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Clinical outcomes of the importance of minimally traumatic tooth extraction for dental implant and aesthetic: a systematic review

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Abstract

Introduction: In the context of tooth extraction, this clinical practice is common for dentists, with the main causes of caries, periodontal disease, and coronal-radicular fractures. The choice for rehabilitation with implants has been growing, and to be carried out, it needs alveolar bone preservation at the implant site and adequate gingival contour, especially in aesthetic regions. However, the new techniques and instruments for minimally traumatic extraction still need to be analyzed, as little research has evaluated the success rate and limitations of these devices. **Objective:** It was developed a systematic review to highlight the importance of minimally traumatic tooth extraction for dental implants and aesthetics. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from November 2024 to January 2025 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 130 articles were found, 32 articles were evaluated in full and 25 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 21 studies with a high risk of bias and 32 studies that did not meet GRADE and AMSTAR-2. Most studies did not show homogeneity in their results, with X^2=81.6%>50%. It was concluded that the use of precise and minimally traumatic techniques enabled satisfactory and functional aesthetic results, as well as improving the patient's aesthetics and self-esteem. The immediate implant placement procedure after tooth extraction preserves bone height and thickness, reduces treatment time and cost, in addition to maintaining the gingival architecture, being important for the aesthetic success of future prosthetic rehabilitation. Also, it presents success rates comparable to implants in fully healed edges, the extraction must be done in a minimally traumatic way, to preserve the maximum bone tissue. The horizontal defects present after the installation of the immediate implant, if they are less than or equal to 3mm, will heal with complete bone filling. However, if they are larger than 3mm, bone graft material and/or membrane should be used so that there is bone healing.

Keywords: Tooth extraction. Minimally traumatic extraction. Dental implant. Aesthetics.

Introduction

In the context of tooth extraction, this clinical practice is common for dentists, with the main causes of caries, periodontal disease, and coronal-radicular fractures. The choice for rehabilitation with implants has been growing, and to be carried out, it needs alveolar bone preservation at the implant site and adequate gingival contour, especially in aesthetic regions. These requirements can and should be planned from tooth extraction, and for that purpose, there are minimally traumatic extraction techniques [1-3].

The conventional extraction technique performed with levers and forceps exerts horizontal movements

and/or rotations in the tooth to be extracted enough to rupture the collagen fibers resulting in bone expansion or fracture of the buccal bone plate. Thus, it is evident that conventional extraction traumatizes the alveolar bone to a considerable extent [4]. Thus, techniques to enable a less traumatic tooth extraction have been available in recent decades, these techniques aim to perform a tooth extraction in the vertical direction, preserving alveolar bone [5]. In this sense, the principle of the new systems for extractions is that there is a minimum of bone expansion and trauma in the alveolus, eliminating forces in the horizontal direction [5].

Some techniques have emerged with this principle, either with special forceps or with sophisticated and highly ingenious systems. These new devices perform a traction force in the axial direction of the tooth root to be extracted, and if applied successfully, it should minimize bone trauma, resulting in the rupture of periodontal fibers without bone expansion [6]. However, the new techniques and instruments for minimally traumatic extraction still need to be analyzed, as little research has evaluated the success rate and limitations of these devices.

The growing technological development of implantology presents dental professionals with a challenge, which consists in the search for an aesthetic gingival architecture, which satisfies the professional's objectives as planned and also the result expected by the patient who is submitted to this type of treatment [7]. Several authors have reported the immediate installation of implants in the socket of extracted teeth. The reason for this procedure is to reduce the treatment time and cost, preserve the height, alveolar bone thickness, and soft tissue dimension, promoting bone-implant contact [8-13].

Some studies report very satisfactory results related to the immediate installation of implants, even in infected sites [10-14]. In this respect, some factors are considered determinants for obtaining a positive result in the treatment of implant installation placed immediately in the extraction of the tooth socket, such as the preservation of the bone margins of the socket during extraction, the primary stability of the implant in the apical portion of them along the walls of the alveolus, careful control of the tissue flap, the narrow closure adapted to the implant neck and meticulous control of the plaque throughout the healing period [12,15,16].

Given this, this study developed a systematic review to highlight the importance of minimally traumatic tooth extraction for dental implant and aesthetics.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 01/14/2025. The AMSTAR 2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 01/14/2025.

