IJKG INTERDENTAL Jurnal Kedokteran Gigi

Interdental Jurnal Kedokteran Gigi
Website: https://e-journal.unmas.ac.id/index.php/interdental
ISSN 1979-9144 (print), ISSN 2685-5208 (online)

Systematic Review

EFFECTIVENESS OF SOCKET PRESERVATION IN MAINTAINING ALVEOLAR BONE VOLUME: A SYSTEMATIC REVIEW

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Received date: February 21, 2024 **Accepted date: April 7, 2024** **Published date: April 21, 2024**

KEYWORDS

Bone graft, socket preservation, tooth extraction

ABSTRACT

Introduction: Alveolar bone undergoes dimensional changes due to resorption after tooth extraction, which can make it difficult to place a denture or implant. Preservation socket procedures are performed at the time of tooth extraction with the aim of minimizing alveolar bone resorption. The purpose of this systematic review is to analyze the effectiveness of socket preservation in preserving alveolar bone.
Review: This systematic review was conducted through an electronic literature search in PubMed, Wiley, and Sciencedirect, which was used to obtain a number of Randomized Clinical Trial (RCT) articles on the effectiveness of socket preservation with graft material versus no socket preservation. This systematic review was conducted following the Preferred Reporting Items for Systematic reviews (PRISMA) guidelines. Based on the 417 articles screened, there were 24 duplicates, and after the articles were included by the criteria of: RCT, human study, publication in English, within the last five years and focusing on the methods and outcomes of socket preservation, 5 articles were found to be relevant.
Conclusion: Of the five studies reviewed, one study using allograft material and four studies using xenograft material, the results were that socket preservation can reduce alveolar bone resorption and can maintain the horizontal and vertical dimensions of alveolar bone compared to no socket preservation.

DOI : 10.46862/interdental.v20i1.8640

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How to cite this article: Lubis FR, Ervina I, Amalia M. (2024). EFFECTIVENESS OF SOCKET PRESERVATION IN MAINTAINING ALVEOLAR BONE VOLUME: A SYSTEMATIC REVIEW. Interdental Jurnal Kedokteran Gigi 20(1), 133-38. DOI: 10.46862/interdental.v20i1.8640

INTRODUCTION

One of the goals of the periodontal treatment is to maintain the teeth in good conditions to provide health, function and aesthetics to the patients. However, sometimes as a result of caries, periodontal disease, endodontic lesions and others, tooth extraction is inevitable.[1,2]

Following extraction of a tooth, a number of changes occur in the alveolar ridge involving modelling and remodeling of bone resulting in a significant loss of bone in horizontal and vertical dimensions of the ridge within the first year following tooth extraction without immediate implant placement. According to Schropp and colleagues most of these dimensional changes occur within the first three months following tooth extraction.[3,6,7] This socket resorption refers to the remodeling that occurs after tooth extraction, and it may result in up to 50% bone resorption, with the magnitude of horizontal resorption usually being more pronounced than the vertical resorption.[2,4,5,9]

Alveolar ridge volume deficiencies may interfere with tooth replacement therapy via fixed dental prosthesis, such as implant-supported restorations.11 Alveolar ridge preservation (ARP) therapy is commonly indicated to prevent extensive alveolar ridge resorption after complete or partial tooth extraction, either as part of immediate implant placement interventions or to reduce the need for ancillary ridge augmentation prior to or at the time of delayed implant placement.[8,11]

Socket preservation by any procedure, performed at the time of extraction for the purpose of minimizing resorption of the bone crest and buccal plate and maximizing bone formation in the alveoli, is very important. This principle, called osteopromotion, can be very successful irrespective of the cause of tooth loss. On the other hand, the principles of osteoconductivity provide the space and framework for cell substrate and biochemical events to enable bone formation to occur. [6]

