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Main clinical approaches to conservative and aesthetic treatment after tooth extraction for dental implants: a systematic review

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Abstract

Introduction: In the aesthetic context after tooth extraction for dental implants, the conservative nature, favorable long-term prognosis, cost-benefit ratio, and, more recently, the aesthetic predictability provided by the restoration of a single tooth with an implant stand out. **Objective:** This study aimed to highlight the main clinical approaches to conservative and aesthetic treatment after tooth extraction for dental implants with safety and efficacy. **Methods:** The PRISMA Platform systematic review rules were followed. The search was conducted from January to February 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 116 articles were found, 36 articles were evaluated in full and 26 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 14 studies with a high risk of bias and 26 studies that did not meet GRADE and AMSTAR-2. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=92.7%>50%. It was concluded that to successfully treat patients facing the loss of a single tooth in an area of high aesthetic importance, the implant team should use a comprehensive strategy that begins with a systematic functional and aesthetic assessment, aiming to identify the factors that can improve or impair the final aesthetic result. This allows the selection and sequencing of the unique combination of orthodontic, surgical-periodontal, and prosthetic techniques on implants, necessary to ensure a harmonious restoration. An extraction socket filled with xenograft results in better preservation of the alveolar bone dimension, less crestal resorption, and better healing of soft and hard tissues with better satisfactory results. Six considerations should assist clinicians in clinical decision-making, highlighting the presence of infection, inability to achieve primary stability in the restored position, presence of damaged socket, periodontal phenotype, aesthetic demands, and systemic conditions.

Keywords: Tooth extraction. Alveolar ridge preservation. Aesthetic. Dental implant.

Introduction

In the aesthetic context following tooth extraction for dental implants, the conservative nature, favorable long-term prognosis, cost-effectiveness, and, more recently, the aesthetic predictability provided by single-tooth implant restoration stand out. Compared to traditional restorative options, this treatment modality is rapidly becoming one of the most common clinical scenarios faced by the implant team [1-3].

The implant surgeon must not only be familiar with the clinical factors that favor a successful functional outcome but must also be able to identify factors that may compromise or limit aesthetic success when considering replacement with an implant after tooth removal. In addition, the implant team must be able to select the appropriate surgical and prosthetic treatment options to manage common aesthetic clinical scenarios with a high degree of predictability [2,3].

It is necessary to provide information pertinent to the diagnosis and treatment planning, as well as the surgical and prosthetic management of patients facing the removal of a single tooth in an area of high aesthetic importance. The evaluation of the aesthetic implant

patient begins with the completion of a detailed health questionnaire and a patient interview, aimed at identifying the patient's general health status [4-6].

In addition to identifying common risk factors, such as uncontrolled diabetes mellitus and smoking, it is essential to document the details of the dental history that led to the removal of the tooth in question. Specifically, a prior history of trauma (subluxation, avulsion with reimplantation) and endodontic therapy (retreatments, apical surgery) associated with acute or chronic infections and their treatment should be documented. The chronology of such events should also be recorded. In most cases, a prior history of trauma, surgical endodontic therapy or retreatments, or infections results in compromised circulation to the supporting periodontal tissues and, therefore, a reduced regenerative potential of the site [6-8].

As a result, osseointegration may be compromised, a reduction in the volume produced by hard and soft tissue site development procedures should be expected, and increased complications resulting from these procedures are likely. After a detailed medical and dental history, diagnostic radiographs, photographs, and study models should be obtained for treatment planning purposes. These records also serve to establish the baseline condition before the initiation of therapy and are useful for later comparison with the final treatment outcome [9-11].

Given this, the present systematic review study highlighted the main clinical approaches for conservative and esthetic treatment after tooth extraction for dental implant placement with safety and effectiveness.

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: 02/15/2025. The AMSTAR 2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 02/15/2025.