Search Strategy and Search Sources

The literature search process was carried out from November 2024 to January 2025 and developed based on Web of Science, Embase, Scopus, Embase, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The following descriptors were used in health sciences (DeCS/MeSH): "Tooth extraction. Minimally traumatic extraction. Dental implant. Aesthetics", and the Boolean "and" was used between the MeSH terms and "or" between the historical findings.

Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using Cohen's test (d).

Summary of Findings

A total of 130 articles were found and submitted to eligibility analysis, with 25 final studies selected to compose the results of this systematic review. The listed studies were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=81.6%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 21 studies with a high risk of bias and 32 studies that did not meet GRADE and AMSTAR-2.

Figure 1. Flowchart showing the article selection process.

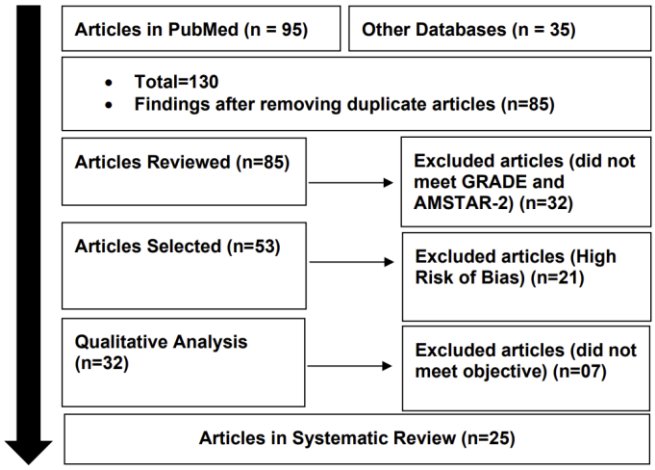

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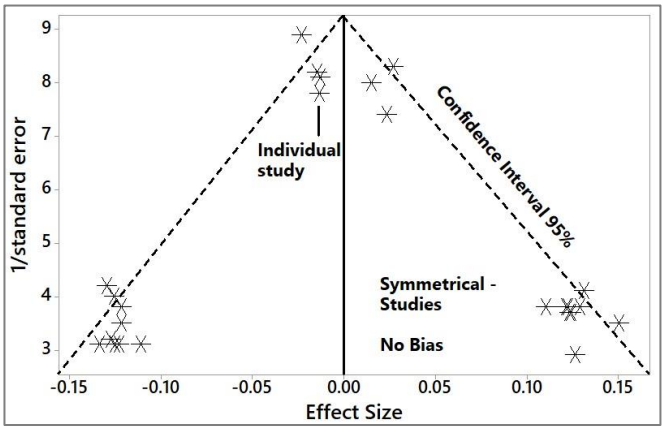
Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) that are shown at the base of the graph and in studies with large sample sizes that are presented at the top.

Figure 2. The symmetrical funnel plot suggests no risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=25 studies).



Source: Own Authorship.

Main Clinical Results and Considerations

It`s evident that the extraction of a tooth initiates a series of reparative processes involving hard tissue (alveolar bone) and soft tissue (periodontal ligament), gingiva) [22]. The bone healing process involves the inflammatory, reparative, and remodeling phases. The first stage is characterized by the formation of the clot, the second by the construction of the bone callus and the third is the remodeling and formation of new lamellar bone tissue.

In this sense, after tooth extraction, the alveolus is filled with blood and the formation of a blood clot occurs [23]. Within the first week after tooth removal, the blood clot that filled the socket is almost completely remodeled and replaced with granulation tissue. After a week of tissue modeling, the deposition of mineral tissue begins [24]. After 2-4 weeks, erythrocytes dispersed between mesenchymal cells can still be observed. In this healing phase, the granulation tissue and a fibrous temporary matrix represent the dominant tissues, constituting an average of 30% and 50%, respectively, of the total tissue that is filling the alveolus [25].

After that, 6-8 weeks of healing, most of the granulation tissue is replaced by the temporary fibrous matrix and bone tissue, and the marginal part of the alveolus anchors islands of immature bone tissue [24-26]. Even at this stage, the fibrous provisional matrix and bone tissue have been shown to occupy about 60% and 35% of the tissue [25]. These tissues are also predominantly demonstrated at a later stage of healing (12-24 weeks), while the lamellar and medullary bone is often less observed and represented. Thus, bone organization and architecture are generally incomplete within 24 weeks after tooth extraction [22].

