Vol. 10/Issue-2/May-August 2024

Computer Aided Implantology Academy
CAI

CBCT
CONE BEAM COMPUTED TOMOGRAPHY
MAGAZINE

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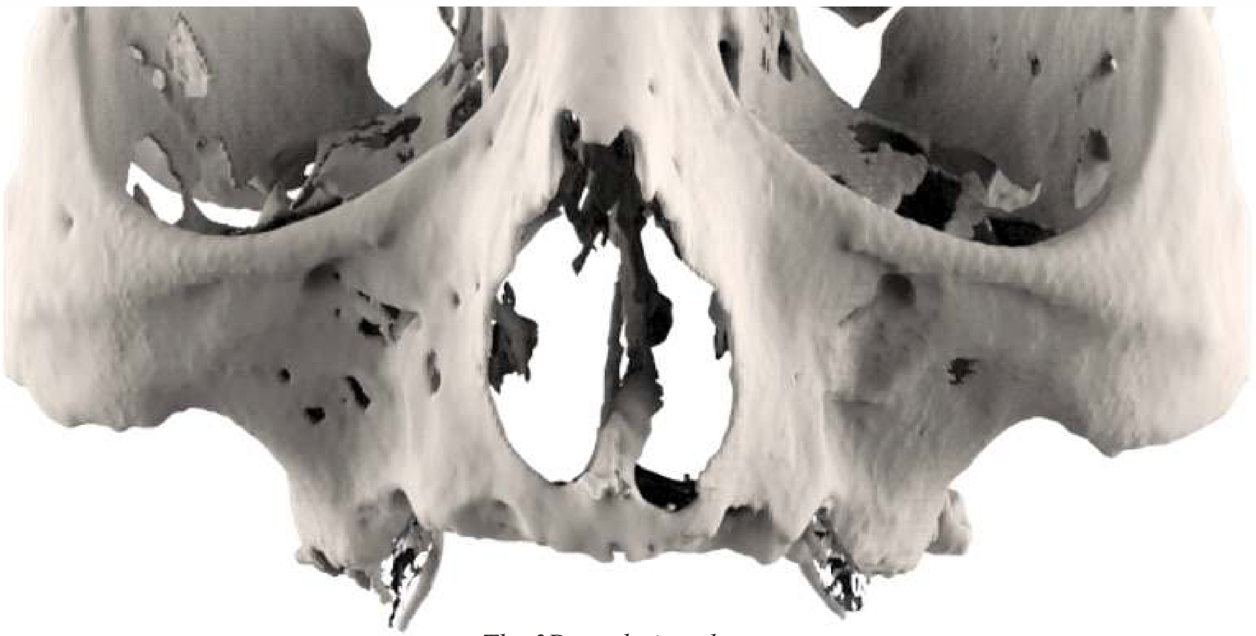
CBCT

E-ISSN : 2583-9012



The 3D rendering shows
two deep intraosseous defects around the existing implants
Image courtesy by : Vrielinck L. | Schiroli G. | Iavarone

Official Publication of CAI Academy
Editor-in-chief **Dr. Prashant Jaju**
www.cbctmagazine.in


ORTHOPHOS SL

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M:+91 9752093011 | Email Id : cbctmag@gmail.com | www.cbctmagazine.in

(India)Publisher : Read & Research Publications -
D-190, Ramprastha Colony, Ghaziabad-201011, U.P., | info@readpublications.org

Designed & Printed by : B S Creative Solution
597, New Ashoka Garden,Bhopal, M.P. M : 9399026880, 9993280129, bscreativebpl@gmail.com
www.bscreativesolution.com

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Oral Medicine & Radiology (India)

FROM THE EDITOR'S DESK

Digital dentistry: Technology is here to stay

We are coming to the end to one of the most traumatized and pressure year ,due to the COVID-19 pandemic affecting our lives like never before. Work from home became the new rule of life for many profession and the state of the art technology played a pivotal role in assisting us during this pandemic .

This year has reiterated the fact that digital world or systems have become integral part of our lives and profession. Right from ordering food, watching television or enjoying our favourite movies to the digital education of our children has now come on the digital platform and its no surprise that both medical and dental world have now become the hotbed for growth of artificial intelligence and digital world for diagnosis, treatment planning and patient education.

Historically digital dental advances had three main pillars for its growth, intra oral imaging, CAD-CAM systems and patient & practice management systems.

Dental imaging world has evolved from the conventional manual world of image acquisition to processing to the completely digitised world of data acquisition, processing and image viewing . Imaging world has witnessed tremendous rise of cone beam computed tomography techniques in various aspects of dentistry and its moving at a faster pace like never before and sooner or later we will be witnessing dental imaging pitfall in the world of MRI and ultrasound.

Digital dental scanners, both intraoral and laboratory-based, transformed restorative dentistry. Real-time imaging proves on-screen digital images of single or multiple teeth, whole arches, opposition arches, occlusion, and surrounding soft tissue. Prosthetic designs , planning, milling and 3D printing is now possible seamlessly and accurately with these digital tools.

3 printing plays an essential role in diagnostics and treatment planning as well as enhancing patient communication, skills training, and maxillofacial surgery . Low-cost printers may be a realistic alternative for in-house production. They can produce clinically acceptable provisional crown and bridge restorations , full arch models and digital copies of plaster orthodontic models .

This current issue on DIGITAL DENTISTRY is focussing on the above the mentioned parameters and our authors have shared their valuable work in their articles showcasing the advantages and limitations of digital dentistry.

I also wish to congratulate all our authors and guest editors for 2020 who have done stupendous work in arranging quality articles for our CBCT Magazine.

Digital dentistry has changed how dentists think, evaluate and function. It has improved the overall patient's experience of dental treatment and is more comforting and painless compared older dental practice . It has created a distributed workflow to capitalize on the best expertise for different functions. Unquestionably, the impact of digital dentistry is disruptive and its for the benefit for all of us.

Happy Reading and Happy New Healthy Year 2021

***Editor-in-chief* Dr. Prashant Jaju**

From the Editor's Desk

Messages

CAI Academy President

Michele Manacorda
CAI Academy President

Dear Friends and Colleagues,

I'm very proud to announce the upcoming **event** of the CAI - Computer Aided Implantology Academy, which will be held in **Milan** next December.

It will be a never-seen-before celebration for our first **20years** of pioneering and innovation. An **Exclusive Meeting** with the introduction of a new format, always looking forward to build the future of our clinical expertise: a **NextGen Contest** for young, brilliant, distinctive surgeons who will define our profession in the years to come with creativity, accuracy, technology skills, passion and dedication.

Our aim is to move ahead with **evolution** in each and every step of our path. Young doctors are the future, and CAI Academy has always been particularly attentive at the new and the updated, in a constant search for the **ultimate horizons** and the better ways to improve our performances and increase the percentage of good and durable results for our patients.

Implantology and Oral Surgery are nowadays progressing toward the **ideal mix of Human Brain and Artificial Intelligence**, meaning that the surgeon still is the centre of our practice, but now he can also use the help of a brand new technology to make his work even more meticulous and precise, verifying every step of the workflow with a second opinion and a point of view made by the **contemporary excellence of computers**. But this excellence must be filtered through experience, expertise, knowledge that only a human brain can perform.
Therefore our goal is to reunite the **best minds in our profession** to find a way to use this new tools inn the best way possibile, without loosing sight of our never ending commitment to our profession and to the clinical approach we've always pursued.

We'll wait for you in Milan!

Michele Manacorda
CAI Academy President

Custom digitally made subperiosteal implant for the treatment of fully edentulous atrophic maxilla : a case report of a new minimally invasive SP4 implant design

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Keywords:

Custom implant subperiosteal Implant, maxillary atrophy , medical prototyping , Cone-Beam Computed Tomography

Purpose:

To present the application of custom-made 3D-printed subperiosteal titanium implant for fixed prosthetic restorations of the fully edentulous atrophic maxilla .

Abstract:

Rehabilitation of atrophic jaws with implant- supported fixed restoration and immediate loading still represents a challenge nowadays. The aim of this contribution is to describe an innovative protocol for the treatment of the advanced atrophic jaws using a new generation of subperiosteal implants made by using the modern digital technology. A case of extreme bone atrophy in the upper jaw, resulting from ossointegrated implant failures, had been treated. This contribution is focused to clearly set-out the using of a new minimally invasive subperiosteal implant design (3D Fast engineering – Padova Italy) . All stages of the protocol from CBCT acquisition to the immediate loading are extensive described. This case supports the use of fully customized subperiosteal implants as a mini invasive and reliable alternative for dental rehabilitation of atrophic fully edentulous cases. Despite this single case demonstrate the efficiency of the protocol more long-term studies with large samples of patients will be necessary to confirm previous assumptions.

Introduction

Rehabilitation of atrophic jaws with implant- supported fixed restoration represents a clinical challenge still today. Many techniques have been described in the literature to overcome this problem. Reconstructive procedures, such as autologous bone grafting or guided bone regeneration,[1] are often used. However, autogenous bone grafting requires a second surgical site,[2] implying additional morbidity,[3] and immediate loading is not always recommended.[4] and for a long period such as more than one year the patient must to maintain removable dentures . However we have to consider that surgery requires general anesthesia and hospitalization. Guided bone regeneration, particularly vertical, is frequently limited in gain and also associated with possible complications in total atrophic jaws. [5]

Both techniques require several months for graft maturation.[6] Alternative techniques for the rehabilitation of atrophic jaws, such as tilted implants [7] and zygomatic implants,[8] appear to provide stable long-term results. Atrophic jaws are associated with anatomical changes, carrying an increased risk of injury to noble structures, thus increasing the needs of specific surgical skills during surgery. Zygomatic implants procedures can be performed often under general anesthesia, depending on the surgeon's experience and the patient condition. A favorable zygoma bone is essential to support the implant.[8] . Moreover the complications such as late lateral exposure and the perimplantitis are difficult to manage with recovery and the unavoidable removal represents fearful solution. On the severely atrophic jaw, the use of short implants remains controversial.[9] Other techniques such as sinus lift,[10] inferior alveolar nerve lateralization,[11] or osteogenic distraction [12] present diverse results in the literature. Custom-made subperiosteal implants are emerging back as a solution for the rehabilitation of atrophic jaws, suitable for both maxillary atrophy and mandibular bone deficiencies.[13,14,15] Several protocols have been proposed for subperiosteal implant techniques.

Case report

In march 2021 a patient affected by advanced bone resorption of the upper jaw, aged 67, has been enrolled in our department for a surgical treatment finalized to the implant supported fixed rehabilitation . The visualization of the diagnostic CBCT (3D accuitomo 170 Morita , Kyoto Japan) highlighted an advanced atrophy both in the premaxilla and corresponding to the sinus cavity . Also two existing conventional osseointegrated implants with advanced perimplanitis were already in place and should be removed during the implant surgery 18.