The need for reconstruction of resorbed alveolar bone has led to a search to improve the techniques for socket preservation and to advance biomaterial studies that could replace or improve grafting procedures. Bone grafts are obtained from different sources: autologous (from the individual themselves), allogeneic (from the same species), xenogenic (from a different species), or alloplastic (synthetic). Due to the necessity to decrease the morbidity involved in removing an autogenous bone graft from a second surgical site, xenogenic, and alloplastic grafts have gained preference in guided bone regeneration procedures. Sealing the post-extraction sockets with membranes protects the grafting material in the cavity and preserves high-quality soft tissue in the region. Furthermore, an appropriate space is created, where the biological potential can be expanded to assist regeneration as desired. Non-absorbable membranes clog the rapid growth of gingival epithelial cells and simultaneously create and help maintain a space where other bone cells can repopulate the area of the socket, creating conditions for new bone formation. Preservation of the post-extraction alveoli plays a vital role in deciding on options for replacing missing teeth, helping to create healthy conditions so that the patient can obtain a better treatment.[6,16,17,20]

In the past two decades, many treatment choices were mentioned, such as socket grafting with a biomaterial alone interposing a barrier element. However, there is no resolution regarding the best method for socket preservation: autogenous, allogenic, or alloplastic . Conserving the alveolar ridge is effective but technically delicate, requiring specific surgical skills. Still, there is insufficient proof regarding the success of these techniques and the advantages of one method over the other. Presently conflicting observations are reported by researchers regarding the use of grafting material for ARP to prevent alveolar ridge resorption.[2,18,19]

Our research question aimed to identify the effect of socket preservation on ridge level maintenance compared to untreated extracted socket. This systematic review was conducted to evaluate the clinical necessity of socket preservation to preserve bone for future dental implant placement. In addition, we aimed to list various methods of socket preservation through randomized clinical trials (RCTs).

This systematic study was conducted through an electronic literature search in PubMed, Wiley, and Sciencedirect, which was used to obtain a number of Randomized Clinical Trial (RCT) articles on the effectiveness of socket preservation with graft material compared to no socket preservation. The keywords used were "socket preservation", "bone graft", "tooth extraction". The following search resulted in a total of 417 citations found. After adjusting for duplicates, 388 publications remained. Next, article abstracts were reviewed, after which 383 studies were removed.

Inclusion criteria: The following criteria were considered essential for inclusion in the systematic review: (1) randomized control trials, (2) human studies, (3) included the previously mentioned keywords, (4) English language publications, (5) trials focusing on socket preservation methods and outcomes.

Exclusion criteria: (1) case-control studies, (2) cross-sectional studies, (3) article language other than English, (4) in vitro studies, (5) cohort studies, (6) animal studies.

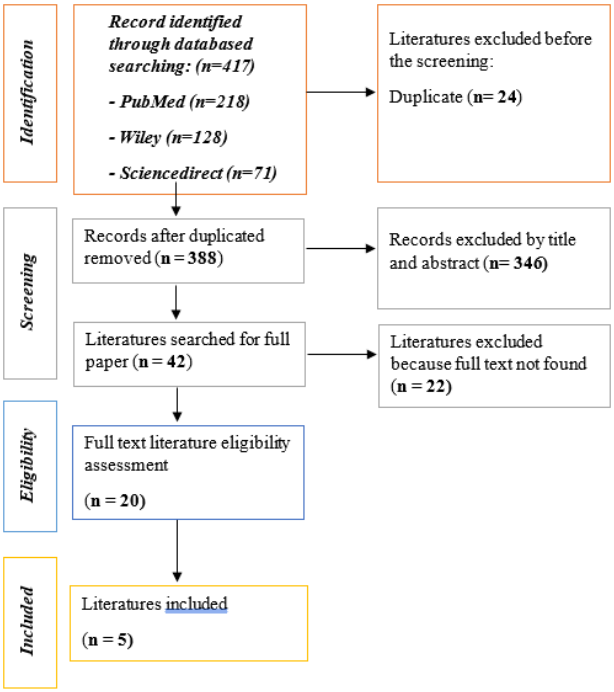

Figure 1. PRISMA flowchart

We used the PRISMA flowchart to report the information received during the examination. Selçuk (2019) highlighted that PRISMA is used to increase transparency in systematic reviews. Therefore, this systematic review followed PRISMA guidelines to eliminate bias and ensure successful completion. Figure 1 represents a PRISMA chart showing the different phases of a systematic review.