All extractions must be performed with a precise indication, because of defined prosthetic planning. In addition, they should be as painless, safe, and comfortable as possible. Thus, new management and extraction techniques have been tested and employed [1-3].

In this sense, in therapy with dental implants, the need to preserve the largest amount of alveolar bone possible is of great importance. The placement of implants right after extraction has been much discussed in recent years, due to persistent clinical failures and also the vestibular bone loss caused by extraction itself. These challenges need to be overcome and new technologies are emerging to meet these needs [4]. In prominence, when the rehabilitation with implants is in an aesthetic region, the procedure requires greater care and becomes more complex, in addition to generally having a greater expectation from the patient [27,28].

In this regard, it is known that for the successful placement of implants or any other type of dental prosthesis, it depends on several factors, and among them is minimally traumatic extraction. New methods for this purpose are emerging and being well accepted, as they propose better preservation of the bone crest, reduction of bone loss in width and thickness, and conservation of the vestibular bone board, making the aesthetic result to be optimized [4].

One of the alternatives of minimally traumatic extraction is the use of membranes and grafts, used to preserve or recover bone volume after tooth extraction, whether in height or width of the alveolar crest, as well as to compensate for any type of bone loss due to trauma [29]. However, these techniques have the disadvantage of increasing the cost, morbidity, and treatment time, in addition to making implant placement with immediate loading unviable [30].

Also, another method found in the literature that enters the context of minimal bone intervention is the exfoliation of the teeth using orthodontic rubber bands. The method offers a gradual removal of the tooth and is more conservative than the dental extractor, however, like the grafting and membranes techniques, it has the disadvantage of requiring longer treatment time, with an average extraction time of six weeks [30, 31]. For patients using bisphosphonates for minimally traumatic extraction, it seems to decrease the severity of postoperative complications, as bone loss is reduced with this technique [30,32].

In this context, the various techniques for minimally traumatic extraction have as main objective the preservation of the buccal alveolar bone and maintenance of gingival contour after tooth extraction. As examples, there are the periotomes, blade of bivers, and dental extractors [33-36]. The periotome is a surgical instrument that works by separating the periodontal ligament from the tooth. The instrument is placed in the groove between the periodontal ligament and the tooth, the entire circumference of the tooth is contoured. The periotome most often reaches the fibers of the cervical and middle third. After the separation of the periodontal ligament and the tooth, extraction proceeds with conventional instruments such as levers and forceps in an atraumatic manner [33]. The bivers blade, similarly to the periotome, aims to break the fibers of the periodontal ligament, facilitating the removal of the tooth with levers and/or forceps.

Besides, tooth extractors perform extraction in the vertical direction, promoting an minimally traumatic extraction [27,35,36]. In this sense, the main indications for dental extractors are when immediate implants will be performed, especially in aesthetic areas and fractured teeth below the gingival margin, because with the use of the screw inserted in the residual root, flaps and osteotomy can be avoided. In addition, dental extractors can be used on any multi-root or single-root teeth that are not in the context of contraindications, including fractured roots, non-retained tooth extractor screw, hypercementosis, root divergence in multi-root teeth, and root lacerations [35].

In this sense, the authors tested a dental extractor to verify its applicability and limitations [5]. Among the teeth to be extracted with the extractor, only 17% were unsuccessful, the causes of failures were the impossibility of retaining the screw inserted in the tooth to be extracted, macroglossia making it difficult to use the appliance, fractured roots, and hypercementosis. Also, a study analyzed the mechanism of action of vertical extractors, using the three-dimensional finite element method, observing the tensile and compressive forces that the dental extractor can cause in the alveolus of the tooth to be extracted. The results found were that the dental extractor favors traction pressures and reduces compressive forces. In addition, the traction pressure develops predominantly at the apex of the alveolus and decreases with the proximity of the cervical. These findings support the idea of minimally traumatic extraction offered by the device [37].

In this sense, as another example, a study with 48 patients analyzed implants in sites with healed bone (control group) and alveoli after extraction (test group). In the test group, a gap less than or equal to 2mm occurred between the bone wall and the implant surface, while in the control group, the bone cortex was in direct contact with the implant. Membranes or filling materials were not used in the surgical sites, which, during healing, were covered by soft tissue. After 12 months of healing, histological analysis was performed and it was noted that the degree of bone in contact with the implant in all samples was high, between 62 and 71%, and there were no differences between the control group and the control group. test. The authors demonstrate that the hard tissue can fill and occupy the marginal defects around the implant, in extraction sites, during healing, and that the vestibular and palatal portions of the bone crest after tooth removal suffer more loss of horizontal tissue and less vertical tissue loss [38].

