PROSTHETIC-SURGICAL GUIDE FOR IMPLANT INSERTION

Augustin Mihai, Lucian Obreja, Tănase Gabriela

ABSTRACT

Our concern has been the development of a Prosthetic-Surgical Guide for implant insertion, aiming to provide superior precision to the clinical stages of implant insertion and prosthesis. This guide supports a more accurate, safe, and tissue-friendly therapeutic plan for the DMA. Apart from the clinical stage of implant insertion into the bone, our designed Prosthetic-Surgical Guide for implant insertion has been clinically used for the precise execution of mucosal stripping (in mucoperiosteal stripping during the implant insertion stage and mucosal stripping for uncovering implants in the prosthesis stage). The outcome was the new Prosthetic-Surgical Guide for implant insertion, a guidance device designed and produced using 3D technology, which made implant-prosthetic rehabilitation safer, being more precise, minimally invasive, intuitive for both doctor and patient, with a significantly reduced risk of infection due to shorter operative times.

Keywords: Prosthetic-Surgical Guide for Implant Insertion, Guided Surgery, Neoalveolar Implant, Pre-Implant Palliative Prostheses, Functional Rehabilitation, Aesthetic Rehabilitation, 3D Design,

1. INTRODUCTION

Implant-prosthetic rehabilitation is the therapy that best achieves the morphofunctional and aesthetic recovery of the dental arches, alongside the return of the ADM to its biomechanical functions prior to tooth loss. Thanks to implant prosthesis, the loss of hard dental and soft tissues in the maxillofacial segment that occurs with other therapeutic methods does not happen, keeping the anatomical tissues intact, providing increased comfort for the patient and superior recovery of the functions of the bucco-maxillofacial apparatus. Guided surgery offers superior precision and predictability for implant-prosthetic rehabilitation.

2. MATERIALS AND METHODS

For a better understanding of the research undertaken, we will briefly list the invasive stages of dental implant insertion and the stages of medical recovery for the oro-maxillo-facial functions through the process of implant prosthesis, stages that were also applied in our clinical studies. Dental implant in neoalveolus. Implant prosthesis involves mandatory therapeutic stages to guarantee the success of the medical act:

1. Diagnosis and treatment planning.
2. Preoperative therapies.
3. The surgical intervention for creating neoalveolar implant sockets and the insertion of implants into the created neoalveolae.
4. Implant prosthesis, with high precision, with good occluso-articular and morpho-functional rebalancing of the ADM. Through the realization of implant prosthesis, morphofunctional and aesthetic recovery takes place, alongside the return of ADM to the biomechanical functions it had before tooth loss. "The motivation for the use of implantation prostheses is the high aesthetic and adaptive capabilities of such structures." (3)

The definitive implant-prosthetic work consists of:

- The dental implant, as an artificial radicular element for prosthetic support;

- Prosthetic abutment, as an anchoring element for the prosthetic work caps;

- The dental crown (or prosthetic work), which is fixed to the prosthetic abutment.

Img.1: The definitive implant-prosthetic work

The surgical guide used in invasive interventions for creating neoalveolar implant sockets in which dental implants are inserted, is a medical device made through 3D design (4) and 3D printing, which offers accurate guidance of medical procedures so that the implants are inserted with submillimeter precision, ensuring the success of the medical act.

In surgical interventions for implant insertion and abutment fixation, a medical procedure necessary in the realization of implant prosthesis, it has been observed that, in many cases, the prosthetist who only has radiographic images available cannot establish with submillimeter precision the position of the implant in the bone. For this reason, the circular incision at the insertion site, made with the laser or with the circular scalpel, is imperfect, or a longitudinal mucosal incision with the help of a classic scalpel is preferred. Compared to therapy that would create a circular incision with submillimeter precision, both compromise variants mentioned damage an increased area of mucosa, resulting in increased intraoperative time, increased healing time, and thus a higher risk of infection and increased discomfort for the patient. The highly precise circular incision made exactly at the insertion site of the healing abutment is the only variant in which postoperative suturing is not necessary, thus being much less traumatic.

