



Guided surgery in dental implant: a systematic review

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Abstract

Introduction: In the context of implant dentistry, dental implants represent about 1,000,000 procedures per year worldwide. Virtual implant planning systems integrate cone beam computed tomography (CT) data to assess the amount of bone and virtual models for the project of a dental implant. **Objective:** It presented, through a systematic review, the main considerations of guided surgery in implant dentistry through evidence from clinical studies and important systematic reviews on the subject. **Methods:** The research was carried out from May 2021 to June 2021 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar, following the Systematic Review-PRISMA rules. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results:** A total of 112 articles were found on guided surgery and implantology. Initially, duplication of articles was excluded. In total, 54 articles were fully evaluated and 23 were included and evaluated in this study. In the GS scenario, advances in technology have contributed to the improvement of models with favorable positioning of implants in aesthetic terms. This provides the predictability of techniques and difficulties that may be encountered during surgical intervention, reducing time and the possibility of errors, allowing for an overall reduction in the costs of oral rehabilitation. **Conclusion:** Guided surgery is considered accurate and reliable compared to free implant surgery. However, the learning curve is undeniable and a clinician with basic surgical skills, including conventional implant dentistry.

Keywords: Guided surgery. Dental implant. Computed

tomography. Computer-guided.

Introduction

In the context of implantology, dental implants represent about 1,000,000 procedures per year worldwide [1]. In this sense, bone density and maxillary trophy are increasingly frequent clinical conditions, with multiple predictors [1-3]. This influences the operative protocol and the choice of the type of implant to be used [4]. Thus, as a highlight, virtual implant planning systems integrate cone beam computed tomography (CT) data to assess the amount of bone and virtual models for dental implant design [5]. In this context, this stimulated the development of numerous equipment and instruments for performing computer-guided (GS) surgeries [6], highlighting CT, with reference points, such as the prosthesis itself, for image capture [7].

These images enable planning for clinical decision-making and surgical procedures for the placement of dental implants. Thus, cone-beam CT has opened a new era of diagnostic capability and responsibility [8]. In this scenario, the guides used in dental implant surgery offer precision and predictability, combining acquired images with existing dentition to create precise guides for implants [9].

Despite this, the accuracy of GS systems for the placement of dental implants depends on a series of cumulative and interactive factors that can lead to errors [7,10,11]. In this sense, information gaps include the image acquisition process, the registration process, software navigation, surgical guide production, and human error [12-14], in addition to requiring investment and effort substantially larger, however, offers a good

result, in the sense of eliminating errors and systematizing the successful reproduction of treatments [15].

In addition, GS allows the protection of critical anatomical structures, as well as aesthetic and functional advantages that come from placing the implant in the location determined by the prosthesis, being indicated in cases with sufficient anatomical orientation and bone volume [16], and when implants with longer lengths are desired [17]. Thus, reconstruction technologies have expanded to include the use of guided surgical planning and computer-assisted design and fabrication (CAD-CAM), and three-dimensional printing [18-24].

Therefore, the present work presented, through a systematic review, the main considerations of guided surgery in implant dentistry through evidence from clinical studies and important systematic reviews on the subject.

Methods

Study Design

The rules of the Systematic Review Platform-PRISMA (Transparent report of systematic reviews and meta-analysis-HTTP: [//www.prisma-statement.org/](http://www.prisma-statement.org/)) were followed [25].

Research Strategy

The search strategies for this systematic review were based on the keywords (MeSH Terms): "Guided surgery. Dental implant. Computed tomography. Computer-guided". The survey was conducted from May 2021 to July 2021 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. In addition, a combination of the keywords with the Booleans "OR", "AND", and the operator "NOT" were used to target the scientific articles of interest.

Study Quality and Risk of Bias

The quality of the studies was based on the GRADE instrument [26] and the risk of bias was analyzed according to the Cochrane instrument [27]. Two independent reviewers performed the research and study selection. Data extraction was performed by reviewer 1 and fully reviewed by reviewer 2. A third investigator decided on some conflicting points and made the final decision to choose the articles.

Results and Discussion

A total of 127 articles were found on guided surgery and implantology. Initially, duplication of articles

was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address the theme of this article. In total, 67 articles were fully evaluated and 31 were included and evaluated in this study (Figure 1).

