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CAD-CAM system in dental implants: a systematic review

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Abstract

Introduction: In the scenario of dental implant procedures, the intraoral scanner and milling unit are used to manufacture a computer-aided design and a computer-aided surgical and radiographic guide. In this sense, the use of CAD-CAM systems is highlighted in the processes of a prosthesis and dental implants, promoting the fabrication of prostheses based on a state-of-the-art three-dimensional system. **Objective:** Conduct a systematic review of the main considerations of the CAD-CAM system for the development of prostheses and dental implants. **Methods:** The present study was followed by a systematic literature review model - PRISMA rules. The quality of the studies was based on the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** The use of digital tools for the automated fabrication of implant parts (CAD-CAM) is an optimizing reality in Dentistry. CAD-CAM enables high-quality, standardized, accurate, and detail-perfect prosthetic restorations. The use of metallic implants in the morse cone system in association with zirconia abutments guarantees a final product with mechanical resistance, biocompatibility, and esthetics.

Keywords: Dental Implant. CAD-CAM. Dental Prosthesis. Intraoral scanner.

Introduction

In the scenario of dental implant procedures, the intraoral scanner and a milling unit are used to fabricate a computer-aided design and a computer-aided surgical and radiographic guide [1]. In this sense, the use of CAD-CAM systems (Computer-Aided Design/Computer-Aided Manufacturing) is highlighted in the processes of a prosthesis and dental implants [2,3].

In this context, the CAD-CAM system was introduced in dentistry to promote the fabrication of prostheses based on a state-of-the-art three-dimensional system [4]. Where the search for aesthetic solutions has been increasingly challenging, given the patient's demand and the growing number of techniques and materials available for protective rehabilitation [5]. Aims that the material's resistance is the primary factor to determine the indication of the technique, as well as the preservation of the rehabilitation over time and the need for movements that lead to the possibility of carrying out rehabilitation of greater extensions [4,5].

In this sense, the CAD-CAM system performs an intraoral scanner, while the CAM is the milling machine [6-8]. Ceramics are the main alternative restorative material for tooth structure due to their favorable properties [8,9]. In addition, fixed complete dental prosthesis supported by metal-acrylic resin implant is an important restorative option. However, maintenance and repair increase time, but CAD-CAM assistance can improve efficiency and reduce complications. Thus, CAD-CAM can fabricate an fixed complete dental prosthesis supported by metal-acrylic resin implant metal-acrylic resin that minimizes individual tooth fracture and facilitates efficient resurfacing of worn surfaces [10]. Thus, one of the main CAD-CAM objectives is the simplification and optimization in the production of prosthetic structures with high quality and aesthetics [9-11].

Based on this entire scope, the present work aimed to carry out a systematic review of the main considerations of the CAD-CAM system for the

development of prostheses and dental implants.

Methods

Study Design

The present study was followed by a systematic literature review model, according to the PRISMA rules.

Data sources and research strategy

The search strategies for this review were based on the descriptors: "Dental Implant. CAD-CAM. Dental Prosthesis. Intraoral scanner". The research was carried out from July 2021 to August 2021 and developed based on Google Scholar, Scopus, PubMed, Scielo, and Cochrane Library.

Study quality and risk of bias

The quality of the studies was based on the GRADE instrument, with randomized controlled clinical studies, prospective controlled clinical studies, and studies of systematic review and meta-analysis listed as the studies with the greatest scientific evidence. The risk of bias was analyzed according to the Cochrane instrument.

