ORIGINAL ARTICLE

IMPLANT-PROSTHETIC REHABILITATION OF PARTIALLY EDENTULOUS PATIENTS WITH SURGICAL GUIDES

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Abstract: Nowadays, the main goal of the oral rehabilitation treatment plan is not only to insert an implant into the bone, but to insert and integrate it so that the surrounding hard tissues and soft tissues are adequate. In this way, the long-term success of the treatment plan will be achieved. *Background:* The main purpose of the study was to present the advantages and disadvantages of using the dental implant insertion technique through the surgical guide as well as to evaluate the degree of its use among implantologists. *Material and Methods:* The study involved 120 patients who presented in the dental clinic requesting complex oral rehabilitation with restorations supported by implants. Following the anamnesis, intraoral clinical examination, laboratory and radiological evaluation, the type of edentulism was diagnosed, for which classical and alternative treatment plans were proposed. *Results:* From the group of edentulous patients, 40 patients chose the implant-prosthetic rehabilitation. Among them, 29 patients chose the guided method of implant insertion. *Conclusions:* Guided placement implant restorations are a viable solution for a painless and successful protocol in implant oral rehabilitation.

Keywords: partially edentulous patients, surgical guides, free-hand technique, dental implant restorations.

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1. Introduction

Clinical implantology has evolved significantly in recent years, starting from the improvement of implant design and surface topography to the development of surgical protocols. Thus, nowadays, implant-prosthetic treatment is a common practice in the field of dentistry, which has evolved from a state of optimism regarding the success of implant therapy, to a more rigorous expectation of long-term success, based on continuous experience development of the field, but also on the research evidence provided by the specialized literature [1].

The field of modern oral implantology, and especially implant prosthetics, depends on establishing a correct diagnosis of certainty, as well as precise and comprehensive planning to ensure the long-term success of the treatment plan and the desired outcome. Also, the treatment plan must meet both the patient's and the dentist's expectations, which are often high [2].

The success of implant-prosthetic therapy is based on careful planning, as well as meticulous execution and careful follow-up by the medical team (surgeon, prosthodontist and auxiliary staff), along with the cooperation of the patient. Today, the goal of the treatment plan is not just to insert an implant into the bone, but to insert and integrate it so that the surrounding hard tissues and soft tissues are adequate. In this way, the long-term success of the treatment plan will be achieved, both functionally and aesthetically [2].

Currently, a dilemma faced by every surgeon is the choice to place the implants with the help of a surgical guide or by the "free hand" technique. Using good technique, surgical guides can be a predictable and confidence-building method for implant placement. The digital planning of the implant-prosthetic treatment provides a varied range of interesting perspectives regarding the establishment of the diagnosis, the individualized planning of the treatment plan and the exact surgical-prosthetic implementation [3].

The concept of microinvasiveness has gained ground, flapless surgery can be performed in association with guided placement of implants [1]. Surgical guides represent the latest advances in dental implant technology. Creating a surgical guide involves performing a sequence of well-established steps. It exactly reproduces the surfaces in the patient's oral cavity and helps the surgeon to insert the implants into the bone with much improved precision. When used appropriately, surgical guides can increase the predictability of implant treatment results. To make the surgical guide, it is necessary to use a CBCT (Cone Beam Computed Tomography) analysis, a digital scanner for dental impressions, as well as a three-dimensional planning system for implants insertion. In this context, digital implant planning and guided implant surgery is based on three-dimensional radiographic data and digitized intraoral surfaces. They provide valuable information and allow excellent planning to optimize

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implantological aspects and prosthetic outcome, improving the safety and efficiency of the surgical procedure and making the restorative outcome much more predictable in terms of biological and aesthetic function [4].

Guided surgery allows dentists to develop a restoration-driven surgical plan with the ultimate goal of achieving positive patient-centered results. Several guided options are available, and the dentist must choose the one that leads to the best result for each specific case. The three-dimensional visualization of the anatomy of the structures and the improved evaluation of the available bone volume and its quality facilitate a more precise diagnosis, the early identification of possible problems, allowing a high score of the level of predictability in surgical planning. In most cases, three-dimensional planning includes the option to virtually anticipate the prosthetic result. The best prosthetic corridor can then be defined, resulting in a more prosthetically precise orientation of the implant position. This planning allows not only to choose an implant suitable for the specific anatomical situation and prosthetic demands, but also to inform prosthetic planning decisions, not least in terms of restorative materials or design details [4].