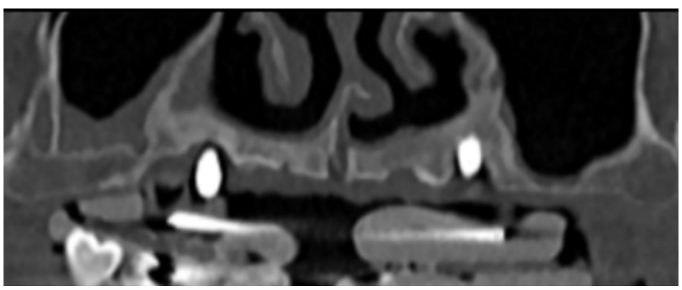

Fig : 1

Panoramic X-ray derived from a 3D acquisition shows a class 5\6 Mish classification of bone atrophy

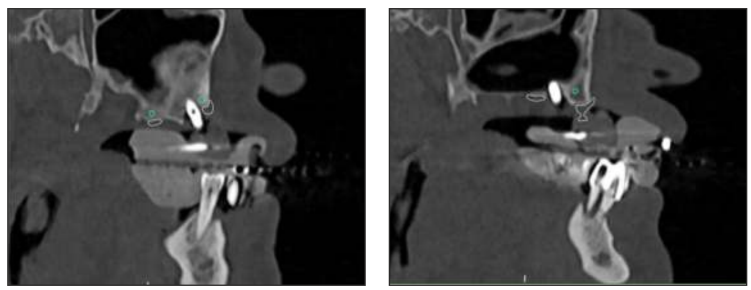

Fig : 2

2 In the Cbct two existing osseointegrated implants , failed by the advanced perimplantitis , are visible .

The rendering confirmed the advanced bone resorption and deeper bone defects around the existing osseointegrated implants.

The main exclusion criteria (heavy smoker, recent history for cancer treatment and bruxism) had been considered to enroll the patient for the major surgery. The conventional surgical treatment such as bone grafting and zygomatic implants were clearly explained in terms of risk of failures and complications. Grafts resorption, delayed lack of reached osseointegration and stability, morbidity and treatment time including the necessity to maintain for a long period a provisional conventional removable denture before the implantation had been exposed. Regarding the zygomatic approach all surgical aspects including the unavoidable skill of the surgeon avoiding surgical risks , the delayed complications such as sinusitis with infection and\or implant exposure and perimplantitis 17 - 18 are clearly explained. An extensive discussion finally had been dedicated regarding the custom made subperiosteal implant option 20 . The 3D replica and a prototype of implant is very useful to correctly described to the patient the surgical procedure and are always necessary to obtain the final decision. The extensive follow-up of conventional already explained options comparing the custom digitally made implants have been discussed 21 . Mini invasive surgery in conjunction with immediate loading can be considered the greatest benefits of this innovative approach thus the patient considered subperiosteal implant as a preferable option and after a special informed consent was prepared for the treatment .

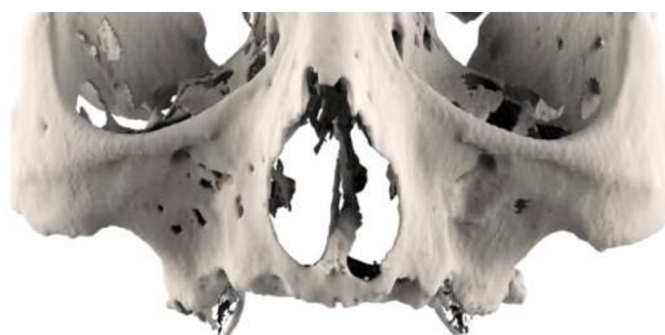

Fig : 3

The 3D rendering shows two deep intraosseous defects around the existing implants

Materials and Methods

After a conventional wax up a radiological scan prosthesis is delivered for a definitive preoperative CBCT. During the acquisition the patient wears a relined in occlusion original device called "3D bite" within the markers for the digital alignment of the images derived from the x-rays.

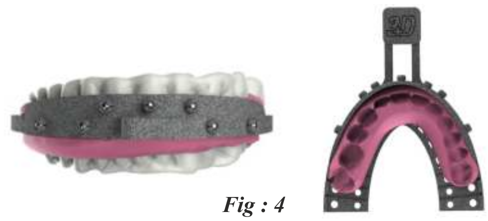

Fig : 4

The original bite , called " 3D bite" , within the radiopaque markers is used during the cbct acquisition to gain the alignment between the rendering from the CBCT and the STL from the models

Even the reference points help the alignment also between the 3D rendered volume of the anatomy and the model derived from the scanning (lab based or intraoral) of the upper/lower dentition and 3D bite. Using the Real guide platform (3Demme - bio imaging solution, Figino Serenza Italy) the clinician can interactively place the abutment taken from an existing library. According to our protocol and as suggested and previously published by Dr. Linkow, the prosthetic position will correspond bilaterally to the first molar and the canine which is the reason why we have named the implant "SP4".

Fig : 5

Using the real guide platform from the existing library the prosthetical connection are placed into the project

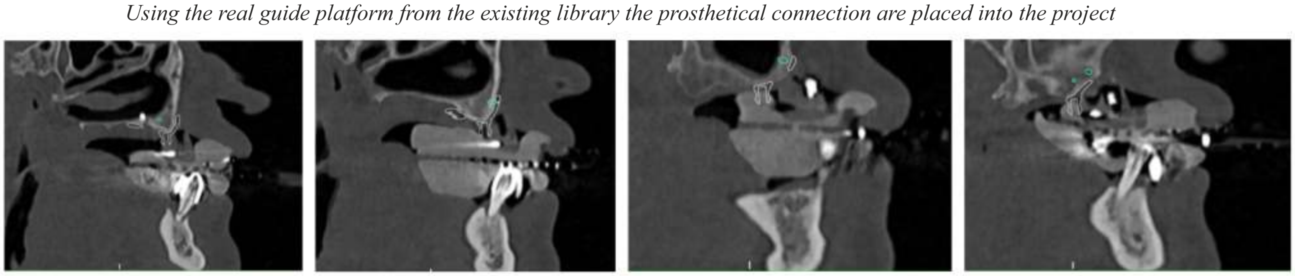

Fig : 6

The four connections must be sited corresponding the anatomical pillar of the maxilla : canine and firs molar bilaterally

Subsequently, the project is then sent to the 3D Fast company (3D Fast engineering , Padova Italy) for the uploading with dedicated software (Freeform Artec 3D, Senningerberg Luxembourg) and for the implant design. All details are managed with the use of a haptic device. Therefore, our protocol works in a completely digital environment. The abutment already placed in advance corresponding to the anatomical pillar of the maxilla , represents the main reference to start the implant design . The positioning of screws is the first step after which the contours of primary and secondary strips are determined.

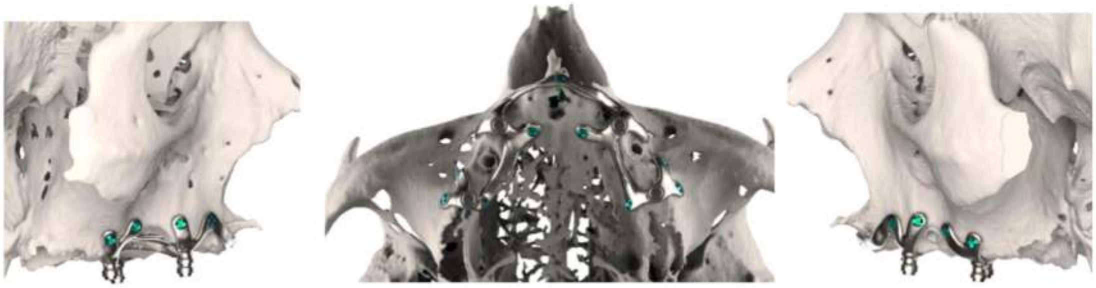

Fig :7
The positioning of the screws represent the first step to start with implant design

All screws in terms of length and direction are planned according to anatomy such as the sinus and nasal cavity, mental nerve and adjacent teeth.

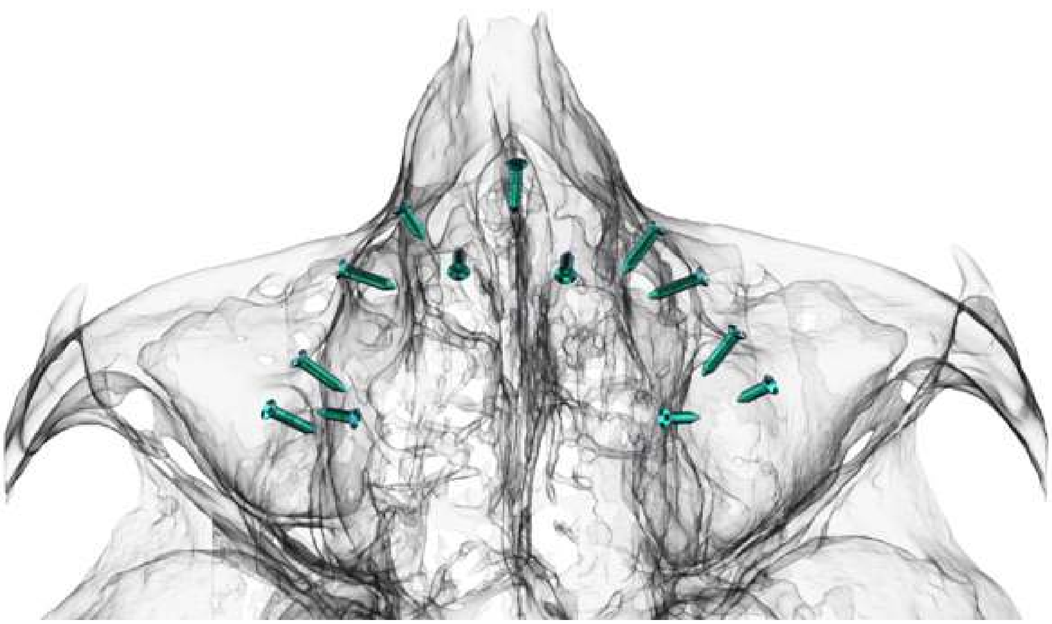

Fig :8
All screws are digitally placed according to the anatomy to prevent the risk of damage of adjacent structures .