REVIEW

Macbeth et al. comparison of ARP techniques showed that GBR with preservation sockets was effective in limiting vertical alveolar bone loss (buccal and palatal) when compared to the unaided healing control group. The test group (GBR) preservation socket used xenograft material (DBBM) and collagen membrane, while the control group had no filling. Results at 4 months healing, the test group and control group all showed a reduction in Mid-socket area (Mid-SA) measurements. Mid-SA was reduced by 4% (-2.27 mm2 ± 11.89) in the test group and 13% (-6.93 MM2 ± 8.22) in the control. The reduction in alveolar process cross-sectional area (APA) was 8% (-7.36mm2 ± 10.45) in the test group and 11% reduction (-11.32mm2 ± 10.92) in the control.[14]

Avila-Ortiz et al. Compared to unaided socket healing, ARP therapy consisting of a combination of socket grafting and socket sealing provides better preservation of alveolar bone after tooth extraction. Socket preservation utilized allografts and non-absorbable membrane materials vs. extraction alone. The mean change in horizontal peak ridge width was -1.68 mm (95% CI, -2.10 to -1.26; P < 0.0001) in the extraction (control) group and -1.07 mm (95% CI, -1.49 to -0.64; P < 0.0001) in the ARP group. These mean changes were not only statistically significant within each group but also significantly different between groups. Similarly, there were significant changes in ΔBRH (change in mid-buccal ridge height) within each group, with ΔBRH being significantly greater in controls than ARP (P=0.012). Median ΔBRH was 1.17 mm (IQR, 0.7 to 2.1; P<0.0001) in controls and 0.61 mm (IQR, 0.46 to 0.94; P<0.0001) in ARPs. There was also a significant ΔLRH (change in midlingual crest ridge height) within each group (median ΔLRH: control: 0.70 mm [IQR, 0.46 to 1.40; P<0.0001; ARP: 0.47 mm [IQR, 0.23 to 0.94; P<0.0001]). ΔLRH was

greater in controls compared with ARPs, but not significant at the P<0.05 level (P=0.075).[12]

Macchtei et al. using biphasic calcium sulfate/hydroxyapatite (BCS/HA); bovine-derived xenograft (BDX), or no grafting (control group). Both the BCS/HA and BDX groups produced less vertical and horizontal bone loss after tooth extraction when compared to no treatment. The results showed that resorption of 0.65 mm in BCS/HA, 0.25 mm in BDX, and 1.71 mm in the control group was observed vertically. At the same time, 0.5 mm in BCS/HA, 1.56 mm in BDX, and 6 mm in the control group were observed horizontally.[15]

De Carvalho Formiga et al. using PTFE membrane with and without xenograft material. The results we found on the changes in bone width and height after the procedure were: buccal plate: control group 0.46 mm, test group 0.91 mm; alveolar height: control group -0.41 mm, test group 0.35 mm; cervical third: control group -0.89 mm, test group -0.11 mm; middle third: control group -0.64, test group -0.50; and apical third: control group 0.09 mm, test group -0.14 mm. The use of a xenograft together with a d-PTFE membrane proved superior to the use of the same membrane and a blood clot only in the apex, middle third, and high alveolar regions.[4]

