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Case report

Use of Stereo lithographic Model in Implantology: Presentation of a Clinical Case with Severe Mandibular Atrophy

Dario Spitaleri[1*], Franco Ferrante[2], Andrea Palermo[3] and Carlo Campana[4]

[1]*DDS, Private Practice in Udine, Italy*

[2]*DDS, Specialist in Oral Surgery, Department of Surgical Medical Sciences and Integrated Diagnostic, University of Genoa, In Genoa, Italy*

[3]*Private Practice in Lecce, Senior Clinical Lecturer BBP University City of London Dental School, UK*

[4]*Ceo Di 3dprintersurgery, Italy*

Abstract

Aim

The aim of this study is to present nowadays the Stereolithographic as an important aid in the clinical practice of implantology and oral surgery.

Materials and Methods

Thanks to the aid of the stereolithographic model, it was possible to rehabilitate a 55-year-old patient, a complex clinical case for extreme mandibular atrophy and for the systemic situation of the same.

Results

The clinical case presented ended with the rehabilitation of the third quadrant, extremely atrophic,with implants, eliminating the lower mobile prosthesis and improving the masticatory function.

Discussion and Conclusion

The anatomical replicas have seen in the last years, in the medical field, one of the most interesting applications. Thanks to the advantage of an immediate and realistic awareness of the anatomical site on which you will have to intervene, you have the opportunity to physically interact with the surgical site, without neglecting a better medical-patient relationship.

Key Words: Stereolithography; Implantology; Severe Atrophy

Introduction

The anatomical replicas represent the most advanced level of the representation techniques of a body tissue. Starting from the two-dimensional images of digital diagnostics, through successive elaborations and using rapid prototyping technologies, physical models are obtained that reproduce any type of geometry [1]. The replicas obtained can be processed with normal operating room instruments, allowing a complete planning and simulation of surgical interventions.

Given the continuous evolution and the current diffusion of the implant-prosthetic techniques, more and more frequently the doctor - dentist is faced with the requests of the patients to give them the possibility of functional and aesthetic rehabilitation in times and in more and more contained costs [2]. The modern

***Corresponding Author:** Franco Ferrante, Department of Surgical Medical Sciences and Integrated Diagnostic, University of Genoa, in Genoa, Italy via Don Cosma 41, Surbo (Lecce), 73010, Italy, Fax +39 083236608, Tel: + 39 3334433758; E-mail: franco_ferrante@yahoo.it

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osseointegratedimplantology has certainly brought considerable progress to daily practice, allowing a far greater number of patients than in the past to benefit from a fixed prosthesis until a few years ago unthinkable, with predictability of successes operators who still reach the 98% [3]. However, it should not be underestimated that there is a large population that can not be subjected to such methods because it lacks the biological and anatomical requirements or the limited economic possibilities. Moreover, very often biological and technical needs imply poorly modifiable therapeutic times, which many patients find difficult to accept.

The modern endo - osseous implantology finds, therefore, some limitations to its application if not at the price of important and extensive regeneration and reconstruction of the maxillary bone atrophy, on which the results of osseointegration are still uncertain, and the biological costs, both psychic and physical, and the economic costs areamplified. Based on these assumptions, research in recent years has addressed the resolution of problems that limit the applicability of implant and prosthetic treatment.

In this direction, therefore, the work focused on evaluating the possibility of combining different surgical - implant and prosthetic - innovative prosthetic techniques, until now scarcely used for this purpose, in association in order to overcome the feasibility limits, the times, the biological costs and needs of traditional endo - osseous implantology [3].

Modern technology has made rapid prototyping systems already available in the industrial sector available to diagnostic medicine. The use of these systems has offered interesting opportunities to all surgical branches of medicine, simplifying the conventional protocols and reducing the time required for execution, but above all it has opened new perspectives in the maxillofacial and dental field. Stereolithographic or anatomical biomodel represents the three-dimensional reconstruction of images obtained with instrumental investigation Tac.

Through the computerized processing of tomographic images and a specific software for tissue segmentation, it is possible to obtain the three-dimensional development of the sections and the subsequent polymerization of a fluid resin, which faithfully reproduces the graphic representation [4].

This reconstruction of the bone and dental structures is obtained from data processed on dedicated software, starting from two-dimensional digital CT data, processed three-dimensionally thanks to the implementation of CAD (Computer Assisted Design) - CAM (Computer Assisted Manufacturing) to overcome the problems related to the deformation and distortion of traditional radiological images.