The positioning of the screw corresponding to the nasal spine, that represents an additional pillar of maxillary anatomy, is key to predicting implant stability after loading over the time. This is another important detail already described and published by Dr Linkow from several years. The definitive file with all details is then digitally sent to the laser sintering machine (Sint & Mill Spring Engineering, Holyday, FL - USA). Then the subperiosteal implant is sent to the post production management and finalization (Trumpf Gruppe, Ditzingen Germany). The platforms are machined microscopically and the surface is treated chemically and mechanically to obtain a smooth texture externally and with limited roughness within the internal part of the implant body. Ten to fifteen days are sufficient for delivering a package that includes: 1) a "3D flap" for the guiding of incision 2) a replica of the anatomy 3) a prototype of the implant 4) a subperiosteal implant 5) a "3D bridge\stabilizer" to help the placement of implant and properly perform an efficient immediate loading 6) the provisional bridge digitally made by pmma (polymethyl methacrylate).

Fig : 9

the packaging contains 6 different devices : 3D flap for the incision , the replica and prototype of the implant for the conservative bone exposure , stabilizer\3D bridge for implant placement and immediate loading and the provisional to simplify and shortened the loading protocol

All surgical devices are autoclavable because digitally made by layers of polyamide (HD Printer). The company strictly produces the bar structure with a laser sintering procedure with a chrome/cobalt alloy to give certainty of accuracy of passive fitting between the implant platform and the provisional bridge. The clinician can decide whether to only receive the stl file from the company to be sent it to the trusted dental technician to produce the provisional bridge by in-lab prosthetic digital procedure. Six months later, in case of any infections or mobility, the clinician can finalize the case using conventional prosthetic procedures. Finally, we would like to underline that, at first, the implant can be produced with prosthetic connection for cemented restoration. Our suggestion is to limit that use, if you want, only for partial edentulous rehabilitations.

Surgical protocol

The surgery can be performed with no hospitalization and the conventional local anesthesia is always sufficient for conducting the entire intervention. The intravenous sedation should be recommended in case of anxious patient. Antibiotic (amoxicillin) 3 a days for 10 days , cortisone (bentelan) two a day for 3 days and chlorhexidine rinse is prescribed . An injection of the cortisone is also recommended at the time of surgery locally and by intravenous avoiding swelling and consequent traction of stitches. After infiltration with articaine with adrenaline 4 % (Pierrel group , Capua Italy) , a full flap has been precisely designed using the device called " 3D flap ".

Fig : 10

Using the “3D” flap device we can easier make the incision corresponding the future positioning of the prosthetical connections

) The line of incision follows the previously planned position of the prosthetic platform emergence providing an efficient repositioning of the soft tissue during the suture. This approach is important avoiding dangerous vertical incisions. Thus the full flap is reflected to expose only the part of bone required to placing the implant. The sterilized prototype of the implant is essential in this part of intervention to minimize the bone exposition and preserve its natural vascularization.

Fig : 11

We can minimize the reflection of periosteum and preserve as much the existing vascularization using prototype of the implant

At this time the positioning of subperiosteal implant, assembled with the " 3D bridge " for easily placement, has been always gained with immediate self-stabilization.

Fig : 12

The subperiosteal implant in place : the strips are strictly adherent to the bone surface and all screws in place

Maintaining the "3D bridge " in place , the " main screws " are positioned . The sequence must be always: first in the nasal spine, two for each buccal side distally and sequentially two palatal medially. Then the 3D bridge can be removed to finalized easier the placement of screws; finally, the stabilization of screws has been finalized by using a dedicated screw driver. In case of loosening an additional self-tapping pre-prepared screw, called "emergence screw", is also available from the kit. This screw is designed with different shape, pitch of threads and it is 0,4 mm wider. A two mm longer is must be used. Thus deep engraving half-thickness incision must been extend all along the contour of the implant to gain a passive repositioning of the flap. This is a main management to prevent the primary exposure of the implant strip . Finally, a suture can be applied by using at first single stitches as follow: first one loop-shaped around each prosthetic platform then the conventionally made stitches along the entire contour. Above a second continuous suture helps the previous one to minimize the effects of the micro-swelling during the ten days after the surgery. In addition using a centrifuge (duo Quattro , Intra-lock system Europe , Salerno Italy) four L-prf derived membranes are also placed under the flap corresponding each prosthetic connection

Fig : 13

The using Prf membranes improve the healing of soft tissue maximizing the new local vascularization and neo-angiogenesis

Fig : 14

Immediate loading with screw retained reinforced restoration

This additional precaution is especially recommended in the case of heavy smoker patients if treated anyway. At the end of the previous procedures the temporary bridge is then placed after the occlusion check and lab finishing

Fig : 15

Panoramic x-ray immediate post implantation

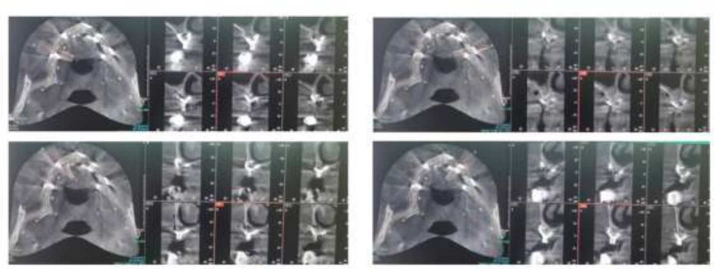

Fig : 16

Cbct post implantation : the intimate implant\bone contact are clearly visible

A panoramic (fig 15) and\or CBCT (fig 16) immediate post-surgery are always taken to confirm the intimate connection between the structure of the implant and the bone. The immediate load represents one of the main key for the success. The subperiosteal implant and its screws must be loaded immediately in conjunction to gain the healing together over the time. Conventional recommendations for implant immediate load procedures have been delivered to the patient. The clinical image with and without the provisional 27month post-op are here also documented.

Fig : 17

Clinical view of definitive bridge in place 27 months post loading

Fig : 18

Clinical aspect of soft tissue healing two years later the surgery

Discussion

The present report documented the use of a digitally custom made subperiosteal implant for the rehabilitation of advanced atrophic maxilla. This implant allows immediate loading avoiding invasive procedure such as bone grafting or complex implantation using zygomatic approach. Other surgical approach is considered not indicated for the treatment of 5\6 Misch classification especially in a completely edentulous patient. Subperiosteal implants were first described in 1943 by Dahl in Sweden 19 . However, those implants were associated with high complication rates, such as soft tissue dehiscence, implant superinfection and mobility, and, eventually, implant loss. The immediate load represents one of the keys for the success of subperiosteal implant protocol. All screws and the structure must be loaded in conjunction immediately after the positioning. The subperiosteal implant is not " firstly bone-retained " and we will never get the osseointegration 22 even if the implant is made by titanium alloy grade 5 . The osseointegration is a natural healing mechanism that take place with their principles around an unknown object well documented from many years. The subperiosteal implant is a complete different approach and the success is gained respecting other factors as already widely published from the 70's years. New acquisition techniques, improved hardware and software, computer-assisted design and selective laser melting, allow the customization of implant therapy improving several aspect as only one surgery, accuracy of framework , screws surgical management , titanium alloy , surface treatment , prosthetic connection . When compared to alternative modern designs , the SP4 custom subperiosteal implant of the present study, given its high precision, does not rely on bone undercuts in order to achieve primary stability. The entire digital workflow allows the planning of the implant structure along the maxillary natural pillars favoring forces distribution. Thus, the final design is very minimal, without the need for the implant wings to be extensive or invasive over the bony structure and surrounding muscle and soft tissue envelope.

The smaller the design, the more predictable the sitting of the implant would be speeding up the surgery and reducing the risk of infection, as well as the easier the removal in the unfortunate case of implant failure . For a more effective summary can also remind the innovative devices introduced by the SP4 protocol and its benefits. The "3D flap guide"for incision predicts the prosthetic emergence of the prosthetic connection avoiding additional incisions and prevents early exposure of the implant . The "prototype of the implant "used in conjunction with a more conventional anatomical replica both greatly useful to expose only a sufficient bone surface for implant placement avoiding unnecessary periosteal reflection and reaching a more quicker and predictable healing. The entire digital workflow of the accurate design allows to get even a customized shape to enveloped the head of the screws . The self-tapping of screws give to the clinician an easier and quicker placement in a critical part of the surgery. In addition, gain an excellent stability over the time as it seems after four years of follow-up of 68 consequent clinical case treated with SP4 implants from 2019. The "3D bridge "helps the clinician during the step of placing to maintain a correct position and immobility during the screws insertion. Its "double use "as the rigid framework of the provisional bridge is a way to drastically shorten the time of immediate loading protocol maintaining the optimal fitting with prosthetic platforms of the implant .

Finally considering all details kept until today the SP4 implant protocol seems to be a likely approach for the treatment of the advanced resorbed jaw with implant supported fixed restoration.

Conclusion

Despite the intrinsic limits of a case report, this study showed that 3D digitally made subperiosteal implants, could be a valid solution for the rehabilitation of the atrophic maxilla avoiding long, invasive and\or dangerous surgeries .

Acknowledgments

We are grateful to 3Dfast srl engineers, Padova (Italy), Sig Sandi Andrea and Sig Escolino Salvatore for service , production and technical support

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Application of Digital Dentistry and 3D Impression in Buccal Surgery: A Case Report

Abstract

A dental auto-transplant is a treatment option that should be considered for replacing teeth that are non-restorable. The success and survival rates are directly influenced by surgical techniques. A CBCT allows the surgeon to make a 3D replica of the donor tooth and decrease trauma related to the extraction and adaptation in the surgical alveolus

Key Words: dental auto-transplant, Cone Beam Computed Tomography (CBCT), stereolithography,

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Introduction:

A dental auto-transplant is the surgical transposition of a donor tooth to the alveolus of the same individual that has been surgical prepared[1]. The principal indications for this procedure include dental trauma, agenesis, or extensive dental decay that makes it impossible to restore the tooth to be extracted[2]. Unlike a dental implant, a dental auto-transplant with success allows the periodontium to grow in synchrony with the adjacent teeth and the periodontal ligament (PDL) of the donor tooth has the potential to induce the formation of new bone, gingiva and PDL in the receptor site[3]. Ideally, the auto-transplant should be done when 50-75% of root formation is present or the root lacks 1mm of apical closure[4,5].

The success of the auto-transplant is defined as the direct physiological implantation of the tooth without any signs of pathology or necessity of extra procedures. The survival is defined as the persistency of the auto-transplanted tooth (in spite of the possible function, esthetic or compromised development)[6]. The success and survival rates of conventional techniques are generally high, with rates between 79-100% and 57-100% respectively[7,8].

The preservation of the PDL in good conditions and the adaptation of the periodontal tissues adjacent to the auto-transplanted tooth are two of the most important considerations to qualify the procedure as successful9 .These factors could be modified by surgical aspects such as the number of attempts to adapt the donor tooth into the surgical alveolus, the distance between the new alveolus and the root of the donor tooth, the time that extracted tooth remains outside the alveolus, the abilities of the surgeon, and the trauma related to the extraction of the donor tooth[10].