Objectives of guided surgery in implant-prosthetic rehabilitation

Guided surgery in implant-prosthetic therapy has the following main objectives, which we adhered to in our studies:

- Correct insertion of implants that allow for the creation of a functional-physiognomic and aesthetic prosthetic work, with minimal sacrifice of healthy tissue.

- Development of the prosthetic-surgical guide that permits the desired insertion of implants, following:

1. Correct positioning of implants in the three anatomical planes of the alveolar ridge: mesio-distal, vestibulo-oral, and occluso-apical.

2. Correct positioning on the alveolar ridge of the implant heads as close as possible to the position of the tooth neck extracted in the vestibulo-oral and mesio-distal plane.

3. The long axis of the implant to be as close as possible to the perpendicular on the occlusal plane, which usually, based on Wilson's curve, has an inclination of 6-10 degrees from vestibular towards oral.

4. The distance between the implant and the adjacent tooth to be at least 1.5 mm, to which is added 0.25 mm, the maximum size of the periodontal space.

5. The distance between two implants to be at least 3 mm. (5)

6. Avoiding and sparing the neighboring anatomical formations that must not be affected.

7. Apart from the clinical stage of implant insertion into the bone, our designed Prosthetic-Surgical Guide for implant insertion has been clinically used for the precise execution of mucosal stripping (in mucoperiosteal stripping during the implant insertion stage and mucosal stripping for uncovering implants in the prosthesis stage).

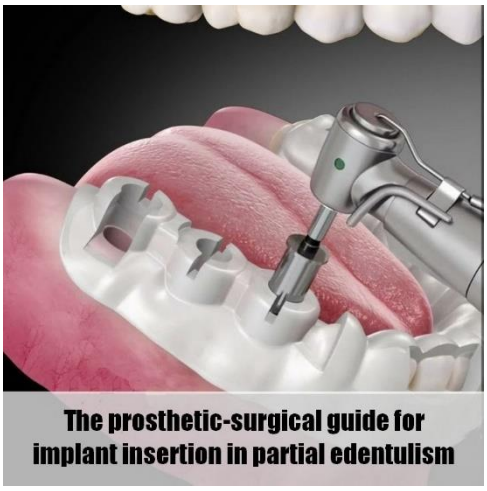
Classification of surgical guides in precise implant insertion

The prosthetic-surgical guide for implant insertion is particularly necessary in fixed prosthetic works anchored on implants, when the implants are inserted in the position of teeth extracted for therapeutic, but also aesthetic purposes. In over-prosthesis, the prosthetic-surgical guide for implant insertion mainly aims for the parallelism of the implants, for anchoring the stabilizing elements of the over-prosthesis.

We have classified the prosthetic-surgical guides for implant insertion as follows:

1. The prosthetic-surgical guide for implant insertion in partial edentulism

Partial edentulism maintains some occlusal landmarks in most cases, including the position of the extracted teeth relative to the remaining teeth. The stabilization of the Prosthetic-Surgical Guide for implant insertion is very well achieved on the remaining teeth in the arch (Img 2), which, if necessary, can be correctly repositioned through orthodontic therapy.



Img. 2 Prosthetic-Surgical Guide for implant insertion is very well achieved on the remaining teeth in the arch

2. The prosthetic-surgical guide for implant insertion in complete edentulism.

Complete edentulism generates severe and generalized occluso-articular and neuromuscular imbalances.

The alveolar ridge no longer presents precise landmarks regarding the position of the collars of the extracted teeth.

The occluso-articular landmarks and correct positioning of the extracted teeth are achieved with the help of pre-implant palliative prostheses, which will become basic landmarks in the making of the Prosthetic-Surgical Guide for implant insertion.

The prosthetic-surgical guide for implant insertion is also classified as follows:

Guide placed on the surface of the mucosa of the alveolar ridge (6)(7).