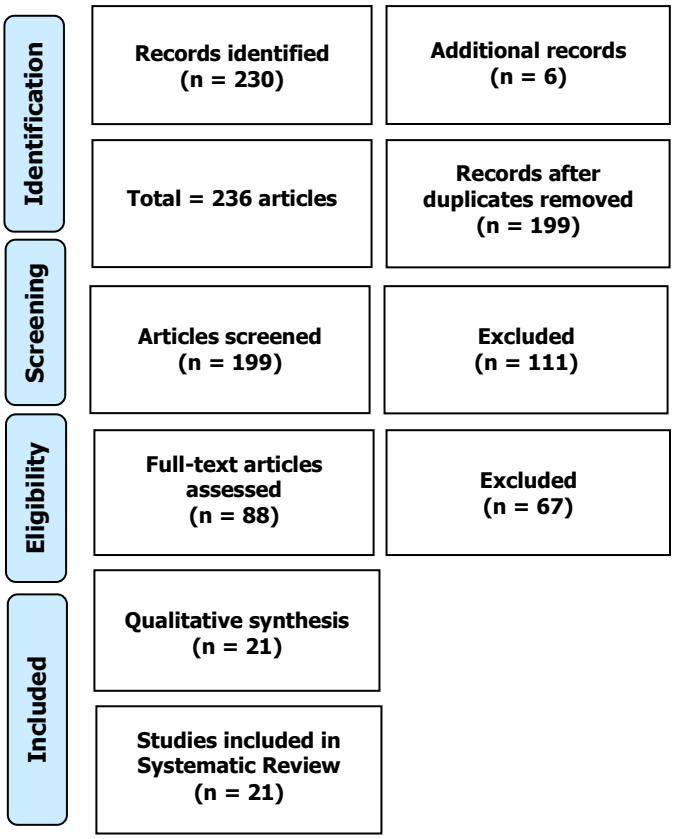
Results and Discussion

In total, 236 articles were found. After the selection process, 88 articles were recruited for analysis, 21 articles were selected and used in this study to compose the textual part (**Figure 1**). The selected articles had moderate quality in their clinical trials. The bias risks found do not affect the reliability of the results. Based on the main literary findings, when the tested materials were used with the CAD-CAM system, the 3D marginal discrepancy of the CAD-CAM frameworks was smaller than that of titanium or zirconia frameworks [12-15].

In this sense, the CAD-CAM system has advanced the dental restoration process to include implant-supported crowns. Thus, a study compared the fracture strength after mechanical loading and thermocycling of various combinations of screw-retained and cemented ceramic materials and polymethylmethacrylate using the TiBase abutment compared to implanted crowns. Screw-retained implant restorations demonstrated higher fracture loads than their cemented counterparts. Lithium disilicate hybrid abutment/crown implant-supported restoration using the TiBase abutment may be an ideal clinical choice due to its simplicity [16].

In addition, one study described a technique to fabricate a custom anatomical healing abutment for delayed loading implants using CAD-CAM from a polymethylmethacrylate (PMMA) blank. The dimensions of the custom healing abutment are measured from a conventional dental radiograph and diagnostic models. The healing abutment is used in the second surgical phase to guide soft tissue healing [17].

Figure 1. Study selection scheme.



Also, the CAD-CAM technique is particularly beneficial for a long scan span and large edentulous space with multiple scan bodies, and a verification device can be used to confirm the accuracy of a definitive implant impression [18].

Another study presented eight patients who underwent three-dimensional reconstruction of the fibula flap with iliac crest graft and dental implants using CAD/CAM virtual planning. The increase in the vertical crest and the horizontal dimensions of the fibula, the peri-implant bone resorption of the iliac crest graft, the implant success rate, and the functional and esthetic results were evaluated. Vertical reconstruction ranged from 13.4 mm to 10.1 mm, with a mean of 12.22 mm. A total of 38 implants were placed in the new mandible, with an average of 4.75 ± 0.4 implants per patient and an osseointegration success rate of 94.7%. All patients were rehabilitated with fixed implant prostheses with good aesthetic and functional results [19].

Besides, a retrospective study of 25 patients analyzed the differences, in terms of mechanical and biological complications, in multi-unit zirconia fixed

dental prostheses (FPDs) in posterior implants produced through a digital workflow. Occlusal and interproximal corrections were not clinically significant. In the study sample, the survival rate and success rate of FPDs after 3 years were 100% and 96%, respectively. Monolithic zirconia FPDs and partial veneer FPDs showed a 100% survival rate, presenting an interesting alternative to metal-ceramic restorations. Partial veneer FPDs had a higher technical complication rate than monolithic FPDs, but without statistical significance [20].

Also, a review article analyzed that a high-performance bioactive polymer (BioHPP) and CAD/CAM computer-aided composite resin materials are a relatively new class of dental biomaterials. To avoid many disadvantages of metals and their alloys in dental practice, such as inadequate color, high density, thermal conductivity, and possible allergic reactions, polymer-based materials (BioHPP) and CAD/CAM composite resins are being developed. They are biocompatible materials that are light, strong, durable, and feature high resistance to bending and compression. However, most of its characteristics have been demonstrated through laboratory tests, while clinical studies are relatively scarce [21].

Conclusion

The use of digital tools for the automated fabrication of implant parts (CAD-CAM) is an optimizing reality in Dentistry. CAD-CAM enables high-quality, standardized, accurate, and detail-perfect prosthetic restorations. The use of metallic implants in the morse cone system in association with zirconia abutments guarantees a final product with mechanical resistance, biocompatibility, and esthetics.

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Data sharing statement

No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

Similarity check

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