With conventional techniques, the extracted tooth serves as a template for the preparation of the surgical alveolus. This involves the manipulation of the extracted tooth, which results in several attempts to adjust it to the newly formed alveolus to achieve an adequate adaptation that could result in damage to the PDL and extend the time that the tooth remains outside the alveolus[11].

Nowadays the auto-transplant can be done by minimizing the damage to the donor tooth during the process of the preparation of the alveolus. This is achieved by elaborating a template of the donor tooth that is designed through a pre-operative Cone Beam Computed Tomography (CBCT) in which the tooth will be segmented, printed and then used as a template that accelerates and facilitates the process of the auto-transplant[12].

Case Report

A 16-year-old female patient of the dental service of the Anahuac University in México came to the office for a dental assessment. The patient has no relevant medical history. The clinical and radiographic examination of tooth #19 revealed severe decay that compromised the furcation and all 4 third molars had 2/3 of radicular formation with a classification of Pell & Gregory IIB, mesio-angled from the classification proposed by Winter (figure 1). Considering the extension of the carious lesion, the prognosis of the molar was poor, and hence non-restorable. Based on the clinical and radiographic examination, the extraction of #19 and the auto-transplantation of one of the lower third molarswas proposed to the patient (figure 2). Once the treatment plan was accepted, a CBCT was ordered and the digital impression was obtained by the segmentation of tooth #17 and 32 and then converted into a STL (figure 3) for the posterior impression trough. A stereolithography was performed to decide which of the extracted molars was adequate to be used as the auto-transplant and to evaluate the fixation into the alveolus of the previously extracted molar.

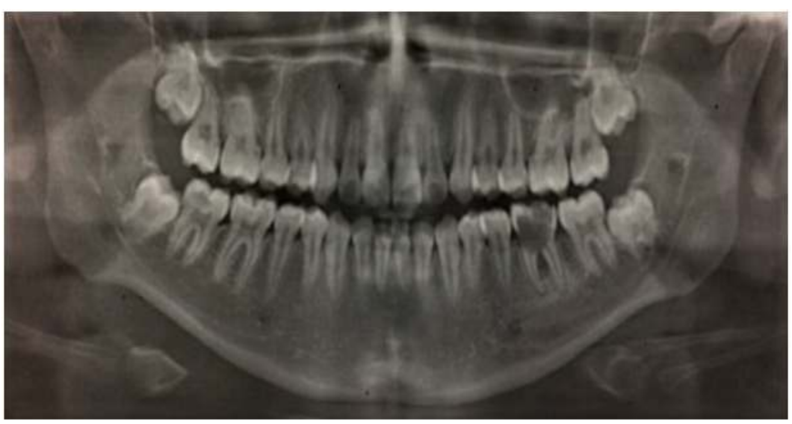

Figure 1. *Initial Orthopantomography, tooth #19 with severe decay and third molars included.*

Figure 2. *3D impression of the lower third molars*

Figure 3.*Yellow STL of tooth 17, Blue STL of tooth 32*

The procedure was done under local anesthesia using 2% lidocaine with 1:100,000 epinephrine with conventional techniques. The extraction was done by dissection of #19 with profuse irrigation of saline solution to the alveolus and then the 3D replicas of the third molars were tested based on the morphology to determinate which one would be adequate to transplant. (Figure 4). Surgical preparation of the alveolus was done in order to make the donor tooth a passive and precise adjustment. Based on the 3D replicas it was decided to extract both molars and in less than 2 minutes the selected molar was placed in the alveolus with minor manipulation (figure 5). The auto-transplanted tooth wassplinted with a metallic wire and composite resin to the adjacent teeth and left out of occlusion. A periapical x-ray was taken for the control (figure 6). Post-operative instructions were given to the patient for conventional surgery, NSAIDS and antibiotics. The patient left withoutany post-operative complications. At 4 weeks, the splint was removed and the patient was kept at 6 month recalls. Three years after the procedure, the patient isasymptomatic; the periodontal tissue around the transplanted molar is health and non-mobile with adequate position and function (figure 7). A composite resin restoration was placed due to decay. Radiographically, adequate bone formation can be seen and the adjacent bone crest is at normal levels.

***Figure4**.Testingthe 3D replica into the surgical alveolus.*

Figure 5. Placing the third molar into the first molar alveolus

***Figure 6**. Immediate X-Ray*

***Figure 7.** 3 year clinical Followup*

***Figure 8.** 3 year x-ray Followup, Projected description with x-ray*

Discussion

A dental auto-transplant is a feasible treatment option to replace a missing tooth[7]. The need to make a replica of the donor tooth is based on the formation of a new alveolus prior to the extraction of the tooth that has been replicated. This is done to reduce the risk of damage and complications, hence minimizing the time and manipulation of the donor tooth once extracted[13].

The reported success and survival rates of a guided auto-transplantwith surgical templates based on a CBCT is from 80% to 91% and from 95.5% to 100%[9] respectively. In comparison, the success and survival rates from a conventional auto-transplant varies from 79% to 100% and from 57% to 100%[7-8]. The clinical precision of the tooth replica compared to the donor tooth had a difference less than 0.25mm[14].

The literature reports several advantages of the guided auto-transplant with surgical templates based on a CBCT: the preparation of the new alveolus with the 3D printed replica of the donor tooth minimizes extra-oral time for the tooth and avoids multiple attempts of adaptation allowing the PDL cells of the donor tooth to stay as intact as possible. The location and position of the auto-transplant can be established with the replica without damaging the donor tooth, simplifying the process.

Even though the auto-transplant nowadays is not the gold standard for replacing lost teeth, it is a valuable therapeutic option that should be considered in specific cases since it offers an elevated success rate and less cost to the patient[15]. The general practitioner and the specialist should be familiar with the criteria for selection and prognosis and stay in touch with the new available technologies that improves the success rate and facilitates the procedure.

Conclusion

By making replicas of the donor tooth based on a CBCT we can make the auto-transplantin an effective way to reduce the surgical time without contributing to the reduction of the damage to the PDL of the donor tooth that could improve the success and survival rates of the procedure.

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Stereolithography in Dentistry. 3D Print

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Keywords: Stereolitography, Computer-aided design, Printing, Digital Dentistry, Additive manufacturing.

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Introduction:

Dental professionals, clinicians and laboratories are looking for digital dentistry technologies and 3D printing, incorporating it with the purpose of assisting procedures, minimizing risks, reducing surgical time and even in communication between the dental surgeon and the patient. Based on tomographic and scanner studies, designs are created assisted by means of a computer and specific software, after which they are translate into their own lenguaje, which transforms these designs into physical objects in 3 dimensions, faithful to the initial model made in the computer. There are various techniques for the manufacture of 3D models, varying the type of material to be added, being the photopolymerizable resin in liquid state, the most used option in dentistry. The efficient use of stereolithography is already well established and proven in practice and in the literature and has multiple applications.

The purpose of this review is to summarize and evaluate the state of the art of 3D printing and mainly stereolithography, being one of the first technologies focused on digital dentistry, in the hope it will make 3D printing feels less foreign and more familiar to use. daily in the dental office.

3D Printing

3D part printing is a group of additive manufacturing technologies where a three-dimensional object is created by superimposing successive layers of material.The way the material deposition occurs defines the type of 3D printing technology. (1)

In the last decade, widespread proliferation of dental 3D scanners, CAD/CAM treatment planning software, and dental mills have contributed to an improved patient experience in dentistry. Broadly conceived, contemporary technologies in digital dentistry consist of these two innovations as they exist in clinics and labs. But recent currents in the world of dentistry have argued that 3D printers can further improve this paradigm, closing the loop by offering affordable fabrication localized to the individual dental practice.

Conventional systems based on impressions with addition and condensation silicones, and a duplicate model in plaster, have shown great precision and versatility in their uses. For comparative purposes, it will be important to consider that a good impression material is one that achieves good dimensional stability, maintaining shape and size for an adequate time, being kept from 24 to 48 hours with minimal variations. The addition silicones are the ones with the greatest stability, most of the contraction occurs in the first 3 minutes after disinsertion, and is compensated by the expansion of the casting material, generally type IV plaster, presenting after said contraction a dimensional stability of 99.8% (2) therefore the precision of said material is not inadequate, which makes us wonder what the real advantage of 3D prints would be. Speed is a fundamental advantage of 3D printing that is critical in the race to bring new products to market, but how fast is fast enough, and what is speed measured? In reality, speed is a relative measure, and when it comes to 3D printing, many variables are related to determine what is "faster" and "slower" hence can be misleading. While some generalizations are appropriate, few are true when the concept of speed is fully considered. The correct conclusion considers the total process time, degree of automation, configuration and printing speed, but really what you are looking for is an efficient process: one that has some bottlenecks, a lot of automation and fast response. To find that efficiency, you need to understand your operations and know the truth about 3D printing and processing time. The time it takes the printer to do the process is the most valued measure of the process. But it is only a component of the elapsed time, to complete the piece said construction time is only one stage of a much longer career. The 3D printing process has many phases, including file preparation, system preparation, construction, post-construction operations, and piecewise post-processing. To measure speed, we must time the whole process: It starts the timer the moment it receives an STL file, and stops it when the part is ready for processing. [3]

Dental 3D Printer

The adoption of dental 3D printers is driven by innovation in three major categories:

1. Accuracy and Repeatability:

Accuracy and repeatability are essential qualities for a 3D printer that will be used in dentistry. To provide the highest standard of care, extremely high accuracy is a non-negotiable feature. Recent advancements in materials and printing technology have supercharged the accuracy of 3D printers, propelling them beyond what was originally thought possible. (Fig 9)(3)

The mockup printing for smile design is a clear example of the need for printers that manufacture with precision, accuracy and detail what is planned and designed in the software. (Fig 1)

The central requirements of dental manufacturing are very high accuracy and repeatable results. Bringing the manufacturing of models and other appliances in-office only pays off if the technology can consistently provide the tight tolerances required for fitted parts. It isn't enough for a single print to provide good results; they need to be repeatable over time and across various environments. Though printers can be easily bucketed into categories based on the details of their underpinning technologies, these categories rarely tell the full story. (4)

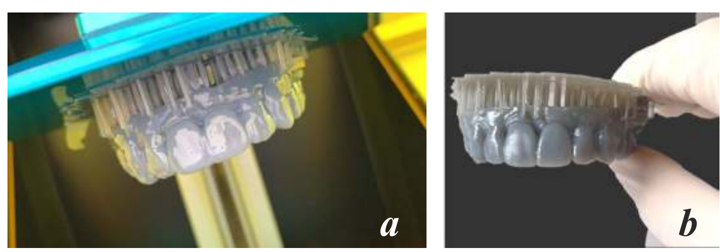

Figure 1. *a) Mock up on printing platform.*
b) mock up with pillars, printer for smile design, with standard resin.