Guide placed on the surface of the bone of the alveolar ridge after the mucoperiosteal flap is raised.(7)

Guide placed at a minimum distance from the surface of the alveolar ridge, fixed on the remaining teeth. (6)

Designing and creating the prosthetic-surgical guide for implant insertion

1.1 Making the prosthetic-surgical guide for implant insertion in partial edentulism without obvious occluso-articular changes.

In these cases, there was no need for pre-implant palliative prosthesis to achieve occluso-articular and neuromuscular rebalancing, as well as the correct positioning of dental crowns on the arch.

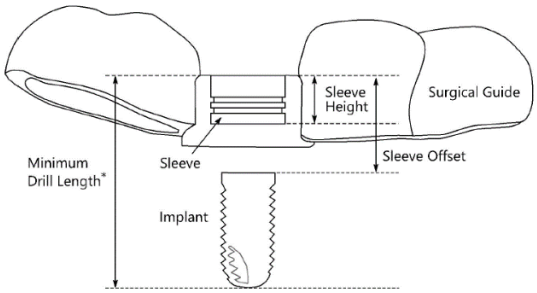
The work steps were as follows:

1. Performing CB-CT of the dental arches with volumetric dental analysis and structural analysis of the edentulous areas and sending the obtained information in DICOM format to the 3D design software.

2. Performing 3D intraoral scanning with volumetric recording of the mucosal tissue and teeth and sending the obtained information in STL, DCM, or PLY format to the 3D design software.

3. With the help of 3D design software, the DICOM information is overlaid with the data obtained from the 3D scan in STL, DCM, or PLY formats previously acquired. The 3D design software is used to design the correct position of the artificial dental crowns in the edentulous areas.

4. Starting from the design of the correct position of the dental crowns of the implants, the position of the implant screws is designed, their axis being perpendicular to the occlusal surface and positioned through the volumetric center of the crown. Based on the design of the future implants' position, the imaging guide is created.



Img. 3: The imaging guide, created according to the Osstem system

5. The imaging guide is transferred in STL file format to the 3D printer, where the Prosthetic-Surgical Guide for implant insertion is printed.

1.2 Making the prosthetic-surgical guide for implant insertion in partial edentulism with obvious occluso-articular imbalances.

In such situations, the proposed work steps are the following:

1. Pre-implant palliative occluso-articular rebalancing with movable acrylic resin prostheses.

2. The crowns of the acrylic prostheses are painted with a washable radiopaque substance.

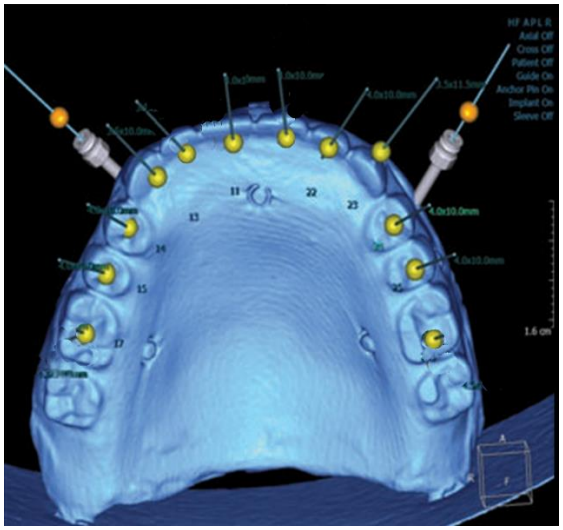
3. A CB-CT of the dental arches is performed with the palliative prosthesis with radiopaque dental crowns fixed on the edentulous area, including dental analysis and volumetric and structural analysis of

the edentulous areas, and sending the obtained information in DICOM format to the 3D design software.

4. An intraoral scan of the arches with the palliative prosthesis on the arch is performed, both separately and in occlusion position.