Search Strategy and Search Sources

The literature search process was carried out from January to February 2025 and developed based on Web of Science, Scopus, Embase, 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. Dental implant*", and using the Boolean "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

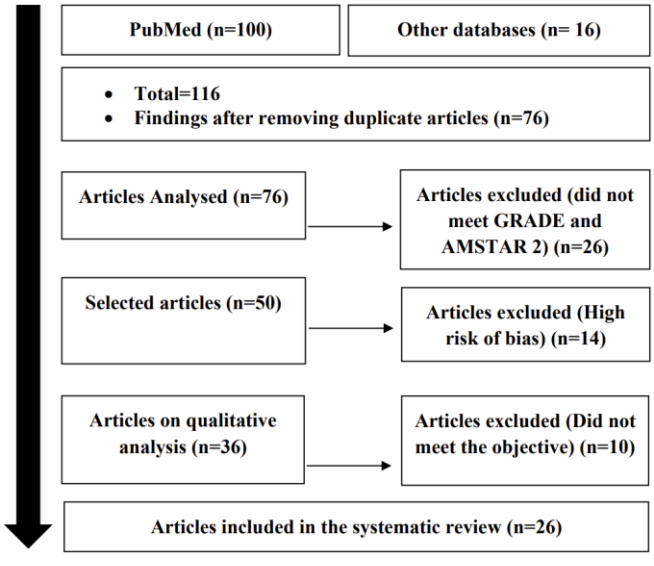
Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. Low 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 116 articles were found that were submitted to eligibility analysis, 36 articles were evaluated in full and 26 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=92.7%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 14 studies with a high risk of bias and 26 studies that did not meet GRADE and AMSTAR-2.

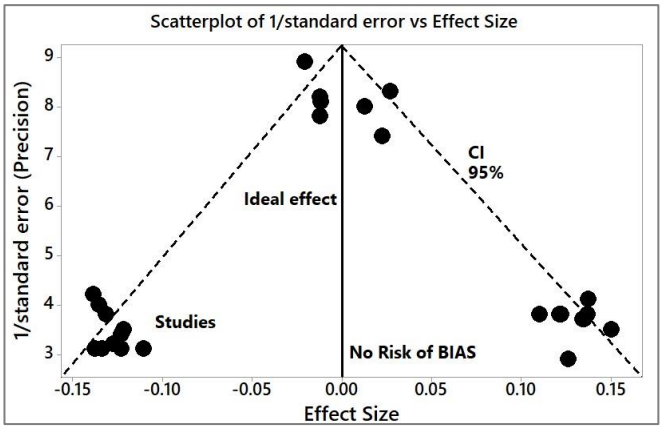
Figure 1. Flowchart showing the article selection process.



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=26 studies).



Source: Own Authorship.

Major Scientific Approaches and Clinical Results

Extraction socket healing in humans is characterized by a series of cellular and tissue changes; a blood clot forms rapidly within the socket, which is then replaced by granulation tissue and eventually osteoid tissue. The center of the ridge shifts palatally/lingually as a result of the buccal bone plates in the maxilla and mandible. Alveolar Ridge Preservation (ARP) procedures have been introduced to prevent atrophy of the alveolar ridge, preserve sufficient bone dimensions to allow placement of implants in prosthetic positions and maintain an acceptable ridge contour in areas of aesthetic interest. Different bone grafts have been used for ARP [1,2].

In this regard, the authors Sah et al. (2025) [12] performed a recent meta-analysis study that evaluated the efficacy of xenograft as a graft material for ARP and reported the results through horizontal ridge width, vertical ridge height, clinical periodontal parameters (such as probing pocket depth (PPD), bleeding on probing (BOP), recession, plaque index (PI) and gingival index (GI), radiological evaluations and associated complications. There was a low to moderate ROB in the included studies. The pooled estimate showed that vertical ridge height (mid buccal (SMD = -1.89 (-2.46-1.31), mesial (SMD = -0.18 (-0.65-0.29), and distal (SMD = -0.11 (-0.58-0.36)) decreased more with the Ext. Alone group, while BOP (SMD = -0.49 (-0.96-0.01)) was more or less similar in both groups. The horizontal ridge width (SMD = 1.15 (0.97-2.05) was better preserved with PRA. The xenograft was clinically and statistically superior.

Thus, the transition from a tooth requiring extraction to its replacement (with a dental implant) requires a series of clinical decisions related to timing, approach, materials, cost-effectiveness, and assessment of potential harms and patient preferences. Six considerations should assist clinicians in clinical decision-making, highlighting the presence of infection, inability to achieve primary stability in the restored position, presence of damaged alveolus, periodontal phenotype, esthetic demands, and systemic conditions [13].

In this sense, the pretreatment clinical evaluation of the patient with an esthetic implant should include a complete functional and esthetic assessment of both the tooth indicated for removal and the neighboring dentition. Focusing attention exclusively on the area indicated for tooth removal and implant replacement will often result in esthetic compromises that can be avoided. The evaluation of the patient with an esthetic implant should include the assessment of facial and dental symmetry [14-16].