Considering the Cochrane tool for risk of bias, the overall assessment in 2 studies with a high risk of bias and 1 studies with uncertain risk. The domains that presented the highest risk of bias were related to the number of participants in each study approached, and the uncertain risk was related to the safety and efficacy of guided surgery and implantology. Also, there was no funding source in 2 studies and 1 studies did not disclose information about the declaration of conflict of interest.

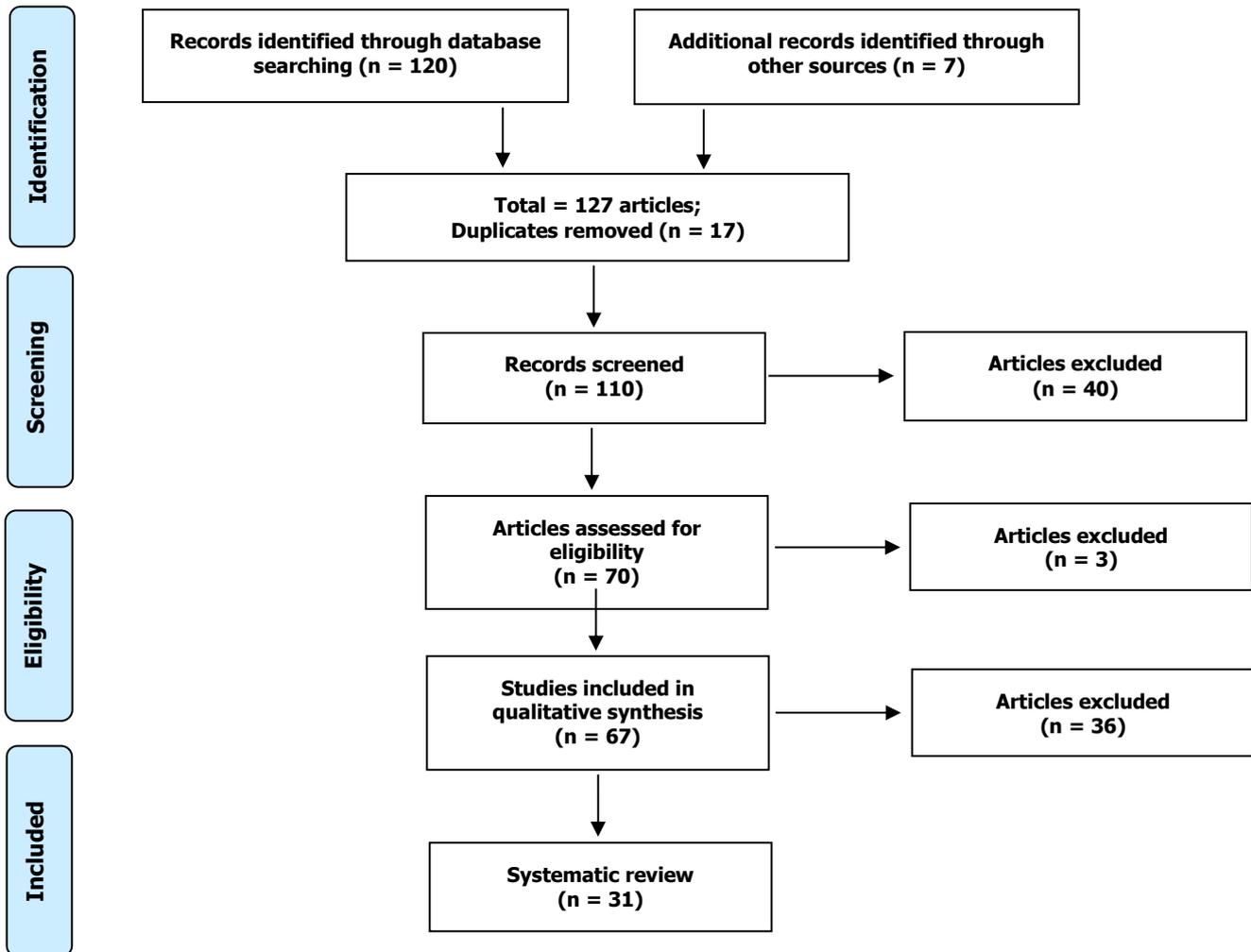
In the GS scenario, advances in technology have contributed to the improvement of models with favorable positioning of implants in aesthetic terms [1]. Information is acquired in the 3D reconstructions that allow to determine the quantity and quality of available bone and also enable the simulation of implant installation in a virtual environment [1]. This provides the predictability of techniques and difficulties that may be encountered during surgical intervention, reducing time and the possibility of errors, allowing for an overall reduction in the costs of oral rehabilitation [6].

