ISSN 2477-8915

# ODONTOLOGÍA

## activa UCACUE

DENTAL RESEARCH

### CONTENIDO



Revista Científica
Unidad Académica de Salud y Bienestar
(593)(7)2821-897
Av. De las Américas y Humbolt
Cuenca - Ecuador

ODONTOLOGÍA activa *UCACUE* Vol. 1 No.1, Enero 2016
ISSN: 24778915

# CAD / CAM AND 3D PRINTING A PROMISING REALITY IN DENTISTRY

CABRERA-DUFFAUT A.*

*Recibido: 08/11/2015*
*Aceptado: 20/11/2015*

## ABSTRACT

New digital techniques constitute a significant advance in the way that traditional models and a large amount of dental applications are made, speeding up production times and improving the quality of the parts that are produced. The aim of this article is to present the structure of the CAD / CAM dental technology and the advantages that 3D printing, for which we refer to previous research that analyses the use of this technology and research of new printing materials. Getting to the conclusion that it's a technology that is constantly evolving and that its use in most laboratories and dental clinics is only a matter of time, it improves the quality of the molds and teeth significantly reducing their processing times.

**KEY WORDS**: CAD / CAM, Dental, 3D Printing, STL, Technology, Design, Intraoral.

## INTRODUCTION

The technology is advancing ever more rapidly in the dental field innovations are the order of the day , responding to multiple situations that arise daily when treating a patient , making it quick and pleasant visit to the dentist. From orthodontic treatment to maxillofacial surgery can benefit from new technological developments called CAD (Computer Aided Design) CAM (Computer Aided Manufacturing) - CAD / CAM, which is used to help dental specialists and laboratory techs to design and manufacture through 3D printing, extremely precise and high quality dental restorations.

This article examines the CAD / CAM technology using the 3D printing technique, operation and structure of this technology will be analyzed, showing some studies that analyze its use and new printing materials.

## BACKGROUND

Throughout the history of dentistry, with new techniques and procedures the search for a more pleasant visit to the dentist has been sought. With technological development, this area of health has benefited by having new tools and materials that help us take a step forward in treatments that allows us to offer greater patient comfort and improve the quality of professional work .[1]

The CAD / CAM Dental technology dates back to 1971 when Francois Duret described the operation of a CAD / CAM system for dental use and since then his system has evolved.[2,3] This technology is an important part of routine diagnostic, treatment planning and the execution of many rehabilitation procedures today. Several authors argue that some procedures such as cast prosthesis are now obsolete.[4]

However the conventional techniques will always be a benchmark in the treatments, but with technological advance within our reach, a great number of options and resources open up to provide better solutions to our patients.

**Structure CAD / CAM:** The origins of this technology date back to 1976 and in the present day its use has been extended to almost all of our fields. Today, thanks to sophisticated design programs, to the advancement of robotics and research on biomaterials it's possible to achieve complete or partial ceramic restorations designed and processed by computers. All these computer controlled systems consist of three phases: scanning, design and manufacturing.[5]

**Processes. First - scan:** It's the process by which the patients oral structure or a real model is digitized to become a virtual model, using a digital printing system.

With these systems, the final restorations are produced in models created from digitally scanned data instead of plaster models based on physical impressions. In addition, they improve patient comfort, patient acceptance and the understanding of the case. Digital scans can be stored on hard disks indefinitely, while conventional models, which can break or chip, must be physically stored, which requires additional office space.

* Docente Máster en Gerencia de Sistemas, Universidad Católica de Cuenca

ISSN: 24778915

The digitization can be:

- In an office with an intraoral camera.
- In a laboratory, using scanners that digitize the plaster models obtained from conventional impressions: 3D Touch Scanner (CMM type) by direct contact or optical 3D scanner (laser and structured light).

The data obtained during scanning, must be accurate and reliable so that the final result of the prosthesis is in line with the minimum demanded setting.[6]

3D cameras or scanners include:

- Closed: obligate to develop projects with a specific software, you are not free to choose and you must always use this closed system.
- Open: produce standard files in STL format, and can be assembled with any open system, in short-term they are cheaper and projects can be designed and printed in any 3D printer.

