

Review Paper: Assessing the Success Rate of Dental Implants Placed Using Guided Systems in Comparison to Free-hand Systems



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ABSTRACT



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There is ample evidence for the widespread use of dental implants in recent decades and the increasing success of this treatment. Accordingly, research and investigation concerning the techniques and systems of the mentioned practice are of remarkable significance. One crucial factor contributing to the success of this treatment is proper implant placement in the bone, and many dentists utilize various guides to facilitate this process. However, some still believe that free-hand systems have more applications. Therefore, the authors of this article decided to review several studies that compared guided and free-hand systems and provide a comparison of these two approaches. In this article, the databases Scopus and PubMed were searched, and Google Scholar was also utilized for the search. A total of 11 article titles were approved and reviewed. Based on the findings of the reviewed articles, it should be emphasized that the use of guides can significantly impact the treatment outcomes, especially for inexperienced dentists and patients with periodontitis who may not have favorable bone conditions. Nevertheless, it's important to note that even free-hand systems still have a considerable success rate.

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1. Introduction

It would seem that currently available dental implants have gained an acceptable level of success, leading to the extensively growing acceptance of the general public (1). As a matter of fact, in one of the related studies, the success rate of this dental treatment was reported to be over 90 percent (2). To be more precise, the success of a dental implant necessitates addressing all mechanical and biological requirements, and, in the case of anterior teeth, aesthetic considerations are also crucial and decisive (3). Unsurprisingly, success in the field of dental treatment has been accompanied by various challenges that dentists have been trying to address since the inception of this therapeutic process. Studies that were previously focused on, mainly emphasized the condition of the existing bone and ultimately the success of osseointegration (1,2). Therefore, these previous studies paid less attention to the final prosthetic outcome (4). Meanwhile, it is important to note that implant planning in edentulous patients who may have bone (4) and tissue defects can be problematic and challenging. Even though, today's issues concerning implant positioning in the bone are considered an essential effort (1), three main reasons were mostly determined for this challenge:

1. The discrepancy between radiographs and clinical conditions can potentially increase the risk of accidents such as sinus perforation or nerve damage (2).

2. Proper positioning will result in a more aesthetically pleasing outcome (1).

3. Correct implant placement will reduce the risk of post-operative complications (1).

Placement errors can result from incorrect mesiodistal, buccolingual, or angulation. As a result, the implant we

have positioned for the patient may lead to issues such as insufficient emergence profile, excessive or insufficient interocclusal space, visibility of the implant collar, or recession of papilla (5,6).

Given the importance of implant positioning and the potential for errors, the use of guides in dental implants has become widespread (7). The aim of using these guides is to reduce uncertainty about the final correct implant position. These guides can be broadly categorized into two main types: dynamic and static guides (1).

The dynamic model includes software that models bone conditions and provides a three-dimensional view for bone drilling and implant placement (8). On the other hand, the static model, which is more commonly used today, employs templates to transfer information from the treatment plan to the patient. This model itself is divided into two methods (8): fully guided and half guided.

Considering the importance of dental implants in replacing missing teeth and the significance of implant positioning, which is a current focus, the researchers have decided to compile a review article on modern guided systems and their differences from non-guided systems.

2. Materials and Methods

For collecting the articles included in this study, various databases, including PubMed and Scopus, as well as Google Scholar as a search engine were employed. Furthermore, the researchers examined the articles of case-control, clinical trial, and systematic review types. The inclusion criterion was to investigate the outcomes of guided implant treatments. Subsequently, studies that did not fit our narrative review were excluded, and the remaining articles were reviewed Figure 1.

