ORIGINAL ARTICLE

SURGICAL GUIDES VS FREE-HAND TECHNIQUE IN THE WORKING PROTOCOL OF IMPLANTO-PROSTHETIC THERAPY

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Abstract: The objective of the study was to compare the advantages and disadvantages of using surgical guides with the free-hand technique in the working protocol of implanto-prosthetic therapy and to evaluate the usefulness of the surgical guide technique in patient implanto-prosthetic oral rehabilitation. Materials and method: 130 patients who presented in the dental clinic requesting complex oral rehabilitation with implant supported restorations participated in the study. Following the anamnesis, intraoral clinical examination, lab and radiological evaluation, the type of edentulism (lateral, terminal, frontal, complete) was diagnosed, for which classical and alternative treatment plans were proposed, with surgical guided implanto-prosthetic therapy or by the free-hand placement method. Results: Out of the total number of edentulous patients, 55 patients agreed to be rehabilitated by the implanto-prosthetic method. Of these, in 38 cases the guided surgical method of implant insertion was used and in 17 the surgical approach was classic (free-hand). Guided placement implant restorations had implant survival rates similar as conventional protocols, and a significant decrease in pain and discomfort in the immediate postoperative period, probably due to the use of flapless procedures. Conclusions: Guided placement implant restorations are a viable solution for a painless and successful protocol in implant oral rehabilitation.

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

 DOI: 10.58179/RJDR1204

1. Introduction

Dental implants restorations have become the golden standard in replacing missing teeth [1]. One of the key factors that make implants known as a reliable option is successful osseointegration, which requires a method that achieves minimized surgical complications such as nerve damage, perforation, and cortical plate perforation to achieve this goal and ultimately achieve the desired result [2].

Prosthetically driven implant surgery has become a standard of care to improve short and long-term treatment success. Precise implant positioning has obvious advantages, such as favorable esthetic and prosthetic outcomes, long-term stability of peri-implant hard and soft tissues because of easier oral hygiene, and the potential to ensure optimal occlusal contacts and implant loading [3].

In the past, 2-dimensional (2D) images such as panoramic and periapical radiographs were used when placing dental implants. However, these modalities could only provide basic information about the anatomy of the mouth and were also liable to significant limitations in accuracy due to inherent disadvantages, such as magnification and distortion [4].

The introduction of cone-beam computed tomography (CBCT), which provides imaging at a low radiation dose and at a relatively low cost, has increased the applicability and justification of 3-dimensional (3D) pre-surgical planning. The oral and maxillofacial regions have anatomical structures that can be visualized in three dimensions using CBCT. CBCT scanners have clear advantages over computed tomography (CT) scanning equipment: they are smaller, require lower radiation doses, and are less expensive [5].

Individual patient 3D-imaging data is essential for virtual dental implant planning, computer aided design (CAD) and computer aided manufacturing (CAM) of a drill guide or implant-supported prosthesis. Anatomical data is derived from (cone beam) computed tomography (CT or CBCT) and optical scans of teeth and mucosa [6].

In recent years, static guided implant surgery, which uses surgical guides for the preparation of the implant site and the positioning of the implant, has gained tradition in the field of implantology [7]. The benefits of this approach are evident and include prosthetically guided implant placement that prevents functional and esthetic compromises, safe surgery avoiding dangerous anatomical structures, and a minimally invasive or flapless procedure with less intra-operative discomfort and post-operative swelling and/or pain for the patient, avoidance of vital anatomy (nerves, sinus cavity, nasal cavity, adjacent dental roots, adjacent implants) [8].

Considering the clinical, biological, functional, and esthetic advantages guaranteed using guided implant surgery, all of which are fundamentally related to the accuracy of 3D implant placement, it is not surprising that this procedure is frequently used today to position implants.

However, although the body of literature on guided implant surgery is now vast, few studies have compared the accuracy of post-

 DOI: 10.58179/RJDR1204

extraction implant placement using surgical templates and the classical freehand technique [9].

The objective of the study was to compare the advantages and disadvantages of using surgical guides with the free-hand technique in the working protocol of implanto-prosthetic therapy and to evaluate the degree of use of the surgical guide technique in patient implant-prosthetic rehabilitation.

2. Materials and method

130 patients who presented in the dental clinic requesting the implant supported oral rehabilitation participated in the study. Following the anamnesis, intraoral clinical examination and lab and CBCT evaluation, the type of edentulism (lateral, terminal, frontal, complete) was diagnosed, for which classical and alternative treatment plans were proposed, with guided implant-prosthetic therapy or by the free-hand placement method.