STL (STEREOLITOGRAPHY) is a standard, widespread and common development CAD format, supported by most CAD software market development.

**Second - software design (CAD):** It consists of integratint the information scanned into a CAD program (Computer Design). The program is used to superimpose the volumetric model of the prosthesis on the virtual model of the dentition. Other software editing tools allow specific customization of the dental restoration to the needs of the case.

Dental CAD systems have a specific design that is applicable only in the dental field. Therefore, it is vertical and custom systems that rely on multiple items such as the use of model libraries or forms of prosthesis. They have a macro application in which the software automatically selects a design proposal after finishing programming margins. Dental CAD systems allow modeling in greater detail in specific areas of the tooth.[7]

Dentists typically use conventional printing materials to record the intraoral condition of the patient, the impression is sent to the laboratory for fabrication of restorations and prothesis. The limitations of these techniques and materials are well known to practitioners. The digital impression-taking systems use a similar process, performing a digital replica of the patient's dentition for laboratory use as a guide for the manufacturing of the case. Also, they prevent a number of factors that negatively influence the results of the restoration, such as volumetric changes when handling print media and plaster models, the distortion of the impressions or models, its abrasion or fracture and problems during transport.

However digital prints are not susceptible to changes in its precision once the lab files are registered and transmitted electronically efficiently and without loss of information.[8]

**Third - Machining (CAM):** Within this CAM (Computer Aided Manufacturing) technology, used in dentistry, there are some alternatives when it comes to making the teeth like using 3D printers that can manufacture them layer by layer.

A 3D printer is a machine capable of "prints" of designs in three dimensions from a design made by computer. The operation is based on an injector head and moving in 3 dimensions XYZ. [9]

In this regard, a few years ago it was unthinkable to believe plaster models could be printed, clear aligners, surgical guides and other small items that are used in dental clinics with a 3D printer.[10]

However, it's an advance that is already used in some dental clinics, thanks to the great development that the industry of 3D printing technologies is suffering. This new technology allows you to create solid structures in reference to a digital file. Their applications have conquered many different areas especially in the fields of medicine and dentistry.

On the market there are several expert companies in this equipment which have a range of 3D printers especially designed for use it in laboratories and dental clinics.

With the new systems and existing materials, models can be printed in full color and different textures, creating an exact copy of the patient's mouth, the color of the teeth and gums, in perfect harmony with the original, there are 900 colors and textures to choose from.

ISSN: 24778915

The aim with this type of 3D printers is to fundamentally increase the production capacity of braces, aligners and retainers, significantly reducing customer delivery times, also taking advantage of greater concern than has been observed in recent years to improve dental health through all kinds of braces, and has favored an increase in demand for this type of treatment. [11]

**Studies related to printing 3D:** There have been a number of scientific studies to verify the use and efficiency of the technology as well as new materials for making prints, we will refer to three of them.

- In the study entitled "Comparison of assessments of spatial analysis with digital models and dental plaster" two sets of 25 alginate prints were taken from patients who had a Class I with crowded permanent teeth. Each print was in a plaster cast and a model of 3-dimensional virtual orthodontic (OrthoCad, Cadent, Fairview, New Jersey).
    - Concluding that the accuracy of the software for spatial analysis on digital models is as clinically acceptable and reproductable as in conventional plaster models.[12]
- A study entitled "Fabrication and characterization of a mixture of bone and bioceramic powder" on the creation of biomaterials in order to produce implants through 3D printing, capable of being introduced into the body is made so that the operation and potential recovery of a patient could be given in a less traumatic way. This study provides the use of a compound based on bone powder and bioceramic capable of being absorbed by the body, so that the graft induces new bone growth.
    - The study showed encouraging results, obtaining the material has an apparent porosity that could be good for blood to flow through the implant, and could induce the growth of new bone, this material could be manipulated to better approximate the characteristics of the powder used in 3D printing and implants produced via this technology they could be introduced into the body without problem.[13]
- This study presents a description of the technology of Rapid Prototyping (RP) applied to craniofacial problems, with which 3D solid models can be produced by adding material. Turn an application from the simulation described surgery to insert four mandibular implants, which form the basis of a fixed prothesis supported by implants. The simulation of the surgical procedure began with the jaw geometry obtained from the processing of biomedical, from a tomography (CT) of a totally edentulous adult female image. This process is performed using the 3D software GIB Points. With the software a text file with the 3D point cloud of the jaw which was subsequently exported to ProEngineer Wildfire 3.0, from which a file was generated in standard STL format, compatible with most RP machines was obtained. The technology used for 3D printing, was Fused Deposition Modeling (FDM). They managed to get a plastic model of a jaw, with large anatomical and dimensional quality, using available technology. In addition, successfully pretend surgical procedure for the installation of four implants using the tools that would be used in actual surgery.
    - Generally, the implemented methodology can be used for surgical planning and avoid trial and error procedures that could jeopardize patient health.
    - Also as a communication tool to explain to the patient surgical procedures to be submitted. In addition, it can be used for teaching purposes for student training, making it an effective learning processes in clinical settings which in turn would result in better outcomes for patients.[14]