2. Production Speed and Scalability

A dental 3D printer should offer rapid print speeds and high overall production throughput. These are a factor of build plate size and light delivery technology, and should not be overlooked. Though the practice may not need high throughput immediately, production needs tend to scale up quite rapidly once they start.

A printer that seems adequate before you start may become a bottleneck when the versatility in applications becomes clear.

Same and next-day chairside production of dental appliances is a longtime dream of digital dentistry, and dental 3D printers have the capacity to make this dream a reality. But while certain aspects of 3D printing technology have begun to converge, there is still a big difference in production speed and scalability between individual printers. A large portion of these discrepancies is motivated by the technology that underpins each printer type, though some are not. (5)

***Figure 2**. Surgical guide for single implant, with auxiliary window, for irrigation and visualization, printed with biocompatible resin, on Anycubic printer in 1 hour and 30 min. The image shows the base and support pillars placed for printing.*

While dental 3D printers are sometimes used to manufacture only one or two parts at a time, many cases require the rapid fabrication of a large number of parts. Clear aligner cases are the obvious standout, but batched nightguards, surgical guides (Fig 2), and denture bases all require large print volume as well. The emphasis of development in this region of the technology is focused on reducing both single-part as well as full-batch print speeds.(6,7)

3. Biocompatible Materials

Materials innovation is at the heart of dental 3D printer adoption. While the production of dental models is crucial for many practices, the creation of dental appliances that can be placed intraorally, such as nightguards, surgical guides, interocclusal splint for orthognathic surgery(Fig 3), and digital dentures, exponentially expand the functionality of the machine. These biocompatible materials help practices exercise control over the timing, cost, and quality of the appliances they deliver to patients.(8)

Dental 3D printers reached an inflection point when biocompatible materials became widely available for desktop machines.

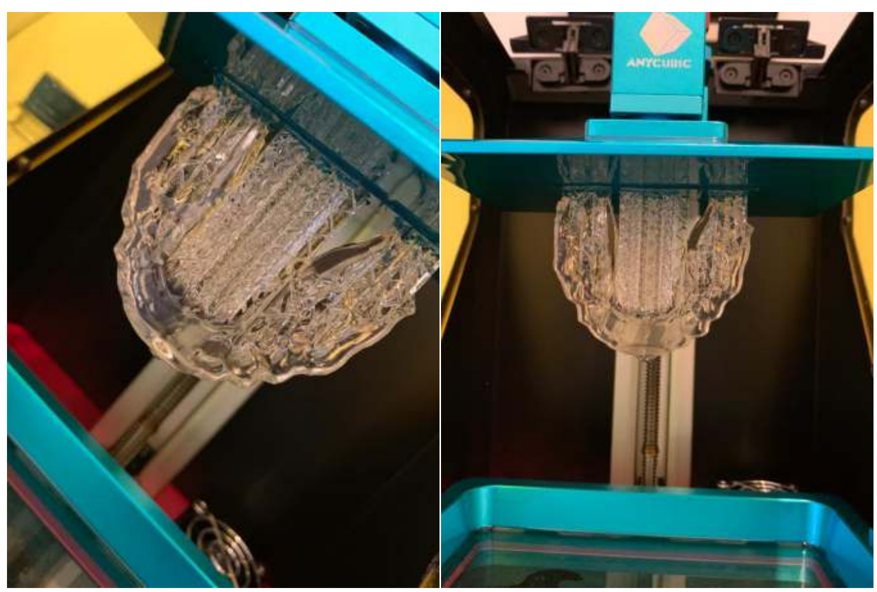

***Figure 3.** Print of interocclusal splint for orthognathic surgery, in Anycubic Printer, in the image it is still shown on the impression platform, above the biocompatible photocurable resin tank and with the support pillars based on the platform.*

These FDA-compliant resins make 3D-printed parts safe for intraoral use and offer great mechanical properties, fast production and low cost, propelling desktop 3D printers into dental practices all over the world.

Since the introduction of biocompatible materials for 3D printing in dentistry, there has been an emphasis on improving mechanical properties to provide printed intraoral parts that have great strength and high resistance to wear. Because materials innovations can come from anywhere, it's important to choose a 3D printer that offers support for third-party materials. (9)

3D printing Technology Types

It is important to know the printing techniques that exist to finally decide the use of a printer according to the use that you want to give it.

Digital dentistry is largely served by a type of 3D printing that falls under the umbrella term stereolithography, often abbreviated as SLA. These printers use ultraviolet-spectrum light to cure photosensitive liquid resin. Broadly speaking, there are three ways to deliver that light in a desktop 3D printer, each with its own advantages and drawbacks.(10)

Figure 4. *Different brands of printer with different types of light projection to cure the resin deposited in their tanks or storage trays, LCD, DLP and SLA technologies. (Images available on the manufacturers web site, Anicubic, Phrozen Formlabs, SprintRay)*

In this process, a liquid photopolymer is transformed into a solid pattern by activation with ultraviolet light, one layer at a time. The photo-reactive polymer is selectively exposed to light to form thin layers by being "drawn" with a laser. It allows the printing of small objects, but with a high quality of details. It can print a large number of highly detailed objects in relatively short periods of time, but it takes longer than DLP. This process is best for printing multiple small highly detailed objects at once and for larger highly detailed prints. This type of printing requires supports during the production of the pattern. Printed objects do not resist high temperatures very well, being able to deform over 60 ° C. It is a very versatile type of technique. There is hardly any waste of material and it requires almost no post-processing since it prints products that are practically ready to use except for smaller printers, called "desktop", where the final product requires a post-polymerization process by light in a chamber separately, in order to obtain the optimal physical properties of the materials used. Digital light processing (resin) (DLP) Also corresponding to a type of stereolithography, a liquid photopolymer is activated by a light projector, solidifying the layers in the form of rectangular blocks (voxel). Unlike the SLA, it is not "drawn" but complete layers are projected onto the resin, printing in layers. It allows printing of small objects, but with a high quality of details. Print speed is faster than SLA as a full layer is exposed in one go. Printing a large area at a time and making smaller objects in more detail resizes the projector to print smaller layers faster. You cannot print a large number of highly detailed objects at the same time, you can print highly detailed objects, but in small volumes. They are restricted by the size of the pixel (voxel), which mainly affects the surface finish, where textures of the blocks (voxels) can be seen. This process is best for printing a very detailed small object, but one at a time, and for printing large parts without much detail more quickly. They also require special supports during their manufacture and with desktop printers a post-light cure process is required. (Fig 4)(11, 12)

3D Printing Fundamental technologies

1. Print volume : This feature of printers differs greatly from one to another, it corresponds to the amount of material that can be printed in a single run. When choosing a 3D printer, it is important to know and make sure that the capacity of the printer is the right size for the planned tasks, since some systems are designed to be used in the clinic to quickly produce some structure and others in the laboratory for production mass of models or other structures, but printing a large number for each run. It is generally proportional to the size of the printer, but this property should be noted, as some clinical desktop printers have different size printing platforms, which translates into a higher or lower print volume.(13)

2. Speed : The printing speed is a very important factor to determine the final use that will be given to the printer either in the clinic or in a laboratory and thus be able to evaluate its efficiency. It depends mainly on the properties of the printer, but also on the material to be used and the degree of complexity of the objects to be printed. That is why it is essential to determine the use that will be given to the printer and then make the decision that best suits whoever obtains it. In desktop printers a higher printing speed is related to a lower quality of reproduction of details, although there are printers that have different printing programs, varying the quality and speed. In industrial printers, this can be compensated.(14)

3. Size : The size of the printer is important in determining its use and final location. It depends on the volume of production that you want to obtain, mass production printers have a much larger size (up to 120 x 150 x 195 cm), on the other hand there is a type of printer that we can call "desktop" that have a much smaller size (from 26 x 38 x 37 cm), but its production volume is lower, being able to produce unitary objects or a few small objects at the same time. (Fig. 5)(14)

a) *Jaw impression on printer plataform.*
b) *Jaw printed without supports and with final curing.*
c) *Jaw Printed lateral view.*
d) *Technical characteristics of anicubic printer. (Image and information available on the manufacturer's website)*

Figure 5. *3D impression of the jaw biomodel for surgery planning is observed in Anycubic printer, with printing size 115Lx65Wx115H with standard white resin. Despite being considered a small desktop printer; it has sufficient dimensions to print larger models like this adult jaw in natural size.*

4. Post-impression treatment

Most of the smaller printers (desktop) only print in resin, subsequently having to create the structure, finish light-curing it in a suitable chamber and carrying out a final washing and polishing with suitable instruments that come with each printer. Larger printers, some of the "chairside" or mass production type, already have a post-polymerization, washing and some polishing system, obtaining a completely finished print. Post-polymerization or post-curing allows the material to have the appropriate properties indicated by the manufacturer, such as mechanical properties, complete polymerization and eliminate free monomers, often toxic. The polymerization chamber basically consists of a UV light box, suitable for post-curing 3D printing materials, equipped with several UV light bulbs or bulbs strategically placed inside the box ensuring that the product is illuminated from all sides, resulting in a fast and uniform cure cycle. They vary in sizes, including being able to put articulators inside. The final washing is very simple and the removal of support structures is done with instruments included with each printer. (Fig. 6)(15).