For each patient who participated in the study, the clinical chart was completed, which included a questionnaire regarding the general state of health, in which personal data, hereditary-collateral and personal antecedents, eating habits, oral hygiene status, diagnosis and treatment plan were mentioned. A complete blood analysis and a radiological 3D evaluation through CBCT were performed to appreciate the systemic state of health of the patient and the bone status of the jaws.

Also, all patients signed the GDPR agreement (personal data management) and completed the standard form for inclusion in the medical research study according to law no. 46/2003. As complementary examinations, intra-oral scans with a digital scanner (Medit I500) were performed.

The two investigations mentioned above were processed in the dental software Blue Sky Plan 3D, with the help of which the project of the surgical guide was made. The data were interpreted and processed with the help of SPSS and Microsoft Excel programs. The clinical study was approved by Ethics Committee of the University of Medicine and Pharmacy of Craiova, with no 52/29.01.2024.

3. Results

Out of the total number of edentulous patients, 55 patients agreed to the rehabilitation by the implanto-prosthetic method. Of these, in 38 cases the guided surgical method of implant insertion was used and in 17 the approach was classic (free-hand).

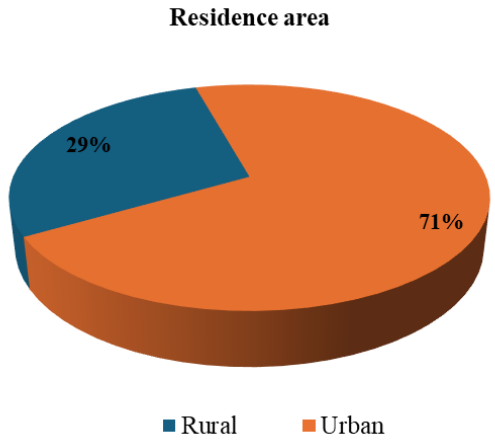


Figure 1. Distribution of study participants in relation to their residence area.

The present study showed that 71% of the patients lived in urban areas, and 29% in rural

DOI: 10.58179/RJDR1204

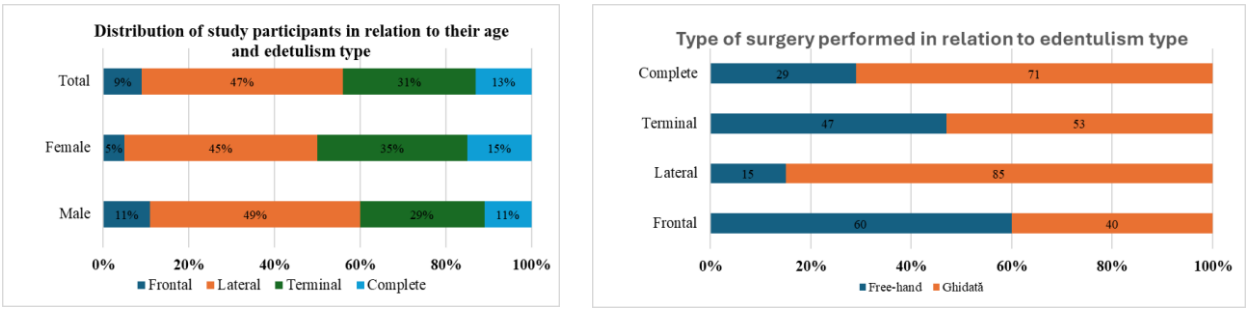
areas (Figure 1). As can be seen from the figure above, the urban environment is significantly more present, compared to the rural one, when we discuss new techniques for solving dental problems.Of the patients who participated in the study, 20 (36%) were female and 35 (64%) were male (Table 1).

Table 1. Distribution of study participants in relation to their age and gender.

Gender	Age (years old)					Total
	18-30	31-40	41-50	51-6	61-70	
Female	2	5	5	6	2	20
Male	7	9	7	8	4	35
Total	**9**	**14**	**12**	**14**	**6**	**55**

The systemic conditions present in the study patients were classified as follows:
- 85% had no known systemic conditions,
- 11% were patients diagnosed with hypertension,
- 4% were patients diagnosed with diabetes (Table 2).

Regarding the type of edentulism, we identified among female patients, 1 patient with esthetic anterior area edentulism, 9 patients with posterior lateral edentulism, 7 patients with terminal edentulism and 3 patients with total arch edentulism. Regarding the type of edentulism, among male patients, we identified 4 patients with frontal edentulism, 17 with lateral edentulism, 10 with terminal edentulism and 4 with total edentulism (Figure 2a).



