Traumathology. 2016 Jun;32(3):240-246. Doi: https://doi.org/10.1111/edt.12235

9. Ebert J, Özkol E, Zeichner A, Uibel K, Weiss Ö, Koops U, Telle R, Fischer H. Direct inkjet printing of dental prostheses made of zirconia. Journal of dental research. 2009 Jul;88(7):673-6. Doi: https://doi.org/10.1177/0022034509339988

10. Olivo EA. Digital Dentistry: The future is now. Revista Estomatología. 2017;25(2):8-9. Doi: https://doi.org/10.25100/re.v25i2.6484

11. Azari A, Nikzad S. The evolution of rapid prototyping in dentistry: a review. Rapid Prototyping Journal. 2009 May 29. Doi: https://doi.org/10.1108/13552540910961946