Figure 6. *Curing chamber, with rotating plate, adjustable programs for time, light and heat, for post-process 3D printing, walls and mirror-like platform to allow light reflection.*

5. STL Formats

The digital files where the object to be printed is designed must be reliable and as good as the final result, in general the formats are very precise. Almost all dental 3D printers are open architecture systems capable of working with STL formats, some can work with other open formats, PLY, or a range of other 3D CAD model formats. These files are designed by CAD software and printed using a CAM application. Although there is a high degree of prior customization of the object to be printed, most CAD CAM applications automate the processes to make the process of sending data and printing very easy. There is also a compatibility of the material to be used. In all printers for dental use, liquid photopolymerization resin (polymer) is used as material, but not all printers offer compatibility of resins for the production of an object, either due to an economic factor, due to the different presentations in which it can be used. come the resin and the compatibility with the system or by the technique used by the printer, which allows the use of one type or another of resin. (Fig 7)(16, 17)

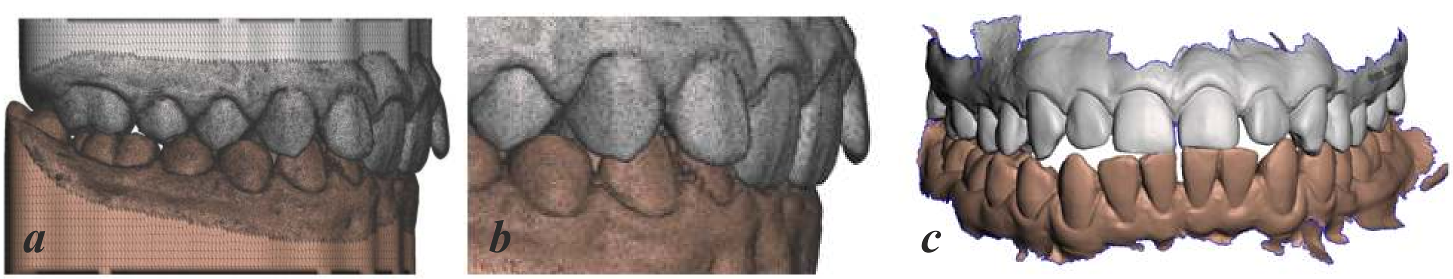

Figure 7. *Image of STL files in viewing and editing mesh mixer software. Intraoral scan image. Both images represent STL files, a format used for 3D printing as an exported language by design and planning software.*
***(a)** stl files in mesh mixer software, **(b)** Zoom where you can see the mesh of triangles that compose the file, **(c)** Intraoral bimaxillary 3d scan view.*

Dental 3D Printing Materials

Currently there is a huge amount of materials for 3D printing, used for different types of production and with different characteristics and purposes, some printers are designed with a single purpose and work with only one type of material, but many printers today they allow a range of material compatibility. It is important to know the characteristics of some materials that could have clinical applications, their properties and their adequate certification. For the choice of a printer, first of all you must be clear about the product (s) you want to obtain and before that the type of material that performs best in that type of production, for example, is very different to manufacture instruments or customize apparatus, which make a model with a great reproduction of details. The following is a general review of some materials used in 3D printing and then in detail the materials used in dentistry and clinical applications.(Fig 8)(18)

Figure 8. *Surgical guide for implants, printed with biocompatible photocurable liquid resin, respecting the principle of devices that are used intraorally with patients. In addition to the precision of details, mechanical properties must be manufactured with ideal materials to be inside the oral cavity. A printed guide is observed prior to the curing process with abutments and support base.*

Numerous resins have been developed to be used with SLA, DLP or cartridge printing systems. They are photopolymers that solidify on contact with light, changing their physical properties. They present a great reproduction of details, smooth and polished surfaces, and complex geometries are obtained without defects. It has many variations with different characteristics. Its biocompatible versions are one of the best options in dentistry for the great reproduction of details, mechanical properties and final finish.(16,19)

Although the most used material in dentistry is the photopolymerizable resin in liquid state, which solidifies on contact with light, to be able to be used with SLA, DLP or printing with light cartridges techniques. Due to its great versatility of uses both at personal and industrial level, biocompatibility, good mechanical and aesthetic properties, great reproduction of details, printing of complex geometries, excellent finish, smooth and polished surface and a relatively short time to obtain the models. Although resin is the most widely used material, depending on the type of printer and the technology that each company develops, there are many different characteristics or associations with other materials that different brands offer, which translates into different uses, better or worse properties. for different objects to print. There are resins for models, custom trays, surgical guides, bite and flat registers, resins ready to be used in the mouth (biocompatible) as for temporary crowns, resins to be cast and create objects, cast or injected (metal or ceramic), resins soft and flexible (for gingiva impression, for example). The presentations of these resins can be in bottles and cartridges depending on the printer used. There are universal resins that can be used with different brands of printers that accept them and there are resins for the exclusive use of certain brands of printers. (Fig 9)(19, 20)


Figure 9. *Surgical guide designed for two implants, printed with biocompatible resin, where the precision and accuracy of the diameter of the cylinders is tested prior to clinical use with the patient, to corroborate their measurements with the drill to be used.*

Conclusion

The 3D models represent a great advance for the dental environment, being the stereolithography technique the most used. This technique should be used by the dentist as an auxiliary resource, which can provide specific information, especially in those cases of greater complexity. Similarly, there are specific indications for the use of the stereolithography technique, thus avoiding unnecessary cost.

There are numerous characteristics when analyzing the types of 3D printers, but the most important thing when choosing a printer or analyzing a group of printers is to decide the use that you want to give it, since despite there are several factors in common there are some determinants between the different brands and even within the same companies there are models for different purposes. On the other hand, companies try to specialize in one area, develop new technology that may appeal to the general public, or focus on a target audience. What the clinician must be clear about is the purpose of use, if he wants a versatile printer that can deliver different products, there are several options and then the rest of the characteristics such as price, size, print volume must be analyzed, compatibility with different systems and materials. But on the other hand, if the professional wants, for example, a printer only to make castable structures, there are fewer options, if he wants the printer only to make provisionals quickly in the clinic there is an option, if he wants a greater production only of models, Laboratory or mass production printers should already be taken into account, which goes hand in hand with a very high initial value. It is worth noting that there is a very important factor for clinical dental work, leaving aside the price, speed, production volume or the size of the printer, which is the reproduction of details, although most of the Dental printers reproduce details with an accuracy of 20 to 100 microns, this could make a difference when making structures in terms of the accuracy of the impression, small difference, but it is necessary to consider. Therefore, it is then impossible to determine which printer is the best in the market.

The role of the models obtained by stereolithography is in continuous updating, where it is worth mentioning the multiple uses in different areas of dentistry. This technology allows an improvement in communication within the multidisciplinary work team and with the patient and, it should be noted, the contribution in teaching students thanks to the planning and design of treatments; improving their learning curve.

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SOCKET SHIELD TREATMENT AND IMPLANT PLACEMENT USING DYNAMIC NAVIGATION

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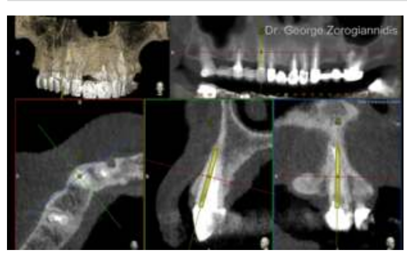
Dr George Zorogiannidis has graduated from the National University in Athens Greece in 1980.He practices General Dentistry in his private office. Since 1989 he started using implants in his practice, and has gathered a vast experience concerning most of the well-known implant systems today. He practices both the surgical and prosthetic aspect in dental implantology, applying the latest and most accepted principles of it. He has participated in a large number of international congresses, During the last 15 years he is using 3D guiding software in all implant cases of his practice, and since April 2020 is the first user in Greece of the Navident system which utilizes Real Time Dynamic Navigation in implant placement, as well as in other oral surgery operations too,

INTRODUCTION

Partial Extraction Therapy (PET) consists of 3 entities: Socket Shield (SS), Pontic Shield (PS) and Root Submergence Technique (RST). The concept is to preserve the periodontal ligament associated with the buccal portion of the root and its vascular supply. In Socket Shield (SS) a portion of the root is intentionally retained. By using Dynamic Navigation, the surgeon can be guided both through the procedures of cutting the root fragment and immediate implant placement.

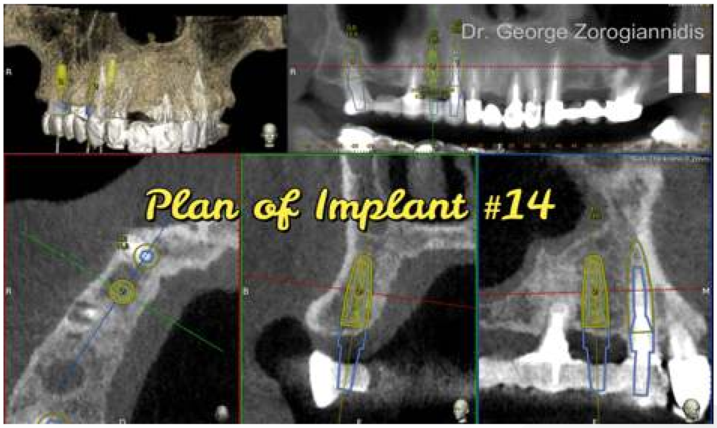
CASE REPORT

A 75-year-old female patient with no systemic diseases or conditions attended the clinic of our office with the main complain "All my upper right teeth are moving". The clinical examination showed a Fixed Partial Denture from #13 through #17 with abutments in teeth #13,15, and 17 and pontics #14,16. Teeth #13 and #15 had a subgingival decay and fracture. Tooth #17 was periodontally compromised. A CBCT was taken and after evaluation it was decided to extract teeth #13,15 and 17 and immediately place implants in sockets #13 and #17 as well as in place of #14. Additionally, Socket Shield (SS) will be performed on tooth #13 due to extremely thin buccal plate, which had already a root canal without any pathology. For this operation Navident® System from Claronav® was used both for planning as well as for drilling and placing implants.