The precision of reproduction, compared to real anatomical structures, is in the order of one tenth of a millimeter or slightly lower if you use the latest generation of equipment using the 'polyjet printing' technology where the print definition reaches 16 microns (it should be specified that the definition of printing does not coincide with the overall accuracy of the product) [5]. This method in the gold - maxillofacial field is currently widespread after the consolidated applications in neurosurgery and reconstructive surgery of the skull and other districts.

The use of this device has therefore made it indispensable not only for the diagnosis and evaluation of the cases treated but above all for the preliminary study of the surgical procedures, for the design of the surgical intervention, the realization of surgical guides for implantology and relative dental prosthesis [6].

Ultimately, stereolithography is a highly effective aid also in odontostomatology. The remarkable advantages of this device are evident both for the diagnostic approach and for the resolution of surgical problems, as it allows a three-dimensional analysis of the site and of the anatomical structures.

The acquisition of radiological data constitutes the first phase of the realization process: from their suitability to allowing the obtaining of a replica having accuracy conforming to the purpose for which it is intended to be constructed, depends on the success of the whole process. The data needed to obtain an anatomical replica are the axial image series of a tomographic examination which includes the structures to be reproduced, saved as standard DICOM 3 files obtained from a zero gantry TC acquisition (without tilting the irradiating source) [7].

The images generated by the TAC have variable values as a function of the absorption of the X radiation that passes through the patient's body, depending essentially on the density of the tissues involved. It is therefore the elective exam to highlight the bone tissue that results to have higher density and well distinct from that of the soft tissues, as expressed by the Hounsfield scale [7]. There are also applications and tomographic machines dedicated to particular applications such as Dentalscan and Maxiscan which are born for odontostomatological use. The first one is a reconstruction applied to a spiral CT and guarantees good images but with a dose of radiation not contained and with an unfavorable risk / benefit ratio for the patient; the second is a volumetric cone-beam volumetric TAC which, compared to very reduced emissions, provides images with a low contrast between fabrics of different densities, even if the rapid technological evolution of TC Cone Beam has introduced the latest generation of equipment into the market.to reach and in some cases overcome the quality of the images made with spiral tactics [8].

From A Data Point of View, The Accuracy of A Model Depends Mainly on Three Factors [9].

1) Field of view size that must be as small as possible by directly affecting the resolution in the axial plane. The images in DICOM format are in fact discretized in 512 x 512 pixels. The size of the single pixel, corresponding to the resolution in the axial plane, is therefore given by the ratio between the size of the field of view and 512. Thus, the lower the FOV, the higher the resolution in the plane.

2) Acquisition step in the case of sequential TAC or thickness of the reconstructed slices in the case of spiral or volumetric TAC. This factor affects the resolution of the model in an orthogonal direction to the axial plane: the smaller the thickness of the slice to which a single image refers, the lower the growth step of the virtual model.

3) Tomographic machine used: traditional CT scan, spiral, axial images of a Dentascan exam or reconstructed by a volumetric CT scan such as Maxiscan. Different settings, different technologies, different reconstruction algorithms and even very variable doses, translate into an equally different contrast between different density fabrics, making bone tissue recognition easier and more reliable [9].

Case Report

A 55-year-old female patient was treated, previously suffering from anorexia nervosa, with active hepatitis C. The patient has been followed since 2001 for the implant rehabilitation part in other dental sectors.

Presents edentulism of the III quadrant associated with severe hemi mandibular atrophy.

Lower skeletal prosthesis wearer, in January 2015, turns to our attention for implant-prosthetic rehabilitation from elements 3.4 to 3.6.

Considering the situation of extreme left hemi mandibular atrophy (Figure 1) with outcropping of the mental nerve, the patient is offered

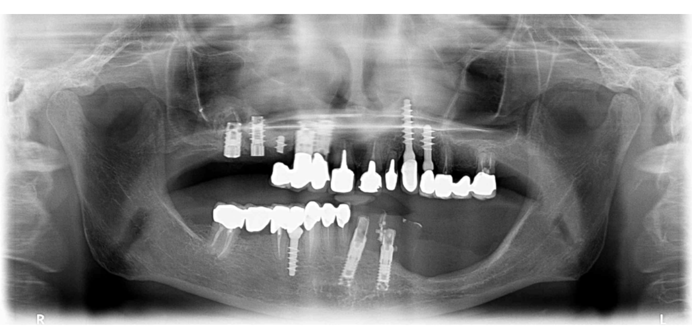

Figure 1:

various implant-prosthetic solutions (use of short implants, all-ON-four treatments, partialsub periostealimplantology) in order to restore a favorable bone anatomy to screw implantology.