(a) (b)

Figure 2. Distribution of study participants in relation to: (a) age and edentulism type; (b) edentulism type and surgery type.

Depending on the type of surgical intervention and patient gender, after analyzing the data, we found that more than half of the patients, both among women and men, underwent surgical intervention using the guided method.

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Table 2. Distribution of study participants in relation to the presence of a systemic disease.

Age (years old)	Systemic diseases			Total
	Type II diabetes	High blood pressure	Clinically healthy	
1 (18-30)	0.00%	0.00%	100.00%	100.00%
2 (31-40)	0.00%	0.00%	100.00%	100.00%
3 (41-50)	0.00%	0.00%	100.00%	100.00%
4 (51-60)	7.14%	14.29%	78.57%	100.00%
5 (61-70)	16.67%	66.67%	16.67%	100.00%
Total	**3.64%**	**10.91%**	**85.45%**	**100.00%**

As can be seen from the statistical data, guided intervention was used for 69% of patients in the study sample. Also 58% of the guided interventions were for lateral edentulism.

Guided intervention was used for 71% of the total arch edentulous patients and only for 29% free-hand intervention. In case of terminal edentulous patients, 53% had guided intervention, and for 47% free-hand, for lateral edentulous patients it was guided intervention for 85% and only 15% opted for free-hand intervention. In esthetic anterior area, for 60% of patients with frontal edentulousness free-hand intervention was performed and only for 40% guided intervention. (Figure 2b).

Table 3. Distribution of study participants in relation to gender and surgery type.

Gender	Surgery type		Total
	Free-hand	Guided	
Female	7	13	20
Male	10	25	35
Total	**17**	**38**	**55**

The patients with frontal edentulism had no associated systemic diseases, among the patients with lateral edentulism, one suffered from diabetes, the other 25 had no other systemic diseases, among the patients with terminal edentulism, one suffered from diabetes, 3 declared that they were diagnosed with arterial hypertension , and 13 had no systemic diseases, patients with total edentulism, 3 were hypertensive, and 4 did not suffer from systemic diseases (Table 4).

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Table 4. Distribution of study participants in relation to edentulism type and systemic disorders.

Edentulism type	Systemic disorders			Total
	Type II diabetes	High blood pressure	Clinically healthy	
Frontal	-	-	5	5
Lateral	1	-	25	26
Terminal	1	3	13	17
Complete	-	3	4	7
Total	**2**	**6**	**47**	**55**

4. Discussions

The present study indicated that guided placement had at least as good implant survival rates as conventional protocols, also showing a significant decrease in pain and discomfort in the immediate postoperative period, but probably due to the use of flapless procedures. However, it should be emphasized that this technique requires good training of the operators to reduce as much as possible unexpected adverse events related to the procedure during guided implant placement [5].

Clinicians worldwide are increasingly turning to guided surgery for the insertion of dental implants, becoming aware of the benefits of appropriate planning, supported by imaging and interactive treatment planning applications [10]. All aspects of the planning phase are based on surgical and restorative fundamentals solid, and as an integral part of the team, dental labs have moved from the analog world to the digital world, providing the necessary support for the new digital workflow [5].

Regarding the free hand protocol, surgical experience plays a significant role in the osseointegration of dental implants [11]. Insufficient surgical experience may increase the occurrence of complications such as high heat during drilling, implant non stabilization, or lack of flap adaption [12].

The impact of the operator's expertise on the precision of implants performed following surgical guides has not been assessed in many reports. There is no consensus in the literature regarding whether surgical experience affects the accuracy of computer-assisted implant surgery. Several in vitro studies have shown that experienced surgeons can place implants more accurately when they use guided surgery (partially, fully, or both). However, other studies have reported inconsistent findings [13].

One challenge in research aiming to address this question is the difficulty of quantifying the level of the operator's experience [14]. To describe the operator's experience, most studies have used the number of implant placement procedures rather than years of practice [15]. One study showed that experienced operators were considered as those who had placed more than 100 implants [16].

Literature data highlights the fact that guided surgery can offer a good level of

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precision, under the conditions of choosing the most suitable surgical protocol and the ability of the surgeon to implement it [17]. 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 the possibility of applying these protocols even in complex cases, such as those with severe bone atrophy [18].