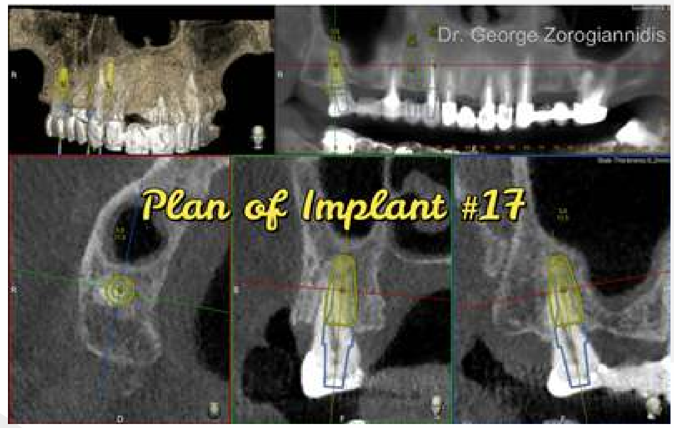


Planning of Socket Shield with Navident

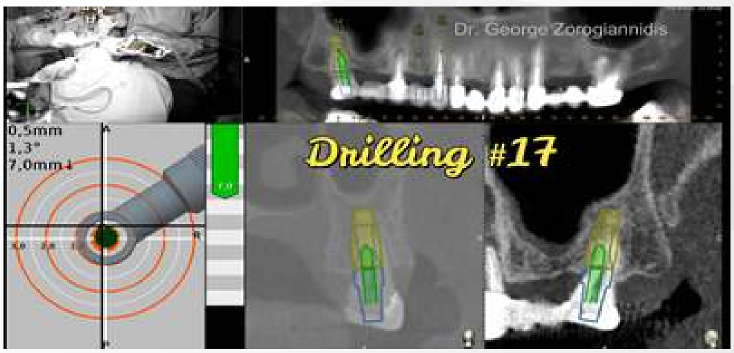
Planning of Implant #13 with Navident

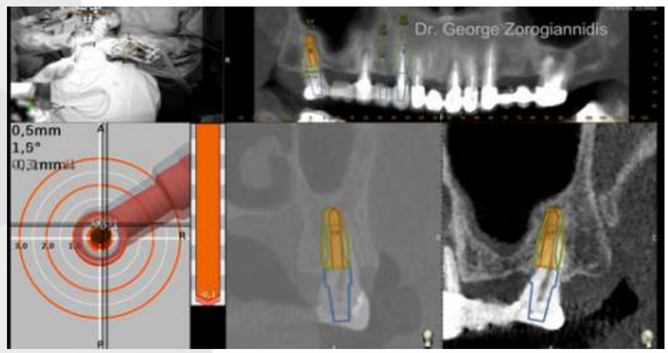


Planning of Implant #14 with Navident

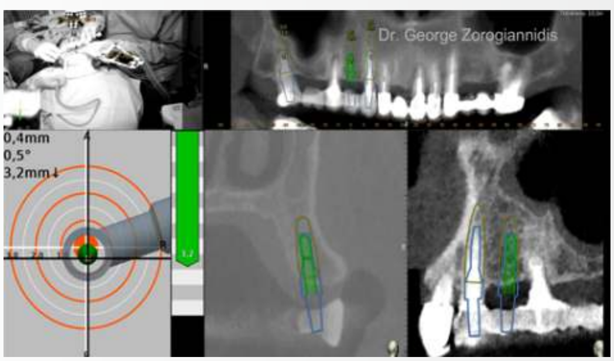


Planning of Implant #17 with Navident

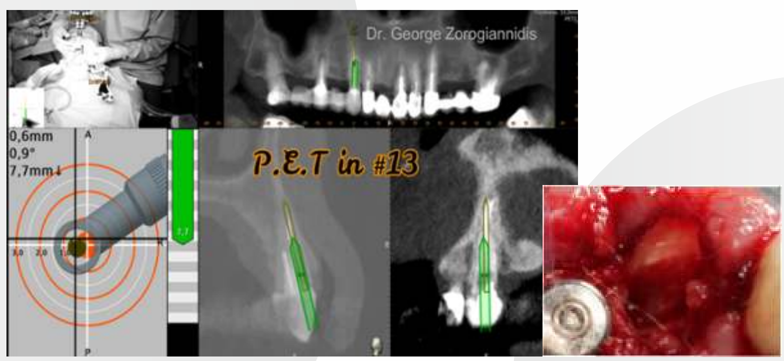




Drilling and Placing #17 Implant with Navident

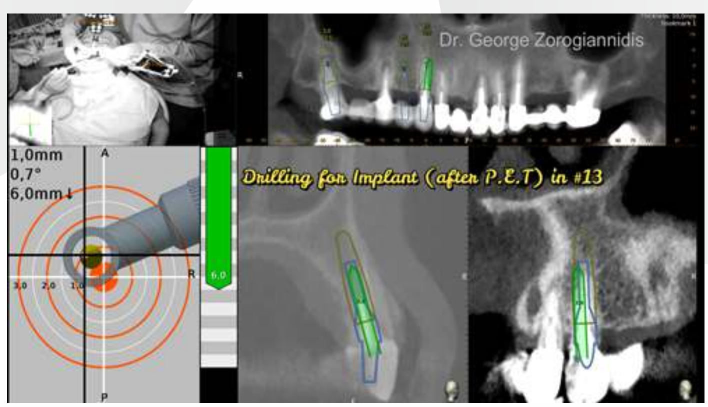


Drilling and Placing #14 Implant with Navident

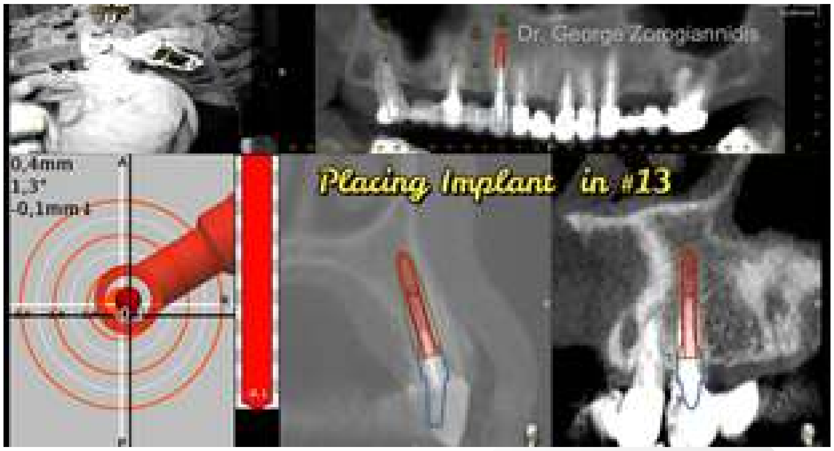


Socket Shield root separation of tooth #13 with Navident

Apicectomy of tooth #13 with Navident



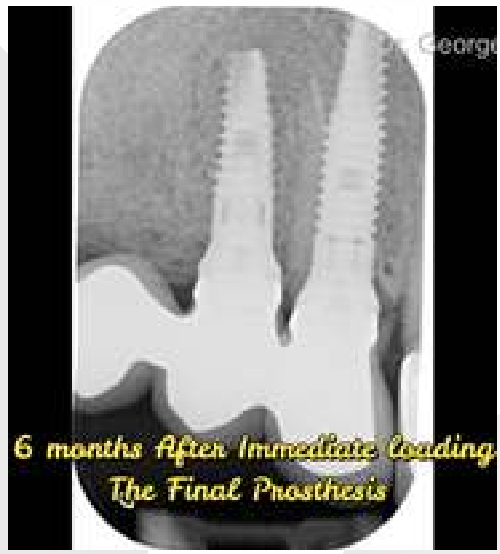
Drilling for Implant #13 with Navident



Immediately after implant placement and socket shield an impression was taken on Multi Units level and within 2 days the patient received a Fixed temporary prosthesis on implants #13 to #14 and #17 which was immediately loaded.

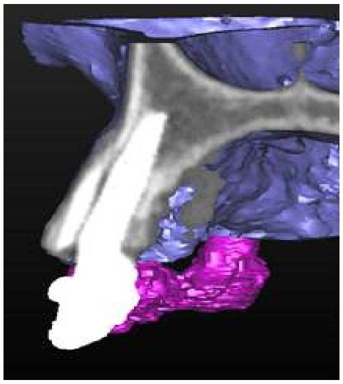
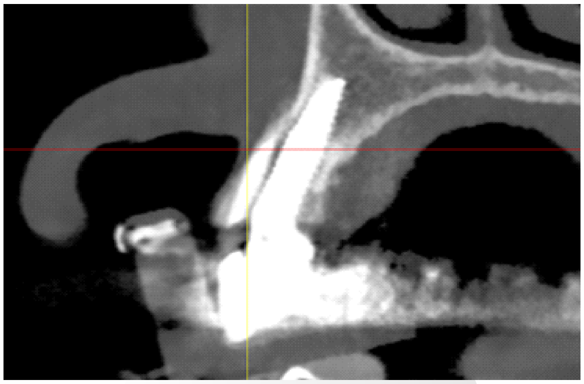
Placing Implant #13 with Navident

After 6 months the temporary prosthesis was replaced with the final one from Porcelain fused to Zirconia on tibase units. Please note the distally inclined root segment of #13 on the 2nd x-ray.

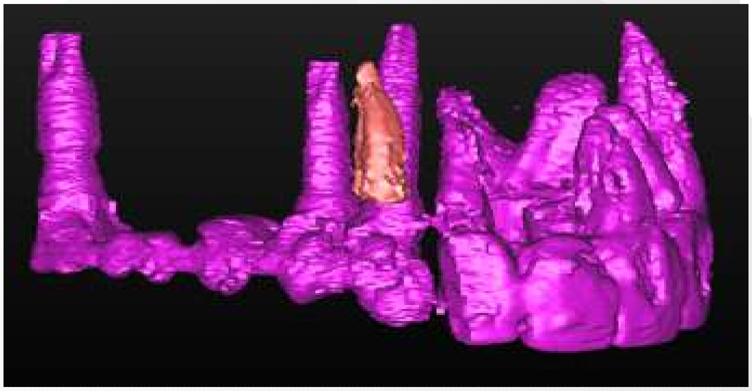
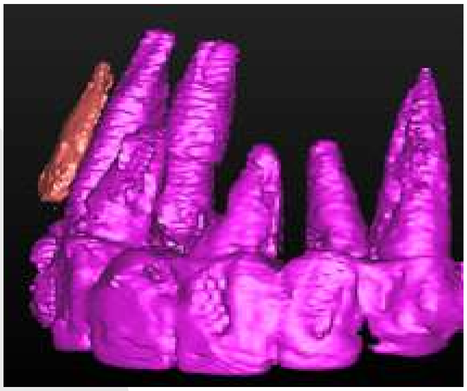


Please Note the Volume mainte nance in area #13

After 7 months it was necessary to do a new CBCT due to failing front upper teeth so we had the opportunity to check the root segment position in 3D as well as the buccal bone maintenance. Here are some cuts and 3D pictures after the segmentation of the data.


The part of the root that has been kept in place is clearly seen and the buccal bone is kept intact.

Please note the distally inclined root segment of #13.

CONCLUSION

Incorporating Dynamic Navigation in other operations besides implant placement in the mouth has been very helpful and the results are very satisfying and precise.

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What kind of printing technology were I Using? What are their features?

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Certification in Autodesk Inventor Advance

Certification in AutoCAD 3D and Animation Rendering

Certification in AutoCAD 2D and advanced tools (plotting tools and DWF)

Introduction:

Nowadays we can already materialize some of our dreams or ideas through 3D printing. This, over the years, has become much more accessible to the ordinary citizen; the increasing of new printer brands and competitive pricing help make it more common to find one in each dental office or lab. Currently, there are various types of technologies to be able to print in 3D. However, this technology has been used for various industries and their developments; in the case of dentistry, it has reached a fairly high level of research, leading the levels of application and use of 3D Printing, which has allowed the development and innovation of this branch of health, as well as the transformation of work protocols and adaptation to new business models.

Printing Systems

Dentistry has incorporated into its use various types of printing technology such as CNC Milling, SLS, FDM, SLA, DLP systems with their LCD printing variant, the last 3 being the most accessible and recommended in clinical practice. These systems not only provide the dentist with the ease of materializing and experimenting at a low cost, but they also represent a lower investment cost both in supplies and in machinery with an increasingly precise and fast performance.

