MedNEXT
Journal of Medical an Health Sciences

REVIEW ARTICLE

DOI: 10.54448/mdnt25S206

Major clinical considerations of minimally traumatic tooth extraction and aesthetic management: a systematic review

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DOI: https://doi.org/10.54448/mdnt25S206
Received: 01-14-2025; Revised: 03-15-2025; Accepted: 03-16-2025; Published: 03-18-2025; MedNEXT-id: e25S206

Editor: Dr. Janaki Vidanapathirana MD, MHP.

Abstract

Introduction: After tooth extraction, the alveolar ridge will commonly decrease in volume and change morphologically. These changes can difficult or even impede the placement of dental implants and prosthetic rehabilitation. Minimizing bone remodeling means optimizing the esthetics and functional aspects, and mainly, the sucess of implant treatment. To avoid the residual ridge resorption different techniques and bone graft materials have been proposed. **Objective:** It was to analyze, through a systematic review, the main clinical considerations of minimally traumatic tooth extraction, in order to highlight the best dental and aesthetic management. **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:** A total of 175 articles were found, and 40 articles were evaluated in full and 29 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 25 studies with a high risk of bias and 30 studies that did not meet GRADE and AMSTAR-2. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=81.3%>50%. The present study suggests that the alveolar graft technique may increase the risk of disease transmission, cost, and time of treatment. Several studies have stated that the graft material is not fully incorporated into the newly formed bone, indicating less vital bone tissue. Spontaneous cicatrization is still the most used feature since, in intact alveoli and small defects, it is a procedure that does not present significant losses that justify the use of edge preservation techniques. In larger defects, techniques after spontaneous healing, such as a block graft, can be used without the drawbacks of alveolar grafting, such as delayed healing and poor bone quality.

Keywords: Tooth extraction. Alveolar ridge preservation. Aesthetic.

Introduction

Tooth extraction is a common occurrence and needs to be minimally traumatic to achieve oral aesthetics. The oral cavity is a complex microenvironment, influenced by oral movements, salivary flow, and bacterial biofilms, contributing to delayed alveolar healing and the onset of post-extraction complications, which can overwhelm patients' aesthetic and functional rehabilitation. Recent advances in materials science and bioengineering have paved the way for developing new strategies [1-3].

Initially designed to solve cases of total edentulism, according to a specific clinical protocol for fixed dental prosthesis, treatment with osseointegrated dental implants however, it became a frequent procedure in replacing a single missing tooth and showed predictable results [1,2]. Tooth extraction is a traumatic procedure that usually results in damage to the surrounding alveolar bone and surrounding soft tissues. Others

reported that reabsorption appears to be progressive and irreversible and have observed that the alveolar ridge will generally decrease in volume and morphologically alter. They believe that this occurs due to the quantitative and qualitative changes that the edentulous areas of the alveolar process will suffer after tooth extraction [3,4].

This bone remodeling can generate damages that involve the installation, aesthetics, survival, and function of the implant in the long term [5-7]. Especially when aesthetic areas are observed, these changes generate obvious consequences for future treatment with implants [8]. Currently, the success of the treatment is not only evaluated by the survival of the implants but also by the aesthetic and functional results. Thus, we should limit the loss of height and width of the alveolar ridge to the minimum, providing a better area for the placement of dental implants [9].

The preservation of the alveolar ridge performed immediately after tooth extraction can bring benefits such as reducing operating costs for both the patient and the dentist and the need for future surgical interventions. Preventing bone remodeling resulting in physiological resorption and the need for future interventions is undoubtedly more effective, although there are many techniques for increasing the ridge [4,10].