In agreement with the patient, an initial resolution of the mandibular atrophy is decided by bone grafting with iliac crest removal and fixing by means of osteosynthesis screws. After 12 months from the consolidation of the autologous bone graft, there was the subsequent implant rehabilitation (Figure 2).

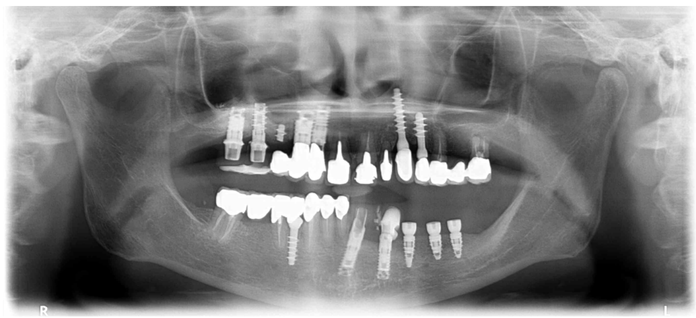

Figure 2:

The use of the stereolithographic model (Figure 3) made it possible to quantify the extent of bone grafting three-dimensionally, to

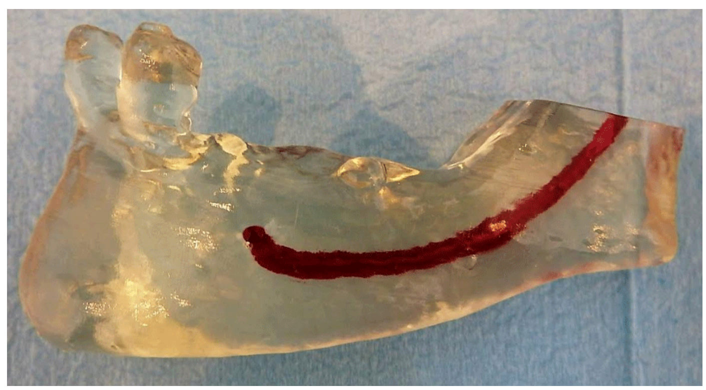

Figure 3:

Figure 4:

view in detail the path of the inferior alveolar nerve, to simulate the surgical procedures and to measure with greater precision the necessary osteotomy to the insertion of screw systems. (UNIVERSE by IMMEDIATELOAD SA - CH). After 15 months of bone grafting, the implant was loaded (Figures 4-5) using ceramic metal crowns cemented with Premier Implant Cement (Premier® Dental Products Company, USA).

After 3 years, an ortophantomography was performed (Figure 6) and to date, the patient is supervised with oral hygiene every 3 months

Figure 5:

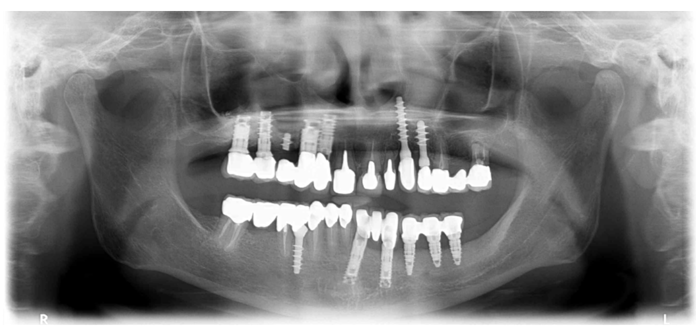

Figure 6:

Results

The patient, scrupulously followed by the dental hygienist, does not present any discomfort or special symptoms in the III quadrant. Thanks to the use of the stereolithographic model, and to the autologous bone graft, it was possible to rehabilitate with implants a quadrant with extreme bone atrophy, eliminating the lower mobile prosthesis that the patient no longer used.

Discussion

After the appearance of stereolithographic, there was a rapid diversification with the emergence of new technologies which, although inspired by the same constructive principle, show not inconsiderable differences.

The various processes differ from each other mainly due to the manner of affixing and the different material used, while maintaining the stratiform generation of the models.

The stereolithographic process is one of the reference processes in the field of rapid prototyping. Stereolithography allows the realization of resin models through the action of a laser beam that is focused on the surface of a bath of photopolymers in the liquid state [10]. The laser beam triggers a polymerization reaction creating a solid layer that represents a section of the model. The elevator is then lowered by an amount equal to the thickness of solidified photopolymer and a thin layer of resin covers the newly constructed section by means of a covering system. The process resumes with the solidification of a subsequent layer which adheres to the underlying section. At the end of the process the model is extracted from the tank after having brought the elevator back to its initial position. Since the model is built in a liquid bath, it may be necessary to simultaneously construct the support elements which will subsequently be removed by finishing processes.