## CONCLUSIONS

- 3D printing is a technology that allows both to obtain a 3D printed transparent dental aligner for daily use, as well as implants, dental caps, bridges, etc., improving quality and significantly reducing manufacturing times.
- This technology allows creating these pieces in a single appointment within hours, and better patient perception of the treatment to be performed.
- The CAD / CAM technology is constantly evolving with new materials and components, which leads to a constant updating of its new features, by dental technicians and dentists who are willing to improve existing techniques.
- Initial implementation costs are a problem for small laboratories and dental clinics, however, with its spread it will be more affordable for everyone because gradually its handling and implementation will be routinary, since those who do not adopt these procedures will remain outside the market.

ISSN: 24778915

## BIBLIOGRAPHIC REFERENCES


1. Bordoni ,N; Escobar, A; Castillo, R. Odontología Pediátrica. "La Salud Bucal del Niño y del Adolescente en el Mundo Actual". Buenos Aires: Editorial Panamericana; 2010.

2. Persson A, Andersson M, Oden A, Sandborgh-Englund G. A three-dimensional evaluation of a laser scanner and a touch-probe scanner. J Prosthet Dent 2006;95(3):194-200.

3. Birnbaum NS, Aaronson HB. Dental impressions using 3D digital scanners virtual becomes reality. Compend Contin Educ Dent 2008;29(8): 96-505.

4. G. A. CAD all over and everywhere?. Int J Comput Dent .2010(13):295-97.

5. Martínez Rus Francisco, Pradíes Ramiro Guillermo, Suárez García Mª Jesús, Rivera Gómez Begoña. Cerámicas dentales: clasificación y criterios de selección. RCOE [revista en la Internet]. 2007 Dic [citado 04 Agos 2015] ; 12(4): 253-263. Available in: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1138-123X2007000300003&lng=es.

6. Mecanizado de estructuras dentales. Revista digital metalcerámica [Internet]. Ene 2013 [citado 02 Agos 2015]. Available in: http://www.interempresas.net/MetalMecanica/Articulos/104713-Mecanizado deestructuras-dentales.html

7. Montagna F, Barbesi M. Cerámicas, Zirconio y CAD/ CAM. Primera edición. Caracas: Editorial Amolca; 2013.

8. Fasbinder D. Evaluación del cad cam para la restauración dental. DENTAL TRIBUNE Hispanic & Latin America [Internet]. 2010 [citado 05 Agos 2015]; 10(10): 16-21. Disponible en: http://issuu.com/dentaltribune/docs/dthla_10_f06c617c57cd72

9. Convención Nacional de Salud Pública [Internet]. Cuba: Rojas A. 2015 [citado 03 Agos 2015]. Available in: http://www.convencionsalud2015.sld.cu/index.php/convencionsalud/2015/paper/view/1778

10. Multiestetica [Internet]. España: 05 ene 2013 [citado 10 ago 2015]. Available in: http://www.multiestetica.com/articulos/la-impresion-3d-ultima-tecnologia-en-clinicas-dentales

11. Izzedin R, Zavarce E, Izzedin N. Odontología Y Gestión Del Conocimiento En Tiempos Tecnológicos, Una Visión Multidisciplinaria. Acta Odontológica Venezolana [Internet]. Feb. 2014; 1(52): 25. Available in: http://www.actaodontologica.com/ediciones/2014/1/art25.asp

12. Leifert MF, Leifert MM, Efstratiadis SS, Cangialosi TJ. Comparación de las evaluaciones de análisis espacial con modelos digitales y modelos dentales de yeso. Am J Orthod Dentofacial Orthop. 2009; 136 (1): 16e1-16e4.