Guided surgery is often associated with flapless implant placement techniques. Although there are no long-term studies in the literature that directly compare the success rate of conventional and flapless implant placement, many studies seem to agree that survival rates of the implant are comparable regardless of the type of protocol or implant chosen. No statistically significant differences in survival rate have been described between implants inserted with flapless guided systems versus conventional flap implant insertion surgery open [19].

A study performed by Huang L et al. found an overall degree of deviation was significantly lower in guided surgery with implant positional guide approach than the freehand approach [20]. From all aspects of compatibility of restoration such as functional, esthetical and biological, implants must be placed correctly in an ideal position. Correct implant position not only has favored prosthetic and esthetic outcomes it has also shown long-term stability of peri-implant hard and soft tissues [21].

In a previous randomized clinical study, using a tooth-supported template, surgeons with varying levels of competence placed half-guided implants on partially edentulous jaws. Skilled surgeons placed implants more accurately than their less experienced counterparts [22].

Another in vitro study showed no statistically significant differences between experienced and novice operators in terms of positional or angular deviations. The expert operators showed larger mean values of all positional and angular deviations than the novice operators, with the exception of depth deviation, where the 2 groups had nearly identical mean values (0.40 and 0.42 mm, respectively) [23].

To fully assess the benefits that guided surgery may provide, the costs involved in these procedures must be assessed [24]. An initial investment in technology, but also in the training of the clinical team, must be considered. Finally, there will be a digital workflow cost for each clinical case. We believe it is important for the clinician to be well trained in both new and conventional digital procedures as they may be required to be applied in case of any unforeseen event during guided surgical procedures [25].

Even though the duration of surgery may be shorter with guided surgery compared to conventional techniques, it appears that much more time must be invested in preoperative planning. If guided surgery can avoid bone augmentation procedures, it can reduce the overall cost of treatment [18].

We believe that many factors are responsible for determining the effectiveness of guided implant surgery, from the diagnostic and planning phases to surgery. Each aspect

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needs to be analyzed more carefully to scientifically evaluate which surgical protocol could provide the best results in the specific clinical situation.

The data presented regarding the accuracy of implant surgery using a surgical guide would be valuable for future studies since in vitro studies should be conducted extensively in advance of retrospective or prospective studies to prevent burdening patients unnecessarily.

5. Conclusions

Patient and technology-related parameters influence the successful implementation of virtual implant planning and implant-guided surgery.

In addition to data processing and computer-aided design of surgical guides, the possibilities and limitations for prosthetic configuration and planning of virtual implants are essential. Flapless guided implant surgery is more precise than guided but with a flap. Poor bone support may limit the applications of guided implant surgery.

There is a need for improvement in the planning of implant-prosthetic rehabilitations using guided surgery in cases with limited bone quality and quantity. The software system used in the planning of the surgical guide must allow the creation of a virtual prosthetic configuration, the selection of different tooth models or the use of a standard tooth shape and must accept as many implant systems as possible from those available.

The type of edentulousness and guided surgical protocol can influence the accuracy of guided surgery. A higher accuracy was found in interdentations when the implants were inserted guided.

Guided implantology is used more and more in the planning of surgical and prosthetic stages in the case of edentulous patients. Implant-prosthetic rehabilitation through guided surgery and immediate loading of implants in edentulous patients seems to be a successful therapeutic protocol.

The data presented regarding the accuracy of implant surgery using a surgical guide would be valuable for future studies since in vitro studies should be conducted extensively in advance of retrospective or prospective studies to prevent burdening patients unnecessarily. Second, clinicians who wish to perform implant placement following surgical guides should conduct a comparison to determine the accuracy of inexperienced versus experienced operators using this in vitro model.

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Author contributions

All authors read and approved the final manuscript. All authors have equally contributed to this work.

Acknowledgements

The authors wish to thank to Mr. specialist dental technician Lucian Draghici for surgical guides design and construction.

Funding information

Not applicable.

Conflict of interest statement

No potential conflicts of interest concerning this study.

Data availability statement

Data availability at request.

Ethics statement

Approved by the Scientific Ethics and Deontology Commission of UMF Craiova (no. 52/29.01.2024).

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How to cite:
Ghiță RE, Drăghici EC, Khaddour AS, Popescu SM, Popescu M, Dragomir A, Mercuț V, Scrieciu M. Surgical guides vs free-hand technique in the working protocol of implanto-prosthetic therapy. Rom J Dent Res. 2024;.Vol 1(Nr.2):43-53.