The epoxy resin of which the pieces are made is well suited to reproduce the surfaces showing good rigidity. A peculiar feature is the good transparency that allows visualization from the outside of internal cavities that are highlighted in the design phase (such as the mandibular canal) as their reproduction is technologically possible [11].

An additive manufacturing alternative to the stereolithographic process is rapid prototyping [12] with polyjet technology, instead of there being a tank containing resin, we have a print head that manages the discharge of the resin liquid through numerous jets that reach a definition of 16 microns and it is fixed and solidified by means of a UV lamp. The liquid has characteristics very similar to an epoxy resin. This innovative technology is finding wide use in the environments connected to dentistry because among the various materials available, it also offers certified biocompatible resins for mucosal support; moreover, with these devices it is possible to generate extremely complex geometries thanks to water soluble support materials.

As regards the processes used in the medical field, the accuracy of the stereolithographic models is very high and reaches 0.2-0.3 mm compared to the maximum size of the single replication [13].

Takinginto account the wholeprocess of transformation from data to physicalimplementation, the accuracythat can be achieved with the anatomicalreplicasisabout 0.5mm compared to the maximum size of the single replica.

The transformation process that leads to the creation of an anatomical replica can be summarized in three fundamental steps: the acquisition of digital diagnostic data, the project that leads to the obtaining of a virtual model and the rapid prototyping process that real 3D physical reproduction [14]. Only an optimal management of each phase that takes into account the others and the purpose for which the single anatomical replica is carried out, guarantees a satisfactory result. The advantages of using anatomical replicas as a surgical aid are related to the physical representation of the tissue of interest. The most modern 3D imaging techniques, beyond the problem of artefacts that, if present, can not be completely eliminated from the reconstructed image, give the most to the illusion of three-dimensionality, however represented on a plane. The perception of the real anatomy through a physical model remains unparalleled, together with the implications that its availability implies.

It is thus possible to carry out easy measurements and have immediate visual and tactile information of the operative scenario. The application that opens is that of surgical teaching having available the faithful reproduction of the real anatomy of a particular district and being able to carry out a large and thoughtful simulation before tackling the actual intervention or at the same time the execution of the intervention from part of an experienced surgeon.

In the case of implants for the lower jaw it is of fundamental importance to know the course of the mandibular canal: it is possible to highlight it during the design phase and create it as a cavity, visible in transparency, which opens at the mentholic foramen and posterior emergence. In the case of implants in the upper jaw, accurate knowledge of the residual bone near the implant site can be very useful.

The extensive and accurate reproduction of any geometry allows the simulation of complex reconstructive interventions to morphologically evaluate the residual bone, the planning of the best surgical approach as in the maxillary sinus lift and the direct modeling on replication of bone grafts. For this last application there are autoclavable materials without deformations such as special nylon, in case you want to model the graft in a sterile environment without subsequent treatments.

The anatomical replicas can be a valid support for the realization of implantable devices such as the juxtaeous implants on the basis of the extensive bone surface that provide a quantity of information unattainable with the normal footprints and eliminating the necessary intervention for the relief of the same impressions: complete anatomy of the district of interest means having extensive external surfaces but also the thickness of the walls, an important factor in the upper jaw, and of the shape and spatial pattern of delicate structures such as the alveolar canal. In all those applications where the detection of the bone impression is necessary, it is also evident how the substitutive use of a model makes this phase less investigative, more comfortable for the patient and less operator and risky for the dentist.

Another possible application is the realization of surgical templates [15], as guides for the insertion of endoosseous implants, on the bone or above the mucosa, based on the reproduction of the bone tissue, of the mandibular canal visible in transparency in the case of the inferior maxilla, and possibly of the mucosa, which can be highlighted by means of suitable measures during the TAC acquisition phase. Bone and mucosa can be reproduced in a single piece or in two separate elements.

For particular applications, such as for the study of alveoli and the root course of the teeth, it is possible to extract the bone tissue and the dental elements as separate objects, creating the models of the individual structures separately. Obviously, the tooth-alveolus study can only be limited to one or more units.

Finally, the included teeth can be effectively represented as cavities very clearly visible in transparency in the stereolithographic model [16].

