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Assessment of Various Bone Grafts and Membranes Used For Socket Preservation - An Institutional Based Retrospective Study

Running Title: Bone grafts and membranes used for socket preservation

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Abstract

The loss of alveolar bone may be attributed to various factors such as periodontitis, facial trauma, endodontic pathology and other aggressive steps used during extraction. Socket preservation is a technique in which the extraction sockets were completely filled with a bone substitute material or sealed with membranes in order to prevent bone loss. For a dental practitioner, it is important to have a clear knowledge regarding various bone grafts and membranes used for socket preservation. The aim of the study was to evaluate various bone grafts and membranes used for socket preservation. The participants were patients who reported to Saveetha Dental College for socket preservation procedure. A total of 25 patients had undergone socket preservation procedure during the specified time period. The data were collected and statistical analysis was done using IBM SPSS version 20.0. Patients in the age group of 19-30 years had highly undergone socket preservation procedure. The procedure was carried out mostly in males than females. The most commonly used graft was found to be Bio Oss (60%) and the most commonly used membrane was GTR combined with PRF (48%). Association between site of socket preservation and types of bone graft used was found to be statistically significant (p-value: 0.001). From the present study, it can be concluded that patients in the age group of 19-30 years had highly undergone socket preservation procedure. The procedure was carried out mostly in males than females. Maxillary anteriors was the most common site. Bio-oss was the most commonly used bone graft and GTR with PRF was the most commonly used membrane among patients who had undergone socket preservation procedure.

Keywords:*Alveolar bone; Bone grafts; Membranes; Socket preservation.*

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INTRODUCTION:

One of the goals of periodontal treatment is to maintain the teeth in good conditions to provide health, function and esthetics to the patient. In certain times, tooth extraction is inevitable as a result of caries, periodontal disease, endodontic lesions and others.(Chapple and Wilson, 2014; Faria-Almeida *et al.*, 2019) The bone that holds the tooth in its place i.e., the socket may often get damaged by infection or disease resulting in deformity.(Dimova, 2014) The loss of alveolar bone may be attributed to various factors such as periodontitis, facial trauma, endodontic pathology and other aggressive steps used during extraction.(Irinakis, 2006) Socket preservation is a procedure in which graft material or a scaffold is placed in a socket of an extracted tooth during the time of extraction to preserve alveolar ridge.(Tal, 1999) Socket preservation helps in maintaining bone and gingival tissue levels. It can greatly improve the person's smile appearance.(Dimova, 2014))

Today, it is possible to preserve the width and height of the edentulous ridge using socket preservation techniques.(Helmy, 2017) The techniques available are basically based on the principle of guided bone regeneration.(Nyman *et al.*, 1982) The technique consists of isolating a bony space, by filling the extraction socket with a bone graft or barrier membrane in order to exclude the epithelial cells. These techniques can be used with or without a bone graft.(Lekovic *et al.*, 1998) The use of a bone replacement graft alone results in some preservation of socket width and height.(Tatum, 1996) The addition of barrier membrane to a bone graft has been shown to have a superior effect than using bone graft or barrier membrane alone.(Seibert and Nyman, 1990) The characteristics of the bone graft and barrier membrane greatly influence the final result.(Helmy, 2017)

Bone grafting is a surgical procedure that uses transplanted bone to repair and rebuild damaged or diseased bones. It can be done with or without the use of membranes. These act as a scaffold or filler for new bone growth. There are mainly four types of grafts which are used. These include autograft (obtained from human bone), allograft (from cadaver), alloplast (made of synthetic materials), xenograft (bone from other animals such as cows). Recently, different types of bone substitutes such as demineralized freeze-dried bone allograft (DFDBA), hydroxyapatite and bioglass were used. Membranes are mainly categorized into resorbable and non-resorbable membranes. Resorbable membranes are made of natural or synthetic polymers like the collagen and aliphatic polyesters. Collagens are the most common type used. Other available membranes include human, porcine, human amnion and bovine pericardium membranes, and chorion tissue, and human acellular freeze-dried dermal matrix. Non-resorbable membranes include dense-polytetrafluoroethylene, expanded-polytetrafluoroethylene, titanium mesh, and titanium-reinforced polytetrafluoroethylene. A promising innovation in regeneration procedures is the use of platelet concentrates. Platelet concentrates are of 3 generations, the first generation incorporates the platelet-rich plasma (PRP) while the second generation involves the platelet-rich fibrin (PRF) and concentrated growth factor (CGF). The third generation platelet concentrates are advanced platelet rich fibrin (A-PRF) and injectable platelet rich fibrin (I- PRF). These platelet concentrates are used for accelerating the healing of soft and hard tissues and also a suspension of growth factors are present in the platelet concentrate membranes which promotes tissue regeneration.(Dohan Ehrenfest, Rasmusson and Albrektsson, 2009)