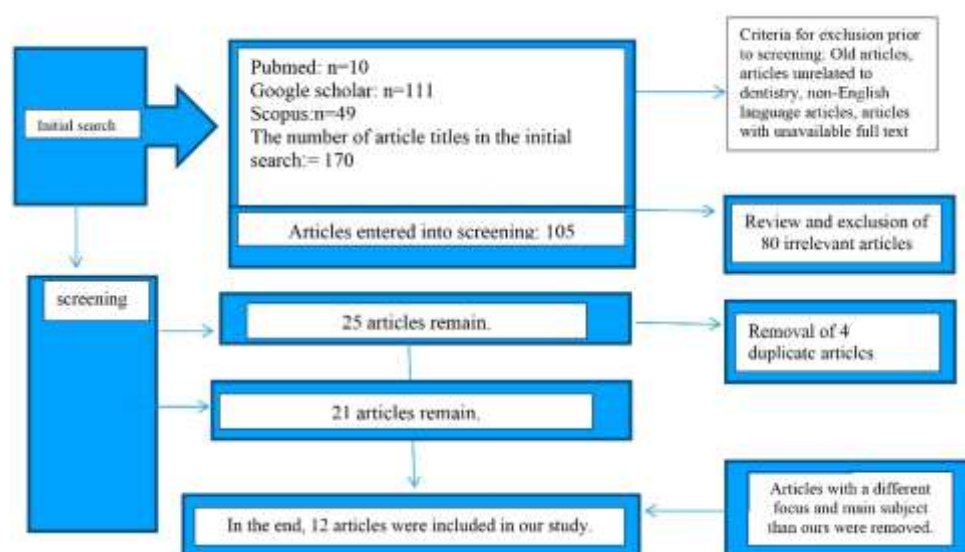


Figure 1. Inclusion and exclusion of article

List of exclusion criteria makes sense for a systematic review study:

1. Articles that were not sufficiently related to the topic.
2. Duplicate articles.
3. Articles that did not provide definitive results.
4. Articles with unavailable full texts.
5. Articles that did not directly use the phrase "guided dental implants" in their titles or abstracts.

Search Strategy in Databases:

In Pubmed, we utilized the following phrase in the advanced search section and manually screened the results.

("Dental Implantation/methods"[Mesh]) AND (guided [Title/Abstract]) AND (survival [Title/Abstract]) OR (failure [Title/Abstract]) AND ("Date"[2005])-

3. Results

It is worth mentioning that two systems, static and dynamic guides, were introduced and their efficacies in various studies were examined. The superiority of the fully guided method over semi-guided approaches and pilot methods is recommended in both static and dynamic systems, advocating for the advantage of guide utilization in all stages of implant placement in both approaches.

It has been observed that the static guide system is effective in reducing angular deviation and associated side effects. On the other hand, the dynamic guide system proves beneficial in immediate delivery scenarios and maintaining peri-implant health, crucial for long-term implant prognosis. The reduction in expected surgery and treatment time, along with postoperative improvement in the guided implant system, significantly aids patient acceptance of the treatment.

Certainly, in the context of aiding peri-implant health, it should be emphasized that, based on studies, digital implants in patients with periodontitis improve implant outcomes. Also, periodontitis may impact digital implant results due to its potential to loosening abutment. In addition to its superiority in patients with periodontitis, the guided implant system proves valuable in implant surgeries for patients with bone deficiencies and non-normal anatomical regions. This system, supported by recent studies, can be significantly helpful for inexperienced and younger practitioners.

Another advantage of fully guided surgery is the possibility of flapless, shorter chair time, leading to reduced discomfort, pain, and postoperative swelling after implant placement.

The guided technique, despite its advantages, comes with drawbacks. For instance, it tends to incur higher treatment costs, presents challenges in controlling depth during implant placement, and may cause tissue heating with the drill's tip during the drilling process, potentially

leading to bone analysis and implant osseointegration issues.

Despite numerous articles and studies suggesting the advantages of guided implants, there remains considerable debate and uncertainty regarding the unquestionable superiority of this technique. Further exploration of the drawbacks of this method may reveal insights into how widely adopting this technique could potentially impact the long-term success rate of dental implants.

4. Discussion

In 2019, Varga and colleagues conducted a clinical trial comparing freehand implant surgery with guided implant systems. One of their evaluation criteria was the angular deviation of the implants over time, and they found that the average of this parameter was higher in the freehand surgical methods compared to the guided methods.