13. Parra Calvache, Luis Carlos, Rojas Mora, Fabio Arturo, Narváez, Diana, Méndez Moreno, Luis Miguel. Manufacture and characterization of a mixture of Bone Powder and Bioceramic: A 3D-printing method processIngeniería y Desarrollo [en linea] 2009, (Julio-Diciembre) : [Fecha de consulta: 12 de Agos de 2015] Available in: http://www.redalyc.org/articulo.oa?id=85212233003

14. Naranjo M. Prototipaje rápido de estructuras craneofaciales. Ingeniería y Ciencia. Diciembre 2008; 4(8):27-43. Disponible en: http://www.redalyc.org/pdf/835/83540802.pdf

15. 3D Orthodontics - from Verne to Shaw. Dental Press J. Orthod. [Internet]. 2014 Dec [cited 2015 Sep 07] ; 19( 6 ): 12-13. Available in:: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2176945120140006000012&lng=en.

16. Macias F. La Tecnología CAD/CAM en la Consult a Denta. Rodyb. Enero - Abril 2015;4(1):1-13. Available in: http://www.rodyb.com/wp-content/uploads/2014/12/3-vol-3-N3-CAD-CAM.pdf

17. Glavich, E. Reseña de "Sociedad de alta tecnología. La historia de la revolución de la tecnología de la información" de Tom Forester. Redes. 1995;4(2): 195-200. Disponible en: http://www.redalyc.org/pdf/907/90711285011.pdf

18. Fernández Bodereau Enrique, Bessone Laura, Cabanillas Gabriela. Aesthetic All-ceramic Restorations: CAD-CAM System. Int. J. Odontostomat. [Internet]. 2013 [citado 2015 Sep 07] ; 7( 1 ): 139-147. Available

ISSN: 24778915

in: http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0718-381X2013000100022&lng=es. http://dx.doi.org/10.4067/S0718-381X2013000100022.

19. Serrat M,Castro J, Montes F, Costa S, Cabratosa J. Impresiones digitales con scanbody para restauraciones unitarias sobre implantes. Gaceta Dental. Dic 2013; 253: 110-118.

20. Swennen GR, Mollemans W, Schutyser FJ. Three-dimensional treatment planning of orthognathic surgery in the era of virtual imaging. Oral Maxillofac Surg.Oct. 2009; 67(10): 2080-2092. Available in: http://www.joms.org/article/S0278-2391(09)01225-7/fulltext

21. Gomez R, Martinez M, García E. Impresiones fáciles sobre implantes. Gaceta Dental. Jul. 2013; 249:170-177. Available in: http://www.gacetadental.com/2013/07/impresiones-faciles-sobre-implantes-caso-clinico-paso-a-paso-23774/

22. Aboul-Hosn Centenero Samir. Planificación tridimensional y utilización de férulas Computer Aided Design/Computed Aided Manufacturing en cirugía ortognática. Rev Esp Cirug Oral y Maxilofac [revista en la Internet]. 2014 Sep [citado 2015 Sep 08] ; 36(3): 108-112. Available in: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1130-05582014000300003&lng=es. http://dx.doi.org/10.1016/j.maxilo.2013.02.003.

23. Gateno J, Xia JJ, Teichgraeber JF, Christensen AM, Lemoine JJ, Liebschner MA, et al. Clinical feasibility of computer-aided surgical simulation (CASS) in the treatment of complex cranio-maxillofacial deformities. J Oral Maxillofac Surg. Jul. 2011; 69(7): Available in: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3119456

24. Centenero S, Alfaro F. 3D planning in orthognathic surgery: CAD/CAM surgical splints and prediction of the soft and hard tissues results - our experience in 16 cases. J Craniomaxillofac Surg. Feb. 2012; 40(2): Available in: http://www.ncbi.nlm.nih.gov/pubmed/21458285