The positions of the upper and lower lips at rest, in a relaxed smile and fully animated positions should be assessed to determine tooth and gingival exposure, as well as the orientation and morphology of the incisal and occlusal planes, proportions, morphology, and dental relationships, including axial inclinations and connection zones; assessment of the orientation and morphology of the gingival plane, the periodontal status of the tooth in question, of the neighboring dentition, determination of the periodontal biotype. Furthermore, the existing soft tissue recession defects should be identified and classified, and the occlusion should be assessed for the presence or absence of functional orientation and adequate interdental and interocclusal space [17,18].

Although the surgeon needs to be able to quantify the existing dentoperiodontal esthetics, it is essential that existing or potential dental and periodontal deficiencies, as well as anatomical limitations, be identified before implant therapy [19-22]. The use of prosthetic-guided soft tissue healing to improve esthetic outcomes in implant therapy involves the early introduction of prosthetic components (provisional interim restorations, tooth-shaped healing abutments,

and implant-supported provisional restorations) that match the cross-sectional anatomy of the missing tooth or the planned esthetic replacement at the gingival level [23-27].

These components assist and guide soft tissue healing after various surgical interventions and have a major influence on the final soft tissue architecture achieved at the implant site. These prosthetic elements can be used to preserve the existing soft tissue anatomy after tooth removal and as a scaffold for guided peri-implant soft tissue healing. The placement of custom abutments and provisional restorations immediately after submerged implant exposure is a method that can be used to initiate early guided soft tissue healing for improved esthetic contours [28-30].

At the time of implant placement, the surgeon must perform a surgical indexing (impression at the abutment level) that is subsequently used to fabricate a working model on which the abutment and provisional restoration are fabricated in the dental laboratory. The surgical indexing procedure involves attaching a specialized impression coping at the abutment level to the implant and recording its three-dimensional position relative to the adjacent dentition using a fast-setting polyvinylsiloxane impression material [2,31,32].

The use of custom tooth-shaped healing abutments is a practical approach for the early initiation of prosthetic-guided soft tissue healing. This approach requires less time and cost than the use of custom abutments and provisional restorations. The restorative dentist can easily remove and replace the custom tooth-shaped abutment during impression procedures, thus facilitating the subsequent prosthetic management of the patient [2,33-35].

Finally, oral rehabilitation using implant-supported dental restorations often requires a Ridge Augmentation Procedure (RAP) before implant placement, since tooth extraction/loss results in alveolar ridge deficiencies. Although surgical techniques and biomaterials related to RAP have been practiced for several decades, the results are not always predictable. Post-surgical complications experienced during the early or late phases of wound healing may compromise the ideal ridge dimensions required for implant placement and may have other consequences, such as negatively impacting the patient's quality of life [36].

Conclusion

It was concluded that to successfully treat patients facing the loss of a single tooth in an area of high aesthetic importance, the implant team must use a comprehensive strategy that begins with a systematic functional and aesthetic assessment aimed at identifying the factors that may improve or impair the final aesthetic result. This allows the selection and sequencing of the unique combination of orthodontic, surgical-periodontal, and prosthetic implant techniques necessary to ensure a harmonious implant restoration. An extraction socket filled with xenograft results in better preservation of the alveolar bone dimension, less crestal resorption, and better healing of soft and hard tissues with better satisfactory results. Six considerations should assist clinicians in clinical decision-making, highlighting the presence of infection, inability to achieve primary stability in the restored position, presence of a damaged socket, periodontal phenotype, aesthetic demands, and systemic conditions.

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The authors declare no conflict of interest.

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Application of Artificial Intelligence (AI)

Not applicable.