Conclusion

The anatomical replicas have seen in the last years, in the medical field, one of the most interesting applications. The three-dimensional physical reproduction of the desired tissues, allows multiple applications in the most diverse disciplines such as odontostomatology, implantology, maxillofacial surgery, plastic surgery, orthopedics, traumatology, reconstructive surgery, oncology and neurosurgery and cardiology. In each of these disciplines, there is infact not only the advantage of an immediate and realistic awareness of the anatomical site on which we will have to intervene, but the possibility of physically interacting with the fabric of interest with the most diverse implications, without neglecting a better relationship doctor-patient.

References

1. Bohner LO, Mukai E, Mukai S, Tortamano P, Sesma N (2016) Bone defect rehabilitation using lyophilized bone pre shaped on astereolithographic model. Contemp Clin Dent 7(3): 398-400.

2. Chiarelli T, Franchini F, Lamma A, Lamma E, Sansoni T (2012) From implant planning to surgical execution: an integrated approach for surgery in oralimplantology. Int J Med Robot 8(1): 57-66.

3. van der Zande MM, Gorter RC, Bruers JJM, Aartman IHA, Wismeijer D (2018) Dentists' opinions on using digital technologies in dental practice. Community Dent Oral Epidemiol 46(2): 143-153.

4. Soares MM, Harari ND, Cardoso ES, Manso MC, Conz MB, et al. (2012) An in vitro model to evaluate the accuracy of guided surgery systems. Int J Oral Maxillofac Implants 27(4): 824-831.

5. Kortes J, Dehnad H, Kotte ANT, Fennis WMM, Rosenberg AJWP (2018) A novel digital workflow to manufacture personalized three-dimensional-printed hollow surgical obturators after maxillectomy. Int J Oral Maxillofac Surg 47(9): 1214-1218.

6. Chandran S, Sakkir N (2016) Implant - Supported Full Mouth Rehabilitation: A Guided Surgical and Prosthetic Protocol. J ClinDiagn Res 10(2): ZJ05-06.

7. Revilla-Leon M, Gonzalez-Martín O, Perez Lopez J, Sanchez-Rubio JL, Ozcan M (2018) Position Accuracy ofImplant Analogs on 3D Printed Polymer versus Conventional Dental Stone Casts Measured Using a Coordinate Measuring Machine. J Prosthodont 27(6): 560-567.

8. Eskandarloo A, Saati S, Ardakani MP, Jamalpour M, GholiMezerji NM, et al. (2018) Diagnostic Accuracy of Three ConeBeam Computed Tomography Systems and Periapical Radiography for Detection of Fenestration AroundDental Implants. Contemp Clin Dent 9(3): 376-381.

9. Liedke GS, Spin-Neto R, da Silveira HED, Schropp L, Stavropoulos A, et al. (2018) Accuracy of detecting and measuring buccal bone thickness adjacent to titanium dental implants-a conebeam computed tomography in vitro study. Oral Surg Oral Med Oral Pathol Oral Radiol 2212-4403: (18)31008-3.

10. Parrish J, Lim KS, Baer K, Hooper GJ, Wood field TBF (2018) A 96-well microplate bioreactor platform supporting individual dual perfusion and high-throughput assessment of simple or biofabricated 3D tissue models. Lab Chip 18(18): 2757-2775.

11. Magne P (2007) Efficient 3D finite element analysis of dental restorative procedures using micro-CT data. Dent Mater 23(5): 539-548.

12. Garg B, Mehta N (2018) Current status of 3D printing in spine surgery. J ClinOrthop Trauma 9(3): 218-225.

13. Vaishya R, Patralekh MK, Vaish A, Agarwal AK, Vijay V (2018) Publication trends and knowledge mapping in 3D printing in orthopaedics. J ClinOrthop Trauma 9(3): 194-201.

14. Canzi P, Magnetto M, Marconi S, Morbini P, Mauramati S, et al. New frontiers and emerging applications of 3D printing in ENT surgery: a systematic review of the literature. Acta Otorhinolaryngol Ital 38(4): 286-303.

15. Happe A, Fehmer V, Herklotz I, Nickenig HJ, Sailer I (2018) Possibilities and limitations of computer-assisted implant planning and guided surgery in the anterior region. Int J Comput Dent 21(2): 147-162.

16. Sato K, Sugawara J, Mitani H, Kawamura H (1998) Use of selectively colored stereolithography for diagnosis of impacted supernumerary teeth for a patient with cleidocranial dysplasia. Int J Adult OrthodonOrthognath Surg 13(2): 163-167.