5. In the 3D design software, the information obtained from CB-CT and 3D intraoral scanning is overlaid, resulting in a position in the three planes of the artificial dental crowns alongside the remaining teeth, as well as the dimensions of the alveolar ridges in the three planes.

6. With the help of 3D design software, depending on the position of the crowns on the palliative prosthesis and the roots of the remaining teeth, the implants are positioned in the bone of the alveolar ridge, perpendicular to the occlusal plane, resulting in the imaging guide is transferred in STL file format to the 3D printer, where the Prosthetic-Surgical Guide for implant insertion is printed.



Img. 4: With the help of 3D design software, depending on the position of the crowns on the palliative prosthesis and the roots of the remaining teeth, the implants are positioned in the bone of the alveolar ridge, perpendicular to the occlusal plane, created according to the Osstem system.

7. The imaging guide is transferred in STL file format to the 3D printer, where the Prosthetic-Surgical Guide for implant insertion is printed.

1.3 Making the prosthetic-surgical guide for implant insertion in complete edentulism.

The occluso-articular and neuromuscular imbalances in complete edentulism are very large, mandatorily requiring palliative prosthesis with the creation of functional-physiological occlusion. The work steps are as follows:

1. Pre-implant palliative prosthesis with movable acrylic prostheses and occluso-articular and neuromuscular rebalancing.

2. Painting the dental crowns on the palliative prosthesis with a washable radiopaque substance.

3. Creating a CB-CT image with the palliative prosthesis with radiopaque dental crowns.

4. 3D intraoral scanning is performed, with volumetric recording of the mucosal tissue and the teeth from the palliative prostheses. The information obtained provides one of the STL, DCM, or PLY formats, necessary for the 3D design software to design the imaging guide. Information in STL, DCM, or PLY format can also be obtained directly from the DICOM of the CB-CT. We preferred to also perform 3D intraoral scanning.

5. In the 3D design software, the information obtained from CB-CT and 3D intraoral scanning is overlaid, resulting in a

position in the three planes of the artificial dental crowns, as well as the dimensions of the alveolar ridges in the three planes.

6. With the help of 3D design software, the coinciding points from the 3D scan and DICOM are selected, in order to overlay the imaging and scanning data, with the ideal positioning of the implants in the alveolar ridge, while avoiding anatomical elements that require it. Based on the presented data, the implants can be correctly inserted into the alveolar ridge, and temporary prostheses with gradual prosthetic loading preceding the definitive prostheses can also be made.

7. The imaging guide is sent to the printing device, where the Prosthetic-Surgical Guide for implant insertion is made.

4. DISCUSSIONS

The steps of implant insertion with the help of the Prosthetic-Surgical Guide for implant insertion are created according to the Osstem system.

We recommend that the mucoperiosteal opercula created during implant insertion be preserved in physiological saline and then, after insertion, be reapplied to the mucoperiosteal defect at the implant ends and fixed with an" X" suture, after removing the surgical guide.

The surgical guide proposed by us has several advantages over other surgical guides, among which we mention:

It has vestibular and oral windows through which good cooling of the drills and bone can be done (Img 5).

Img. 5: Vestibular and oral windows through which good cooling of the drills and bone can be done

The guide has guide cylinders made of the same material as the guide, forming "de facto" a common body, with a single diameter, eliminating errors due to the possible disintegration of the metallic sleeve in the guide, noted by Van Assche and Quirynen (13), and by Tali Chackartchi, Georgios E. Romanos, Laszlo Parkanyi, Frank Schwarz, Anton Sculean (15).

The drills and other components for creating neoalveoli and inserting implants have a cylinder immediately above the active area, which fits exactly inside the guide cylinder (Img. 5).

The technical concept and work steps presented are considered by us to be the most precise regarding the creation of the surgical guide by printing followed by the precise insertion of implants and subsequently their prosthesis, starting with the temporary prosthesis of gradual prosthetic loading.

5. CONCLUSIONS

Postoperative healing was faster, due to minimally invasive maneuvers.