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References

1. Garispe A, Sorensen C, Sorensen JR. Dental Emergencies. 2022 Dec 7. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–. PMID: 36943982.
2. Sclar AG. Strategies for management of single-tooth extraction sites in aesthetic implant therapy. J Oral Maxillofac Surg. 2004 Sep;62(9 Suppl 2):90-105. doi: 10.1016/j.joms.2004.06.041. Erratum in: J Oral Maxillofac Surg. 2005 Jan;63(1):158.
3. Zamora GP, Molina-González JM, Martínez-Marco JF, Ruiz AJO, Mardas N, Garcia-Sanchez R. Aesthetic outcomes of different materials for delayed, singletooth restorations for immediately placed implants. A randomized controlled clinical trial. J Dent. 2024 Jul;146:105067. doi: 10.1016/j.jdent.2024.105067.
4. Yin Y, Shuai F, Liu X, Zhao Y, Han X, Zhao H. Biomaterials and therapeutic strategies designed for tooth extraction socket healing. Biomaterials. 2025 May;316:122975. doi: 10.1016/j.biomaterials.2024.122975.
5. López-Valverde N, Macedo de Sousa B, Blanco Rueda JA. Changes of the Alveolar Bone Ridge Using Bone Mineral Grafts and Collagen Membranes after Tooth Extraction: A Systematic Review and Meta-Analysis. Bioengineering (Basel). 2024 Jun 3;11(6):565. doi: 10.3390/bioengineering11060565.
6. Buchbender M, Gath L, Jaeckel F, Seidel A, Kesting MR, Wichmann M, Adler W, Matta RE. Investigation of Morphological Changes of the Soft Tissue in the Aesthetic Zone: A 3D Virtual Analysis after Conventional Tooth Extraction and Benex® Extraction. Dent J (Basel). 2024 Aug 9;12(8):252. doi: 10.3390/dj12080252.
7. Zufia J, Sala L. Single extraction socket classification for aesthetic outcomes (CEO). Int J Oral Implantol (Berl). 2024 Sep 16;17(3):309-324.
8. Barcelos, m.; novaes jr., a.; conz, m.; harari, n.; vidigal jr., g. Diagnosis and Treatment of Extraction Sockets in Preparation for Implant Placement: Report of Three Cases. Braz Dent J, 2008, 19(2), p. 159-164.
9. Barboza E, Zenobio E, Shibli J, Granjeiro JM, Carvalho PSP, Sendyk WR. biomateriais substitutos de osso: de onde viemos, onde estamos, para onde vamos? revista perionews, 2011, 5(4), p. 344-350.
10. Aldredge WA, Nejat R. delayed implant procedure using deproteinized bovine bone mineral: a report of 109 consecutive cases. compend contin educ dent, 2011, v. 32, n. 4, p. 66-71.
11. Gholami GA, Najafi B, Mashhadiabbas F, Goetz W, Najafi S. clinical, histologic and histomorphometric evaluation of socket preservation using a synthetic nanocrystalline hydroxyapatite in comparison with a bovine xenograft: a randomized clinical trial. clin oral impl res, 2012, 23, p. 1198–1204.
12. Sah N, Sarode PP, Warang A, Tarase T, Gavhale P, Mirgane M. Alveolar Ridge Preservation Using Xenograft Following Tooth Extraction: A Systematic Review and Meta-Analysis. Cureus. 2025 Apr 7;17(4):e81815. doi: 10.7759/cureus.81815.
13. Tonetti MS, Jung RE, Avila-Ortiz G, Blanco J, Cosyn J, Fickl S, Figuero E, Goldstein M, Graziani F, Madianos P, Molina A, Nart J, Salvi GE, Sanz-Martin I, Thoma D, Van Assche N, Vignoletti F. Management of the extraction socket and timing of implant placement: Consensus report and clinical recommendations of group 3 of the XV European Workshop in Periodontology. J Clin Periodontol. 2019 Jun;46 Suppl 21:183-194. doi: 10.1111/jcpe.13131.
14. Vignoletti F, Matesanz P, Rodrigo D, Figuero E, Martin C, Sanz M. surgical protocols for ridge preservation after tooth extraction. a systematic review. clin oral impl res, 2012, 23, supl. 5, p. 22-38.
15. Vignoletti F, Discepoli N, Muller A, de Sanctis M, Munoz F, Sanz M. Bone modelling at fresh extraction sockets: immediate implant placement versus spontaneous healing. an experimental study in the beagle dog. j clin periodontol, 2012, 39, p. 91-97.
16. Hammerle CHF, Araujo MG, Simion M. on behalf of the osteology consensus group 2011. evidence-based knowledge on the biology and treatment of extraction sockets. clin oral impl res, 2012, 23 (suppl. 5), p. 80-82.
17. Da Rosa JCM, da rosa DM, Zardo CM, Rosa AC,