Gabay et al. The test group used deproteinized bovine bone xenografts containing 10% collagen (DBBM-C), covered by procaine collagen membranes (CMXs). The control group had untreated sockets. Six months later, the horizontal alveolar width showed a significant decrease ($p < 0.05$) in both groups although it was smaller in the test group 1.19 ± 1.55 mm, compared to the control 2.27 ± 1.52 ($p = 0.087$). At 5 mm sub-crestally, a statistically insignificant reduction was noted in both groups, 1.61 ± 1.53 and 1.96 ± 1.52 mm for the test and control groups, respectively ($p = 0.542$). occupying 12.9 ± 9.88% in the test group. ARP using DBBM-C and collagen matrix resulted in a small reduction in vertical and horizontal dimensions. These changes were consistently smaller than in the control, but did not reach statistical significance. The larger than anticipated standard deviation and smaller difference between groups might explain this phenomenon.[13]

DISCUSSION

The demand for ARP interventions has increased in recent years due to the popularity of dental implant therapy. Nonetheless, research efforts over the last two decades have been focused on increasing predictability through minimally invasive approaches and the use of biologics to promote enhanced outcomes.[8]

In this systematic review we compared preservation sockets with bongraft and barrier membrane materials with sockets without any treatment, from the observation of 5 RCTs, four RCTs using Xenograft and one using allograft as bone graft material in preservation sockets, from the five RCTs showed good results obtained in preservation sockets in maintaining alveolar bone dimensions due to physiological resorption from tooth extraction, although from the results of the Gabay et al RCT the changes in vertical and horizontal dimensions were said not to reach statistical significance, but consistently the results obtained in the test group were smaller than the control. dimensions due to physiological resorption from tooth extraction, can be seen in the summarized table.

Table 1. Summary of the studies included in the systematic review.

No	Article	Inclusion criteria	Methods	Result
1	Macbeth Et al.	RCT, Human study, Preservation socket, Methods and results	Xenograft, Collagen membrane vs. No-socket preservation.	showed a reduction Mid-SA (Mid-socket area): ARP:(-2.27mm2), Control:(-6.93mm2) Mid-APA (alveolar process crosssectional area): ARP:(-7.36mm2) Control:(-11.32mm2)

2	Avila-Ortiz et al.	RCT, Human study, Preservation socket, Methods and results	Preservation socket with allograft, non absorbable membrane vs No-socket preservation.	showed a reduction ΔBRH (change in mid-buccal ridge height) ARP: 0,61mm Control: 1,17mm ΔLRH (change in midlingual crest ridge height) ARP: 0,47mm Control: 0,70mm
3	Macchtei et al.	RCT, Human study, Preservation socket, Methods and results	Biphasic calcium sulfate/ hydroxyapatite (BCS/HA) vs bovine-derived xenograft (BDX) vs No-socket preservation.	showed a reduction Vertical BCS/HA:0,65mm, BDX:0,25mm, dan Control:1,71mm Horizontal BCS/HA:0,5mm, BDX :1,56mm BDX, dan Control:6mm
4	de Carvalho Formiga et al.	RCT, Human study, Preservation socket, Methods and results	Xenograft, PTFE vs No-socket preservation.	Bone width and height after the procedure Buccal plate: ARP: 0,91mm Control 0.46mm Alveolar height: ARP: 0,35mm Control: -0.41mm
5	Gabay et al.	RCT, Human study, Preservation socket, Methods and results	Xenograft 10% kolagen (DBBM-C), Membran kolagen vs No-socket preservation.	horizontal alveolar width ARP:(1.19mm) Control:(1.71mm) sub-crestally ARP:(1.61mm) Control:(1.96mm)

CONCLUSION

The results of this systematic review suggest that socket preservation through socket filling with bone graft can be an effective therapy to prevent physiological bone resorption after tooth extraction, both in the horizontal and vertical dimensions. Group analysis showed that the use of membranes, and the use of xenograft or allograft bone graft material can contribute to improving outcomes, especially in the midbuccal and midlingual sections. Preservation sockets are also an option for alveolar bone preparation to place implants in an ideal restorative position without the need for GBR surgical procedures as preparation before implant placement. This information is expected to be one of the options for dentists in preparing the prosthesis placement area to get better results.

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