In their evaluation of variables related to side effects of these methods, it was demonstrated that all guided methods had superiority over freehand methods. However, for some variables, no significant differences were observed between these approaches. As a general statement, this research ultimately specified that static guided systems provided much better results compared to freehand systems. Furthermore, according to the results of this study, any level of guidance would improve dental implant outcomes. Different guide templates have been categorized based on three different protocols and the extent of guidance.

In the pilot protocol, only the initial drill is guided, and this initial hole guides the rest of the osteotomies. In the half-guided protocol, all osteotomies are guided, but implant placement is not guided. In the fully guided system, all stages are guided, including implant placement.

This study acknowledges that most research has examined and emphasized the superiority of the fully guided protocol while considering it more desirable than lower degrees of guidance. However, sometimes the differences between protocols may not be significant (1). In this study, the static guided system has been well examined, but the dynamic guide system can be equally effective. This may be an area for further research and investigation.

The next article that the authors investigated regarding this topic was a study conducted with the aim of examining the dynamic guided system and its impact on implant placement and the removal of soft and hard tissues, as well as any specific effects it may have in cases of immediate implant placement.

In this study, the results of implant placement were examined in two separate phases:

Phase one of the study examined both the success of the prosthetic and implant placement and the treatment-related side effects. In the second phase, the authors investigated factors that commonly threaten the long-term success of implant treatment, including:

1. Marginal bone loss (MBL).
2. Implant stability quotient (ISQ).
3. Implant plaque and bleeding indices.

According to one of the purposes of this review in order to pursue a detailed examination of the success of different implant systems, this fact that the results and success of these implants have been thoroughly assessed in two phases in consort with the detailed examination of the key factors, is supposed to be of significant importance.

The fact that the implant success rate in this study, using the guided method, was evaluated to be over 98%, alongside a 100% survival rate for these prosthetics, is definitely noteworthy. These results indicate that the dynamic guided approach can facilitate immediate implant placement and significantly improve its quality.

On one hand, considering that this study also assessed the health and preservation of hard and soft tissues, it seems that these methods may be effective for preserving the periodontium. Therefore, both static and dynamic guided systems appear to be effective in improving implant outcomes when compared to each other. Based on these two articles, the static system is effective in reducing angular deviation and side effects, while the dynamic system is effective in cases of immediate placement and preserving periodontal health.

It's clear that these studies emphasize the importance of the type of guidance in immediate implant placement. This is significant because it appears that immediate implantation can be highly effective for patients and the treatment team when performed using methods that enhance its accuracy and efficiency. Besides, the use of CAM/CAD systems and the focus on guidance in these studies underscore the advancements in technology and planning that can benefit dental implant procedures.

The main difference in this study, compared to the previously discussed studies, is that it focuses on immediate implantation in a maxillary segment that has undergone bone grafting. Furthermore, this treatment team believes that this method reduces the expected time for surgery and treatment, as well as post-surgical recovery, which is important as it can increase patient acceptance of the treatment. This showcases the versatility of immediate implantation in various clinical scenarios and its potential benefits in reducing the overall treatment timeline (9).

The systematic review published in 2020 aimed to compare guided implant surgery (fully guided) and free-hand implant placement in terms of marginal bone loss,

complications, and implant survival. Recent systematic reviews have reported that the primary benefits of fully guided surgery include accuracy in implant positioning, the possibility of flapless surgery, shorter chair time, reduced discomfort, pain, and post-operative swelling, and implant placement. This highlights the advantages of fully guided implant surgery, which can contribute to better patient outcomes and satisfaction.

In contrast, even with technological advancements, the conventional non-guided protocol, also known as free-hand surgery, is still widely used due to the lower cost of treatment and better depth control when manually placing implants. Another disadvantage of guided techniques is the cooling with liquid irrigation at the drill tip during the drilling process, which is not as effective as the freehand method, as the surgical guide can block liquid irrigation, potentially causing tissue heating, bone resorption, and implant osseointegration issues. Therefore, there is no conclusive evidence regarding the difference between computer-guided surgery and freehand surgery in terms of marginal bone loss (MBL), complications (mechanical and biological), and implant survival (10).