Canullo L. restauração dentoalveolar imediata pós-exodontia com implante plataforma switching e enxertia. revista implantenews, 2009, v. 6, n. 5, p. 551-558.
18. Spinato S, Agnini A, Chiesi M, Agnini AM, Wang HL. comparison between graft and no-graft in an immediate placed and immediate nonfunctional loaded implant. implant dentistry, 2012, v. 21, n. 2, p. 97-103.
19. Levin B, Tawil P. posterior tooth replacement with dental implants in sites augmented with rhbmp-2 at time of extraction - a case series. compend contin educ dent, 2012, v. 33, n. 2, p. 104-112.
20. Penarrocha-oltra D, Demarchi C, Maestre-ferrin L, Penarrocha-diago M, Penarrocha-diago M. comparison of immediate and delayed implants in the maxillary molar region: a retrospective study of 123 implants. j oral maxillofac implants, 2012, v. 27, n. 3, p. 604-610.
21. Cardaropoli D, Tamagnone L, Roffredo A, Gaveglio L, Cardaropoli G. Socket preservation using bovine bone mineral and collagen membrane: a randomized controlled clinical trial with histologic analysis. int j periodontics restorative dent, 2012, v. 32, n. 4, p. 420-430.
22. Scheyer ET, Schupbach P, Mcguire MK. a histologic and clinical evaluation of ridge preservation following grafting with demineralized bone matrix, cancellous bone chips, and resorbable extracellular matrix membrane. j periodontics restorative dent, 2012, v. 32, n. 5, p. 542-552.
23. Al-Hezaimi K, Rudek I, Al-Hamdan KS, Javed F, Nooh N, Wang HL. efficacy of using a dual layer of membrane (dptfe placed over collagen) for ridge preservation in fresh extraction sites: a micro-computed tomographic study in dogs. clin oral imp res, 2012, p. 1–6.
24. Margonar R, Queiroz T, Luvizuto ER, Marcantonio E, Lia RCC, Holzhausen M, Marcantonio JRE. Bioactive glass for alveolar ridge augmentation. j craniofacial surg, 2012, v. 23, n. 3, p. 220-222.
25. Agarwal G, Thomas R, Mehta D. Postextraction maintenance of the alveolar ridge: rationale and review. Compend contin educ dent, 2012, v. 33, n. 5, p. 320-326.
26. Barone A, Orlando B, Cingano L, Marconcini S, Derchi G, Covani U. A randomized clinical trial to evaluate and compare implants placed in augmented versus non-augmented extraction sockets: 3-year results, j periodontol, 2012, v. 83, n.7, p. 836-846.
27. Suaid F, Grisi MFM, Souza SLS, Palioto DB, Taba JRM, Novaes JRAB. buccal bone remodeling after tooth extraction using the flapless approach with and without synthetic bone grafting. a histomorphometric study in dogs. clin oral impl res, 2013, 24, p. 407–413.
28. Hong JY, Lee JS, Pang EK, Jung UW, Choi SH, Kim CK. Impact of different synthetic bone fillers on healing of extraction sockets: an experimental study in dogs. clin oral impl res, 2012, 00, p. 1–8.
29. Pagni G, Pellegrini G, William V, Giannobile WV, Rasperini G. Postextraction alveolar ridge preservation: biological basis and treatments. int j dent, 2012.
30. Dalapicula SS, Vidigal JRGM, Conz MB, Cardoso ES. características físico-químicas dos biomateriais utilizados em enxertias ósseas. uma revisão crítica. implantnews, 2006, v. 3, n. 5, p. 487-491.
31. Irinakis T. rationale for socket preservation after extraction of a single-rooted tooth when planning for future implant placement. j can dent assoc, 2006, vol. 72, n. 10, p. 917-922.
32. Shakibaie B. comparison of the effectiveness of two different bone substitute materials for socket preservation after tooth extraction: a controlled clinical study. int j periodontics restorative dent, 2013, v. 33, n. 2, p. 222-228.
33. Oliveira RB, Silveira RL, Machado RA. uso do enxerto desmineralizado homógeno em alvéolo pós-extração: relato de casos. rev cir traumatol buco-maxilo-fac, 2005, v.5, n.4, p. 31-36.
34. Dantas TS, Lelis ER, Navesb LZ, Fernandes-Neto AJ, Magalhaes D. Materiais de enxerto ósseo e suas aplicações na odontologia. unopar cient ciênc biol saúde, 2011, 13(2), p. 131-135.
35. Peck MT, Marnewick J, Stephen L. alveolar ridge preservation using leukocyte and platelet-rich fibrin: a report of a case. case reports in dentistry, 2011, p. 1-5.
36. Leblebicioglu B, Tatakis DN. Complications following alveolar ridge augmentation procedures. Periodontol 2000. 2023 Oct;93(1):221-235. doi: 10.1111/prd.12509.