The surgical guide has clinically proven its reliability for dental implants in bone and

for mucosal decappings, these being performed with precision.

The doctor must accurately calculate any intraoperative corrections, the computer not having available any possible changes in clinical data, unless these were anticipated preclinically and based on this an alternative to the original virtual project was prepared.

Through the use of pre-implant palliative prostheses, patients had the opportunity to understand more clearly the functionality and aesthetics of their future teeth on implants.

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7. REFERENCES

1. Schwarz MS, Rothman SL, Rhodes ML, Chafetz N. Computed tomography: Part, I. Preoperative assessment of the mandible for endosseous implant surgery. Int J Oral Maxillofac Implant. 1987;2(3):137-141. PMID: 3481354
2. De Souza A, Papaspyridakos P, Weber H-P, Konstantinos Vazouras, Matarazzo F. Effect of dental implant therapy on the preservation of orofacial tissues: A systematic review and meta-analysis Clinical Oral Implants Research 2023; 34:240-256. doi: 10.1111/clr.14106
3. Kamol A FEATURES OF REPEATED PROSTHETICS OF PATIENTS WITH COMPLETE ABSENCE OF TEETH EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE 2022; 22-25. doi:
4. Dioguardi M, Spirito F, Quarta C, Sovereto D, BAsile E, Ballini A et al. Guided Dental Implant Surgery: Systematic Review 2023; 12: 1490 doi: 10.3390/jcm12041490. PMID: 36836025
5. Ramanauskaite A, Sader R Esthetic complications in implant dentistry Periodontology 2000 2022;88:73-85. doi: 10.1111/prd.12412
6. Pan Y, Tu Y, Wang T, Liang J, Lin H Clinical study of precision analysis and deviation control of a domestic guide plate-assisted edentulous implant surgery Journal of Stomatology, Oral and Maxillofacial Surgery 2023;124:///. doi: 10.1016/j.jormas.2022.11.004
7. Chackartchi T, Romanos G E, Parkanyi L, Schwarz F, Sculean A Reducing errors in guided implant surgery to optimize treatment outcomes Periodontology 2000 2022; 88:64-72. doi 10.1111/prd.12411. PMID: 35103317
8. Bali V, Singh A, Bhalla P Immediate Tooth Extraction, Placement of a Tapered Implant, and Provisionalization in the Esthetic Zone: A Case Report International Journal of Health Sciences 2021; 5(S2):32-45. doi 10.53730/ijhs.v5nS2.5361
9. Rotter BE, Blackwell R, Dalton G. Testing progressive loading of endosteal implants with the Periotest: A pilot study. Implant Dent. 1996; 5:63. doi 10.1097/00008505-199600510-00006. PMID: 9151614
10. Misch CE. Density of bone: Effect on treatment plans, surgical approach, healing, and progressive bone loading. Int J Oral Implant. 1990 6:23-31. PMID: 2073394
11. Misch CE. Progressive bone loading. Dent Today 1995 14:80-83. PMID: 9567099
12. Perel ML. Progressive prosthetic transference for root form implants. Implant Dent. 1994 3:42-46. doi: 10.1097/00008505-199404000-00008. PMID: 7920389

13. Waltimo A, Könönen M. A novel bite force recorder and maximal isometric bite force values for healthy young adults. Scand J Dent Res. 1993;101:171-175. doi: 10.1111/j.1600-0722.1993.tb01658.x. PMID: 8322012
14. Van Assche N, Quirynen M. Tolerance within a surgical guide. *Clin Oral Implant Res*. 2010; 21: 455-458. doi: 10.1111/j.1600-0501.2009.01836.x. PMID: 20074247
15. Tali Chackartchi T, Romanos G.E., Parkanyi L., Schwarz F., Sculean A Reducing errors in guided implant surgery to optimize treatment outcomes Periodontol 2000 2022 88:64-72. doi: 10.1111/prd.12411. PMID: 35103317