The use of guided surgery requires a series of steps, each of them necessary to make an accurate treatment plan that will use surgical guides. All these steps together form a "digital workflow". Correct virtual planning minimizes surgical risks, especially for less experienced surgeons.

Virtual surgery will always lead to a better understanding of patient-specific factors. If during planning, an implant is inserted too close to vital structures or adjacent teeth, or implant insertion is impeded by other vital structures, the software alerts the surgeon to the problem and the implant can be repositioned to eliminate the possible risk. With the mastery of the digital workflow, benefits will be obtained, both from the point of view of a better positioning of the implant next to the prosthetic result, but also a better efficiency in implant placement [5].

Accurate implant positioning is essential to achieve favorable esthetic and prosthetic results. Prosthetically guided implant surgery is recommended as it will ensure adequate prosthesis design, favoring long-term stability of the peri-implant hard and soft tissues. Surgical approaches combined with computer-assisted static implant surgery can overcome the likely deviations in unguided implant placement [6].

Regarding the advantages of the technique, the use of guided implant surgery consists in the insertion of implants using flapless surgery. This minimizes the patient's discomfort, reduces the operative time and ensures the placement of the implants in the best restorative position. Another advantage of flapless surgery is that at the end of the intervention there is no need for sutures, which for patients represents discomfort in the post-operative

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days. Clearly, the use of guided surgery with appropriate planning improves prosthetic outcomes and reduces surgical complications [3].

The digital planning and insertion of implants is a method used more and more frequently in dental offices because it provides consistently better results, especially in partially edentulous patients. Placing an implant that is "restorable" is no longer an aspiration of the dentist. Properly performed guided surgery, in association with appropriate treatment planning, raises the level of excellence while increasing efficiency and safety [3].

The main objective of the study was to present the advantages and disadvantages of using the dental implant insertion techniques through the surgical guide, as well as to evaluate the degree of its use among implantologists.

2. Material and method

The retrospective study included 120 patients presented in the dental clinic for the complete rehabilitation of the stomatognathic system in the period of October 2022-October 2023. Dental charts were used to collect data obtained from the anamnesis and intraoral clinical examination that conducted to the diagnosis of the type of edentulousness of the patients (lateral, terminal, frontal). Also, treatment options proposed, both classic solutions and alternative solutions, that is, by the free-hand method or with guided implant-prosthetic therapy were noted. From the group of edentulous patients, a number of 40 patients opted for implant-prosthetic rehabilitation. Among them, 29 patients chose the static guided method of implant insertion.

The dental chart completed for each study participant included a questionnaire on general health status, with: personal data, hereditary and personal antecedents, eating habits, oral hygiene status, as well as diagnosis and treatment plan. All participants signed the agreement for the management of personal data (GDPR) and completed the standard form for inclusion in the medical research study according to law no. 46/2003. For all implant rehabilitation cases, a CBCT and intraoral scans were performed. Both of the aforementioned investigations were processed in the Blue Sky Plan 3D dental software, which was used to create the draft surgical guide. Data were interpreted and processed using SPSS and Microsoft Excel programs.

The clinical study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova, with no 52/29.01.2024. Declaration of Helsinky was respected in the study.

3. Results

In the retrospective study, 120 patients aged between 18 and 68 years were included. From the group of edentulous patients, 40 patients opted for implant-prosthetic rehabilitation, and among them, 29 patients chose guided method of implant insertion. 72.5% were male and 27.5% female, the environment of origin being in a larger proportion urban, respectively 80% of the patients come from the urban

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environment and only 20% of the patients come from the rural environment.

Analyzing the age category of the patients, 4 age ranges were obtained as follows: 18-35 years (20.2%), 36-46 years (16.5%), 47-56 years (27.5%), 57 -68 years (35.8%) (Figure 1).