5. Conclusion

In a study conducted in the Department of Periodontology at Seoul in 2012, the aim was to determine the accuracy of pre-surgical planning for implant placement using two types of radiographic images (Digital Panoramic Radiography [DPR] and Cone Beam Computed Tomography [CBCT]), and to identify the differences in measurements between radiographic images and actual specimens. Pre-surgical planning is often done with radiographic images such as panoramic radiography, lateral cephalometry, and periapical radiography, as well as computerized tomography (CT). The length and angulation of the implants are typically determined from panoramic radiography. However, in the anterior region, where there is more curvature compared to the posterior region, panoramic radiography may not be reliable for pre-surgical implant planning, emphasizing the need for cross-sectional imaging for anterior dental implants.

The findings of this study indicated that the average measurement error before surgery for CBCT was significantly lower than DPR in the upper jaw, while there was no significant difference between the two imaging methods in the lower jaw. Therefore, pre-surgical planning can be comfortably done using DPR in the lower jaw. However, in the upper jaw, where the anatomy in the buccolingual dimension needs evaluation, pre-surgical planning using CBCT is recommended, as this imaging method provides buccolingual information that cannot be obtained from DPR. This study is

significant because, unlike other studies we examined, it focused on the differences between the maxilla and mandible (2). To enclose, the authors of this study confirmed the evidence from previous studies regarding the effectiveness of guides. They emphasized that digital implants in patients with periodontitis can improve implant outcomes because periodontitis can impact the results of digital implants due to the potential for loosening of abutments. The results of digital implants in these patients using imported digital guides are comparable (3).

In an interesting study, influential authors assessed the impact of using a guide among inexperienced dentists. This in vitro study involved obtaining computed tomography images of edentulous models with a unilateral free end prior to the procedure. Subsequently, all stages, including drilling and implant placement, were fully guided. This study ultimately distinguishes the guided system from other implant-assisting systems and considers it highly effective. (6) We examined and reviewed a study related to this article, aiming to investigate and compare conventional implants with computer-guided implants. In this study, out of a total of 18 patients, 5 received computer-guided implants. The study emphasized the value of using computer systems in implant surgery.

The primary focus and what intrigued the authors of this article was the emphasis on implant surgery in patients with bone deficiencies. This study highlights that previously, surgery in patients with bone deficiencies and non-standard anatomical areas had to be performed by highly experienced surgeons, and sometimes it was even considered impossible. With the assistance of computer technology, these conditions have been facilitated. These two articles provide us with a broad perspective, but they also leave a significant question in our minds: Can digital implants replace the expertise and skills of experienced surgeons? While this question may seem like an exaggeration at the moment, we know that these systems can be a significant aid to young and inexperienced dentists (11). In a systematic review, the impact of

computer-guided template-based guides on dental implants was examined. This study was significant for us in two aspects: first, due to the high number of reviewed articles, and second, among the reviewed articles, it was the first study to specifically address the complications related to guided techniques in surgery, which were mostly short to medium-term in terms of duration. However, it is worth noting that this study does not negate the positive effects of guided systems or the high success rates of these implants, stating that the success rate of this series of implants is over 90%. Instead, this study provides a realistic perspective, suggesting that this rate is comparable to conventional implants and is not a surprising figure (12).

Ethical Considerations

Not applicable.

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None.

Authors' Contributions

Maryam Zohary: Conceptualization, Methodology, Writing - Review & Editing **Mahsa Koochaki:** Resources, Investigation, Visualization **Anahita Izadi :** Methodology, Visualization **Zahra Mehrazin:** Writing - Original Draft, Data Curation **Soheil Taghavi:** Project administration, Supervision.

Conflict of Interests

The authors declare no conflict of interest.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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