A case report study showed the application of the immediate dentoalveolar restoration technique to reconstruct the buccal bone wall, with an autogenous graft from the maxillary tuberosity, which had been lost by root fracture, and provide the necessary bone substrate for the installation of an implant and its provisioning. One of the greatest risks inherent in the survival of immediate implants is the maintenance of their stability during the healing period. In this case, due to a mechanical trauma in sports activity in the first postoperative month, there was a complete failure in the osseointegration process, confirmed by tomographic examination of both the implant and the bone graft. The deleterious effects of this accident were compensated with a new approach and reapplication of the immediate dentoalveolar restoration technique with a smaller diameter implant and with conical macro geometry in conjunction with the new bone reconstruction under the

same compromised socket; associated, after the period of osseointegration, with maneuvers to increase the volume of gingival tissue by subepithelial connective tissue graft. The tomographic result demonstrated the success of the surgical procedures, and the clinical/photographic analysis obtained showed the stability of the gingival margin without compromising the aesthetic result of the prosthetic restoration [39].

A prospective multicenter cohort study was carried out to identify implant risk factors, complications, and patient-centered results after immediate implant placement in a single tooth and loading in aesthetic areas. Immediate consecutive implants placed in incisors, canines, and premolar sites were included. Data from 215 implants in 215 patients were collected at 15 centers in 2 years. Potential risk factors were identified in 116 patients (54.21%). There were 11 dropouts after 1 year and 37 after 2 years. Failures were relatively frequent (14.6%) before delivery of the definitive prosthesis. No significant association was observed between early failures and risk factors. One failure and six recessions were observed after the definitive prosthesis. High satisfaction scores were recorded in 2 years. No recession occurred in the risk-free group. Five cases of mucositis and one case of peri-implantitis were observed in the 2-year follow-up [40].

Finally, a study analyzed the result of immediate post-extraction implants placed with and without bone graft in the maxillary premolar area for 3-year follow-up after loading at the aesthetic level. After tooth extraction, 102 patients received 115 immediate dental implants. After 3 years, 1 implant failed in each group. Thirty-seven patients had inflammation and bleeding, 19 mucositides, and 2 peri-implantitis. The level of the mesial bone was -0.61 mm in group B (with a bone graft) and -1.01 mm in group A. The distal bone level in group B was -0.71 mm and -1.12 mm in group A. The average vestibular probing in Group B was increased (+0.40 mm) than in group A (+0.36 mm). The average palatal value of group B was higher (+0.54 mm) than group A (+0.38 mm). No statistically significant difference was found between the 2 groups. However, the Pink Esthetic Score and patient satisfaction were higher in group B than in A ($p < 0.001$). Therefore, the use of an inorganic bovine bone substitute with a resorbable collagen barrier in immediate post-extractive implants seems to improve the aesthetic results after 3 years of follow-up [41].

Conclusion

It was concluded that the use of precise and minimally traumatic techniques enabled satisfactory and functional aesthetic results, as well as improving the patient's aesthetics and self-esteem. The immediate implant placement procedure after tooth extraction preserves bone height and thickness, reduces treatment time and cost, in addition to maintaining the gingival architecture, being important for the aesthetic success of future prosthetic rehabilitation. Also, it presents success rates comparable to implants in fully healed edges, the extraction must be done in a minimally traumatic way, to preserve the maximum bone tissue. The horizontal defects present after the installation of the immediate implant, if they are less than or equal to 3mm, will heal with complete bone filling. However, if they are larger than 3mm, bone graft material and/or membrane should be used so that there is bone healing.

CRediT

Author contributions: **Conceptualization-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá, Renato Gomes Azevedo; **Formal Analysis-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá; **Investigation-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá; **Methodology-** Eduarda Garcia Caldeira; **Project administration-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá; **Supervision-**Renato Gomes Azevedo; **Writing - original draft-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá, Renato Gomes Azevedo; **Writing-review & editing-** Eduarda Garcia Caldeira, Heloisa Aura Garcia, Pedro Antônio Teixeira de Sá, Renato Gomes Azevedo.

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Informed Consent

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No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

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