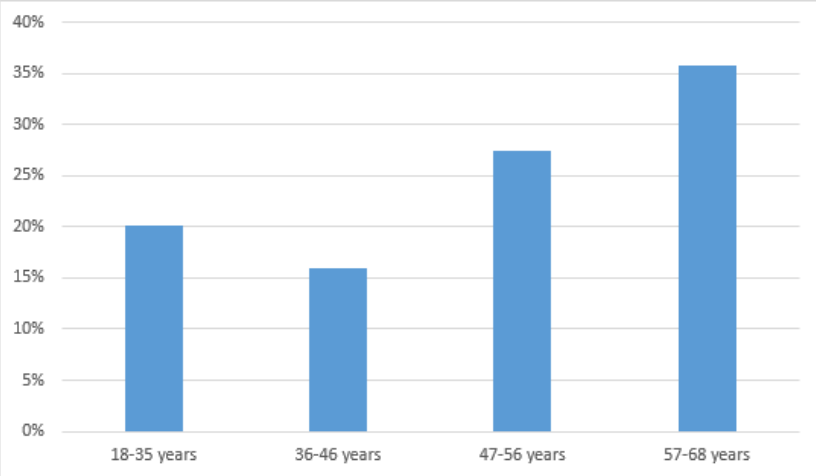

Figure 1. Distribution of patients by age range

The patients presented certain systemic conditions. Thus:

• 75% did not present serious systemic conditions

• 15% of patients had hypertension

• 5% had diabetes

• 5% liver diseases (hepatitis, hepatic steatosis)

Among female patients, 2 presented partial anterior edentulism, 5 partial posterior edentulism, and 9 patients presented posterior terminal edentulism. In the case of male patients, we identified 6 with partial anterior edentulism, 7 with partial posterior edentulism and 11 with posterior terminal edentulism (Table 1).

Depending on the type of surgical intervention, it was found that most patients, both female and male, underwent the intervention through the guided surgical method. In addition, guided surgery was used in 29 (73%) patients, of which 14 (49%) patients had partial posterior terminal edentulism, 10 (34%) partial posterior edentulism, and 5 (17%) patients had partial anterior edentulism (Table 2).

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Table 1. Distribution of patients according to the edentulism type by gender.

Gender	Partial Edentulism type			Total
	Anterior	Posterior	Terminal	
Female	2	5	9	16
Male	6	7	11	24
Total	8	12	20	40

Table 2. Distribution of patients according to intervention by gender.

Gender	Intervention type		Total
	Free-hand technique	Guided technique	
Female	6	12	18
Male	7	17	24
Total	11	29	40

Considering the edentulism type and the systemic conditions, the patients included in the study can be divided as follows (Table 3):

- patients with partial anterior edentulism did not present systemic conditions,
- among the patients with partial posterior edentulism, 6 did not have systemic diseases, but 2 had diabetes and 5 HTN;
- in the case of posterior terminal edentulism patients, 15 had no systemic diseases, but 3 had HTN and 2 liver diseases.

Table 3. Distribution of patients according to systemic conditions and edentulism type.

Edentulism type	Systemic disorders				Total
	Diabetes	N/A	HTN	Liver diseases	
Partial Anterior	0	**7**	0	0	**7**
Partial Posterior	2	6	5	0	13
Terminal Posterior	0	15	3	2	20
Total	2	28	8	2	40

One of the cases presented in the dental clinic is that of a 50-year-old male patient without serious systemic diseases. The odontal diagnosis is: multiple simple and complicated odontal lesions, treated and untreated. Prosthetic diagnosis according to Costa: non-prosthetic right lateral mandibular edentation and non-prosthetic

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right lateral maxillary edentation, and according to Kennedy: non-prosthetic Kennedy class III mandibular edentation and non-prosthetic Kennedy class III maxillary edentation.

In the case of the edentulous cleft in quadrant 4, the insertion of an implant (Bredent GmbH & Co.KG, Germany) with the help of the surgical guide made of resin (NextDent SG, Vertex-Dental B.V., The Netherlands) was proposed as a treatment plan. After obtaining informed consent, the patient underwent CBCT analysis to assess the quality of the remaining post-extraction bone structure. To design and make the surgical guide, an intraoral scan was performed, and then the actual surgical stage began. The implant prosthesis was made 3 months postoperatively, with a zirconium crown (Figure 2).