In this sense, CT stands out to provide the making of bio models, allowing a threedimensional assessment of the individual anatomy of patients and more efficient access to the quantity and quality of the areas proposed to receive implants [11]. In this regard, a review study showed that all systems exhibit three-dimensional surface models or two-dimensional cross-sections with varied orientations for virtual implant planning. Computer-aided design and manufacturing (CAD / CAM) of drill guides can be carried out by the user with the help of standard parameters or just by the software provider [28].

Another review study showed that the computerized GS approach is considered to provide more predictable, safe, and rapid implant placement. Thus, digital planning and placement of dental implants in the correct position continue to optimize the classic dental implant approach. However, this guided surgical approach also contains some errors and risks, which must be identified and rectified [29].

Also, a systematic review study compared implant GS versus freehand in terms of marginal bone loss, complications, and implant survival. The studies involved a total of 154 patients with 597 dental implants and a mean follow-up period of 2.25 years. There was no difference between computer-guided surgery and freehand surgery in terms of marginal bone loss,

Figure 1. Eligibility.



mechanical complications, biological complications, and implant survival rate. Therefore, GS and freehand produced similar results for marginal bone loss, mechanical and biological complications, and implant survival rate [30].

Besides, a study evaluated whether computer-aided 3D implant planning with the model-guided placement of dental implants based on magnetic resonance imaging (MRI) is feasible. Magnetic resonance-based GS with subsequent prosthetic treatment was successfully performed in nine patients. The mean deviations between the virtually planned and resulting implant position, the mean deviation of the occlusal surfaces between surface scans and MRI-based dental reconstructions, as well as the visualization of important anatomical structures were acceptable for clinical application [31].

In addition, one study validated a robot-guided dental implant GS method. The results showed that the central deviation error value in the hexagon (refers to the center of the implant platform level) was 0.79 ± 0.17 mm, the central deviation at the apex was 1.26 ± 0.27 mm, horizontal deviation in the hexagon was $0.61 \pm$

0.19 mm, horizontal deviation in the apex was 0.91 ± 0.55 mm, vertical deviation in the hexagon was 0.38 ± 0.17 mm, the vertical deviation at the apex was 0.37 ± 0.20 mm and the angular deviation was $3.77 \pm 1.57^\circ$, preliminarily validating the feasibility of the robot-guided dental implant method [32].

A retrospective cohort study evaluated the survival and success rate of implants and related full-arch fixed prostheses at 5 to 8-year follow-up when performed with immediate function using a flapless surgical procedure and computer-aided technology (NobelGuide®) in patients previously treated with fresh frozen homologous bone grafts. The study showed that patients who previously received fresh frozen homologous bone grafts for maxillary or mandibular bone atrophy can be safely treated with implant-supported prostheses based on the NobelGuide® protocol, with the aid of a computer-generated guide [33].

Another study showed that excellent reliability for MRI-based dental treatment plans as well as an agreement between decisions based on dental MRI was observed. The ideal implant position was not achieved

in all cases by dental magnetic resonance imaging. Dental magnetic resonance-derived surgical guides were sufficiently accurate to perform implant placement [34].

Also, the palatal or lingual surface of the teeth cannot be easily identified. Thus, one study described the use of a digitally designed prosthetic shell to improve the planning accuracy of the weld-guided approach for immediate abutment-supported restorations. As a result, importing the virtual shell into the planning program provided an effective protocol for using definitive information from the prosthetic space to predictably plan the shape and position of the structure, increasing accuracy and reducing time [19,20].

Conclusion

Guided surgery is considered accurate and reliable compared to free implant surgery. However, the learning curve is undeniable and a clinician with basic surgical skills, including conventional implant dentistry.

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Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

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