In attempting to neutralize bone remodeling, several approaches have been suggested such as the immediate placement of implants, the use of different graft materials associated or not with the use of occlusive membranes, which would avoid the tendency of soft tissues to invaginate in the alveolus, in addition to without access [3,4,11]. The maintenance procedures of the post-extraction alveolar ridge corroborate for placement of the implant in an esthetic and functionally more favorable position because they are predictable procedures that certainly prevent the depression of the collar [12-16]. Today, fresh extraction cells represent a challenge for the dental surgeon. Much research has been done on the use of synthetic materials to replace, repair, or augment biological tissues. Therefore, a careful evaluation of the risks and benefits of the use of biomaterials should be carried out, with full knowledge by the dental surgeon regarding the characteristics, properties, and concentration of the materials [1,2,17].

Thus, this study aimed to analyze, through a systematic review, the main clinical considerations of minimally traumatic tooth extraction, in order to highlight the best dental and aesthetic management.

Methods

Eligibility and 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: 01/19/2025. The AMSTAR 2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 01/19/2025.

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, Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The following descriptors (DeCS /MeSH Terms) were used: *Tooth extraction. Alveolar ridge preservation. Aesthetic*, and using the Boolean "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

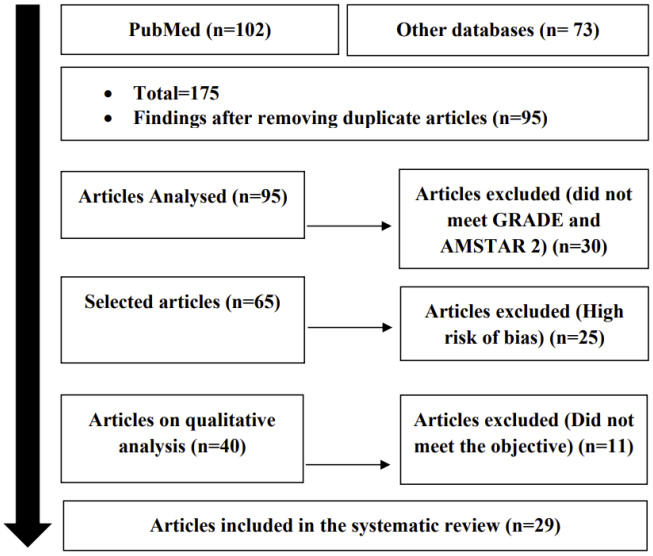
Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. Low 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 d test.

Results and Discussion

Summary of Findings

As a corollary of the literature search system, a total of 175 articles were found that were submitted to eligibility analysis, 40 articles were evaluated in full and 29 final studies were selected to compose the results of this systematic review. The studies listed 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 studies. 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=81.3%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 25 studies with a high risk of bias and 30 studies that did not meet GRADE and AMSTAR-2.

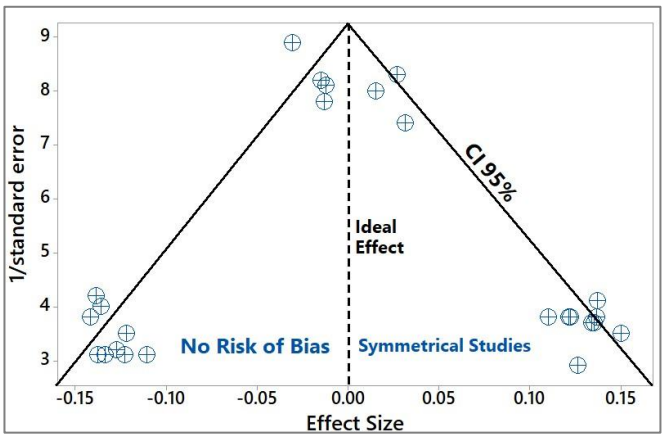
Figure 1. Flowchart showing the article selection process.



Source: Own Authorship.

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 shown at the top.

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. Studies with high confidence and high recommendation are shown above the graph (n=29 studies).



Source: Own Authorship.

Major Results and Considerations

The main purpose of alveolar grafting is to preserve the alveolar ridge anatomy and optimize implant placement in an ideal three-dimensional position required for functional and aesthetic rehabilitations [1-3]. Within the synthetic materials used to fill the alveolus, the deproteined bovine bone (spongy, cortical or the mixture of both) associated or not to the use of guided tissue regeneration technique seems to be the most common [4-7].