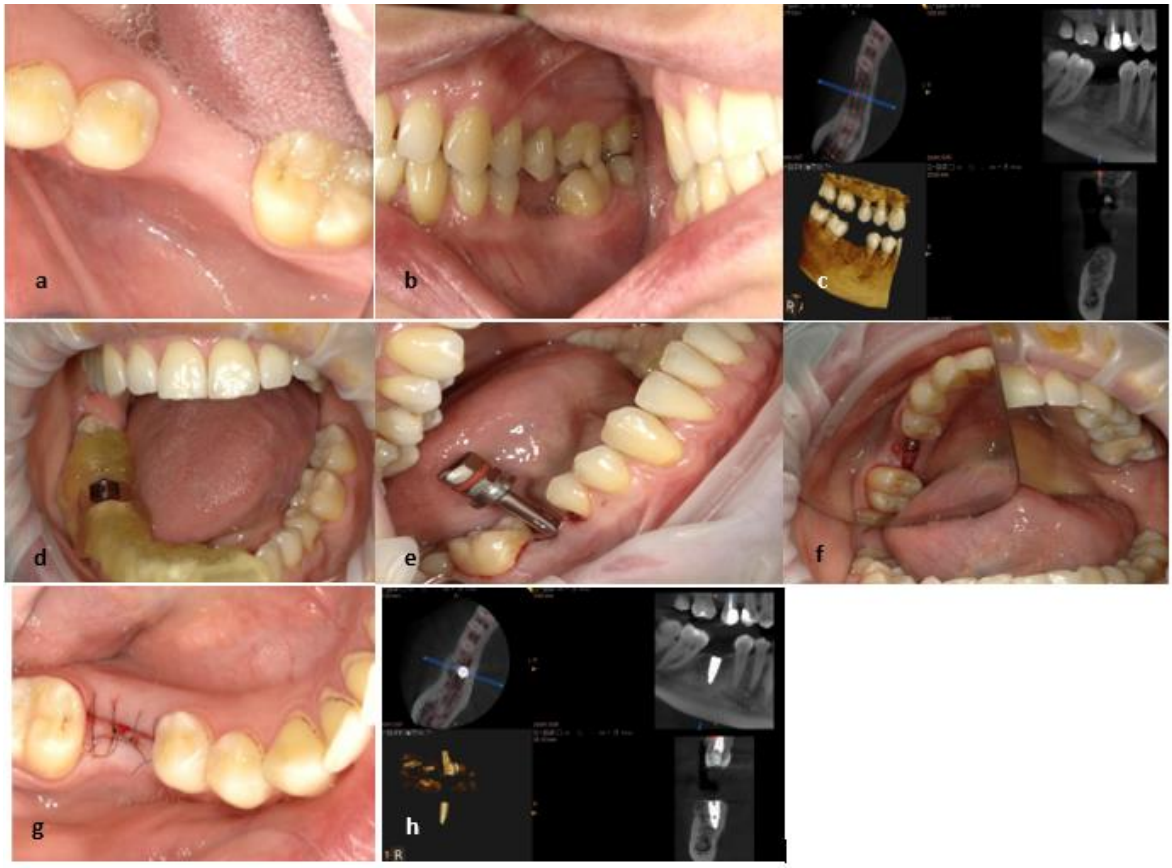

Figure 2. a.b. Edentulous cleft quadrant IV c. Initial CBCT image d. Surgical guide used for insertion of the IV quadrant implant e. Intraoperative aspect f. Intraoperative aspect - gingival former g. Postoperative aspect – suture h. Control CBCT - implant inserted in quadrant IV

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4. Discussions

In recent years, numerous scientific papers have been published in specialized literature with the aim of evaluating the accuracy of the implant-prosthetic restoration techniques of edentulous ridges. The data from the specialized literature highlight the fact that the technique of guided surgery can offer a good level of precision, under the conditions of choosing the most suitable surgical protocol and the ability of the practicing surgeon to implement it. This translates into practice, on the one hand, by avoiding serious complications, such as damaging nerves or blood vessels, and on the other hand, by being able to apply these protocols even in more complex cases, such as those with severe bone atrophy.