However, it is very important to know what system we are working with since it is essential toput the equipment to good use, avoid the deterioration of our units, use the supplies correctly and configure each printer with to the specifications needed to achieve a printed object with quality and precision.

SLA system - Stereolithography

It was the first technology created in the world and continues to be one of the most preferred in the dental field due to the use of liquid resin and the precision achieved by its printed objects.

The functionality of this system lies in the fact that it draws each segmented layer of the object to be printed, point to point made by a low frequency laser light beam that photopolymerizes the resin, solidifying it on the printing platform, thus forming our final object.

The guide of this laser light beam is directed by galvanometric mirrors that refract it following the coordinates provided by the programming of the file generated in the software of each brand or generic, slicer. (Fig 1) Among the fundamental parts of this system we would have:

1. Print Base (Z axis)
2. Supports
3. Print Object
4. Scraping system (X axis)
5. Resin tank
6. Laser beam
7. Scan mirror
8. Galvanometric Mirrors
9. UV Laser

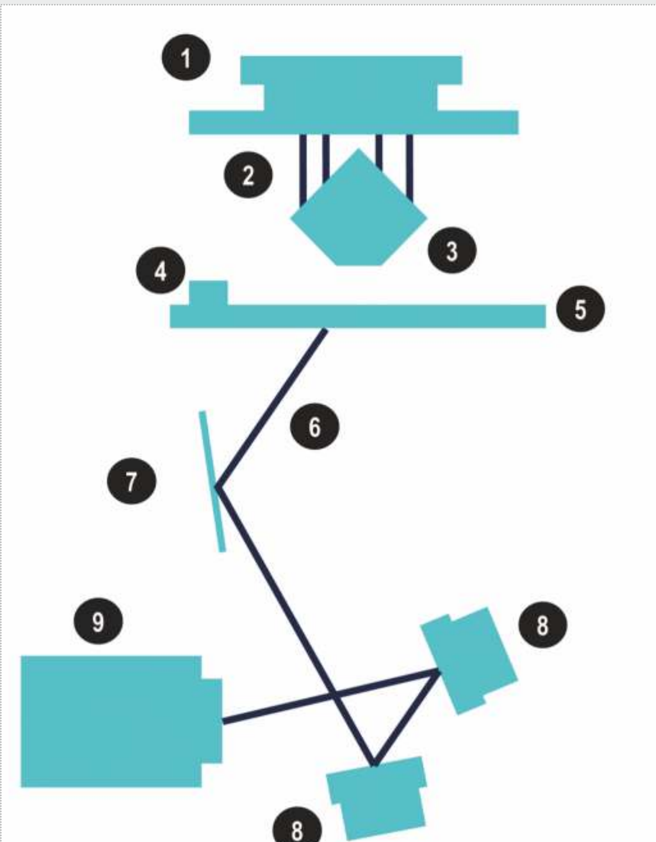

Fig. 1 *Parts of DLP system*

DLP System - Direct Lighting Processing

Technology that is increasingly surprising in terms of quality and speed. This system has a functionality very similar to the SLA but replaces the laser light beam and galvanometric mirrors with a digital light projector. This image is composed of square pixels called voxels. that photocure each entire layer at once on the printing platform, which reduces the print time

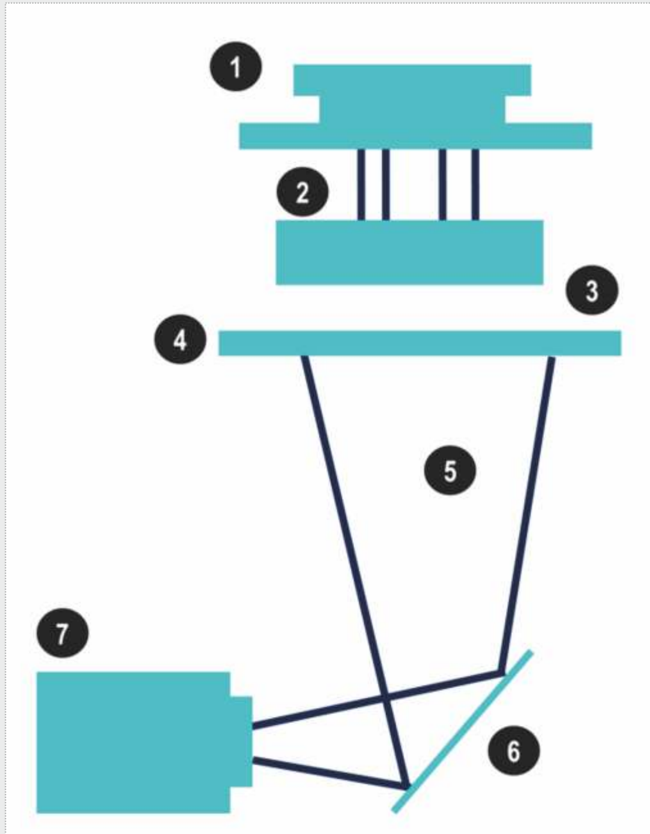

Fig. 2 *Parts of DLP system*

relative to SLA technology (Fig. 2).The basic parts of this mechanism are:

1. Print Base (Z axis)
2. Supports
3. Print Object
4. Resin tank
5. Beam of light
6. DMD (digital micro mirror device)
7. Light source projector

LCD system

It is a recent variation of DLP technology, uses a UV light lamp screen or LED display eliminating projectors, they propose a uniform projection mechanism of each layer solidifying the resin as in DLP technology. The quality and speed of this technology is increasing due to the constant innovations regarding the definition of screens, currently in 4K format, which makes it the most economical but very efficient within all systems, since many models are replacing the functionalities of SLA and LCD technologies. (Fig 3) The basic parts of this mechanism are:

1. LED Light Screen
2. Scanning mirror (depending on the manufacturer)
3. Resin tank
4. Build plat formor dock
5. Z-axis worm gear

SLS System - Selective Laser Sintering

It revolutionized the world of industries that work with metals, but oriented to dentistry, it allows great precision for the manufacture of accessories and tools for different treatments. The functionality of this technology lies, as in SLA technology, in the use of a diode or CO_2 laser that synthesizes, scans and solidifies layer by layer of polymer powder of the object to be built, the focus of this laser is Guided by galvanometric mirrors that, through the programming described by the slicer file, allows drawing point by point.

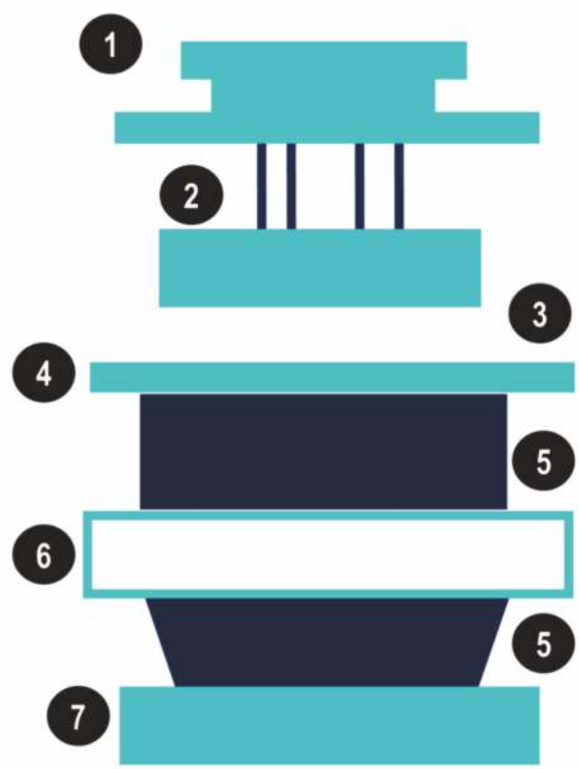

Fig. 3 Parts of LCD system

In this system material loss is reduced and the use of supports attached to the printing object is eliminated. This process is carried out vertically in an increasing direction (from bottom to top). For the printing process you will need a tank that is filled with polymer powder which is heated to a temperature slightly below its melting point and then by means of a blade a layer of the powder is poured on the printing platform and The laser begins to solidify the polymer by drawing the layer and leaving the rest of the powder without solidifying, which serves as a support for the construction of the object to be printed. The basic pieces of this technology are:

1. Heaters
2. Construction chamber
3. Blade or powder delivery system
4. Coater
5. To be
6. Galvano metric mirrors
7. Scan mirror

FDM system - Fused deposition modeling

It is the best known system in the general market, it works unlike previous systems with plastic filaments which are fused by a hot extruder that deposits it point by point, layer by layer, just like SLA technology, it works vertically in increasing sense on a printing bed that, depending on the material, will need to be preheated for greater adhesion of the object to be printed. Due to the material used, it is one of the systems that provides the lowest final quality in the objects, in the dental field it is used for prototyping of anatomical structures. (Fig4) As fundamental parts of this system we have:

1. Filament
2. Extrusion gears
3. Platform or upper guides
4. Extruder
5. Print Object
6. Build platform or print bed
7. Supports

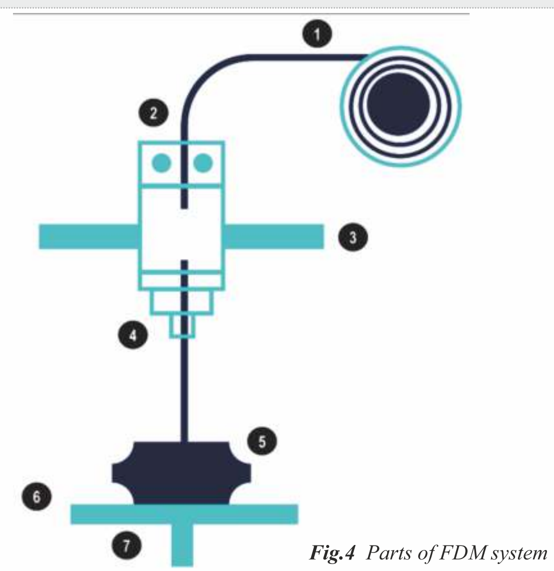

Fig.4 Parts of FDM system

Conclusion:

Each printing system has advantages and disadvantages, which must be evaluated after purchasing the equipment, so that they can meet the expectations. Preferences in the choice of the printing system can be focused on the analysis of the business model that we develop, the load of printed objects that we want to obtain in a certain time, the economic investment that we can generate, but it will always be essential to remember that each team It requires a learning curve on the part of the professional, a process that goes hand in hand with constant training, technical support from the distributors and follow-up to the update and improvements that are generated in the 3D printing equipment.

Based on the aforementioned technologies, multiple comparisons have been made, however, it is very important in each and every one of them to correctly calibrate the equipment, optimally generate and configure the print file, and correctly place the supports if required for thus being able to have the best quality in the final printed objects.

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