It has been stated that in intact wall alveoli we can use osteoconductive materials and the use of membranes may not be necessary. Guided tissue regeneration techniques, with osteoinductive materials associated or not with the use of regenerative membranes, are used in alveoli with compromised walls or the absence of any wall [12-15].

Significant three-dimensional bone loss was reported in addition to reducing the quality and quantity of keratinized gingiva in alveoli without adequate treatment, emphasizing the importance of using appropriate materials and demonstrating better results with the use of Bio-Oss® compared to NanoBone [16]. Preservation of the collar using deprotected mineral bovine bone (Bio-Oss®) and nanocrystalline hydroxyapatite (NanoBone), together with a collagen membrane, reduced alveolar ridge changes after tooth extraction and allowed for a more favorable implant positioning. There was no superiority between histological and histomorphometric materials [17-21].

The deproteined bovine bone particles inserted into the bone defects cannot be fully resorbed and remain around the recipient bone as inert foreign bodies. The study also cites other authors, who report osteoclastic activity after months of healing, suggesting that over time these particles will remodele and form new bone. This remodeling would occur only 10% per year [22]. A considerable limitation in horizontal and vertical resorption was observed using the preservation of the alveolus with bovine mineral bone and porcine collagen membrane when compared with spontaneous healing, also histologically observing the formation of new bone with large mineralized portion due to the xenograft material [23-26].

The alveolus was filled with a matrix composed of mineralized and demineralized allograft together with a absorbable collagen membrane and histologically observed bone formation in three healing periods [27,28]. The authors reported that osseointegration occurred independently of the moment of grafting and that the presence, especially at early times, of intense osteoblastic activities, suggesting a permanently active bone regeneration, may have contributed to implant survival [29,30].

In immediate implants, defects of about 1.5 mm between bone walls and implants have shown good spontaneous healing, but to avoid loss of vestibular bone volume, these defects should preferably be filled with biomaterial associated with membranes. Although immediate unit implants offer an increased risk of

failure, aesthetic results and marginal peri-implant radiographic bone levels are optimized by filling the defect around immediate unit implants using an inorganic bovine bone substitute (Endobone) with resorbable collagen (OsseoGuard) [29,30].

One study evaluated alveoli with hydroxyapatite, biphasic calcium phosphate, tricalcium phosphate, and alveoli without any type of graft. It was observed that bone formation was late in the grafted alveoli with synthetic bone filling and that the healing process was different according to the biodegradation pattern. In addition, they noted that alveoli grafted with tricalcium phosphate had fewer residual particles in all healing periods [29].

Finally, with current advances in stem cell technology, in the future it may be possible to regenerate the teeth or maintain the alveolar bone. Promising results were observed with frameworks grown from mesenchymal stem cells of the bone marrow inserted into fresh alveoli [1].

Conclusion

The present study suggests that the alveolar graft technique may increase the risk of disease transmission, cost, and time of treatment. Several studies have stated that the graft material is not fully incorporated into the newly formed bone, indicating less vital bone tissue. Spontaneous cicatrization is still the most used feature since, in intact alveoli and small defects, it is a procedure that does not present significant losses that justify the use of edge preservation techniques. In larger defects, techniques after spontaneous healing, such as a block graft, can be used without the drawbacks of alveolar grafting, such as delayed healing and poor bone quality.

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Author contributions: **Conceptualization-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario, Andreia Borges Scriboni; **Formal Analysis-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario, Andreia Borges Scriboni; **Investigation-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario; **Methodology-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario; **Project administration-**Andreia Borges Scriboni; **Supervision-** Andreia Borges Scriboni; **Writing - original draft-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario, Andreia Borges Scriboni; **Writing-review & editing-** Brenda Marques da Silva, Ligia Galdino Diniz, Barbara Caroline Bezerra Belizario, Andreia Borges Scriboni.

Acknowledgment

Not applicable.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

Peer Review Process

It was performed.

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