The use of CBCT-guided implant planning and placement does not obviate the need for the surgical and restorative team to diligently adhere to the basic principles of implant surgery and prosthetic dentistry. The well-established concepts of implant spacing, insertion depth and angles, case planning and engineering, minimally invasive soft and hard tissue manipulation, soft tissue and bone grafting, osseointegration healing time, soft and hard tissue healing, heat generation, dental materials, ideal occlusion and more must be maintained and respected. Guided implant surgery facilitates the placement of dental implants in an ideal position according to a restoration-oriented treatment plan.

Currently, most of the surgical guides used for the insertion of dental implants are based on 3D scanning and 3D printing technology, and their accuracy is closely related to the accuracy of their execution [19]. Guided surgery allows the planning and scanning of edentulous ridges using the planning software, thus improving the three-dimensional orientation of the implants, along with the overlay of the bone ridge image, which makes it possible to assess the emergence profile of the implant [20]. Intraoral optical scanning can reduce post-operative preparation steps, therefore the time required to obtain virtual models is much shorter. It includes 3D computer simulation and guide fabrication. Guidance systems can be used to directly import Digital Imaging and Communication in Medicine (DICOM) data into an interactive diagnostic and treatment planning tool. Using these softwares, the implant site can be predicted and the placement can be simulated and visualized from different perspectives. This simulation can visualize the implant in the cortical and trabecular bone in the 3D virtual model based on CT or CBCT imaging. This allows accurate planning based on available data. A surgical guide then transfers this pre-surgical planning to the surgical field [21].

Errors that may occur due to guidance systems may also be influenced by other factors, such as the quality of the image obtained, the experience and knowledge of the system operator. The accumulation of errors may increase if there are additional

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errors during the production of the guide. While no definitive statement can be made about which system is better, it is certain that the software affects the deflection and can be as important as the implant itself. To evaluate the benefits and results of guided surgery, the costs of these procedures must also be evaluated, as well as the training of clinicians. It is very important that doctors are well trained in new digital procedures, as well as conventional ones, because they can be needed and applied in any unpleasant event during surgical procedures. Mainly, with the help of guided surgery, the operative time is much shorter compared to conventional techniques, but it seems that more time needs to be invested in preoperative planning [22].

A multitude of factors are responsible for determining the effectiveness of guided surgery, from the diagnosis and planning phase to the actual surgical intervention. Each of these aspects must be carefully analyzed in order to benefit from a well-designed surgical protocol. The level of experience of the surgeon affects the accuracy of implant placement using the tooth-supported surgical guide. Therefore, the use of computer-guided surgery through a partially guided protocol does not fully compensate for the experience level of the operator. However, such a surgical guide can be used in the complete training of novice surgeons, as it can bridge the gap between in vitro simulation training and freely performed surgery [23].

Due to the planning and placement of implants, in accordance with the prosthetic treatment plan, surgery with the help of a surgical guide can bring significant benefits to oral rehabilitation procedures.

In this way, the provisional prosthetic works can be prepared before the clinical phases, thus, immediately after the stages of the implant surgery, the functional loading of the newly inserted implants can be easily achieved. At the same time, it is possible to use a single prosthetic abutment, both for provisional rehabilitation and for definitive rehabilitation, thus time and costs can be improved [22,23].

5. Conclusions

In most clinical situations, oral implants can be inserted without a guidance system, but the accuracy is apparently much better with the help of the surgical guide for a successful outcome. New technologies based on three-dimensional patient assessment for dental implants have significantly transformed dental practice, facilitating more accurate diagnosis, more detailed planning and more predictable treatment.

It is crucial that practitioners acquire a deep understanding of these technologies and invest in continuing education to ensure their correct and effective application for the benefit of patients. It is essential that practitioners are aware of the costs and benefits associated with the use of these technologies in order to make informed decisions. The software used in planning the

surgical guide must allow the creation of a virtual prosthetic configuration, the choice of different tooth models or the use of standard tooth shapes. Deficiencies in bone support may limit the applications of this technique. However, guided implantology is used more and more nowadays, but an improvement of the work protocol is necessary in cases with a limited amount and quality of bone.

In conclusion, guided implantology can represent a successful solution in the insertion of implants, both in cases with partial edentulism, and in cases with total edentulism.

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Data availability statement

Will be provided on request.

Ethics statement

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