It is important for a dental practitioner to have a clear knowledge regarding various bone grafts and membranes available for socket preservation. Similar studies have been conducted to assess the latest information about various biomaterials used for socket preservation and to evaluate them in terms of

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dimensional and histological changes of alveolar bone.(Stumbras*et al.*, 2019) This research is needed to eliminate the discrepancy in selecting the type of bone graft and membranes and its combination in socket preservation. It will also give us knowledge regarding most common grafts and membranes used. Previously our team had conducted numerous clinical trials for management of various periodontal conditions(Panda *et al.*, 2014; Thamaraiselvan*et al.*, 2015; Varghese *et al.*, 2015; Ramesh, SheejaSaji Varghese, *et al.*, 2016; Avinash, Malaippan and Dooraiswamy, 2017; Khalid *et al.*, 2017; Priyanka *et al.*, 2017; Ramesh, Ravi and Kaarthikeyan, 2017; Ravi *et al.*, 2017; Kavarthapu and Thamaraiselvan, 2018) and have formulated various review articles in the field of periodontics (Khalid *et al.*, 2016; Moothae*t al.*, 2016; Ramesh, Sheeja S. Varghese, *et al.*, 2016) and in-vitro studies to rule out the particular drug efficiency(Ramamurthy and Mg, 2018; Ramesh *et al.*, 2019) over the past 5 years. Now we are focussing on retrospective studies. Therefore, the aim of this present study was to evaluate various bone grafts and membranes used for socket preservation.

MATERIALS AND METHODS:

Study sampling

The current study was an institution based study performed on patients who had undergone treatment at Saveetha dental college and hospitals, Chennai. A retrospective study was conducted in Saveetha Dental College, chennai. The retrospective study sampling was done. The samples were collected from June 2019 to March 2020. The samples were patients treated by dentists in Saveetha Dental College. Patients who had undergone socket preservation procedure were included in this study. The case sheet entries were all entered by the dentists. All the case histories of patients in the specified time period were obtained from the Department of Periodontics, Saveetha Dental College. All of the datas was cross checked and verified by an examiner to avoid any missing case records. Cross verification of all the diagnosis, intraoral pictures and case sheets were done. To minimise sampling bias, a simple random technique was followed. Patients in the age group between 19 to 65 years were segregated and included in this study and the others were excluded.

Ethical approval

The necessary approvals in gaining the datas were obtained from the institutional ethical committee (SDC/SIHEC/DIASDATA/0619-0320).

Data collection

A total of 25 patients had undergone socket preservation procedure during the specified time period. The datas collected were then examined by one reviewer, and then they were entered in the Microsoft Excel sheet. The data was imported, transferred to a host computer and processed using SPSS version 20.0 for software analysis and the variables were defined in the software.

Statistical analysis

The statistical test used was descriptive statistics and inferential statistics. The statistical software used for statistics was IBM SPSS version 20.0. The type of analysis was descriptive analysis (percentage, mean and standard deviation) and inferential test (Chi square test) and results were expressed as bar graphs. P value less than 0.05 was considered to be statistically significant.

RESULTS AND DISCUSSION:

A total of 25 patients who had undergone socket preservation were included in this study. From Figure 1, it was found that socket preservation was mostly done in patients in the age group of 19-30 years (60%) followed by 31-42 years (20%), 55-66 years (12%), 43-54 years (8%).

From Figure 2, it was found that socket preservation

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procedure was mostly carried out in males (80%) than females (20%) in this study. Loss of alveolar bone may be due to various reasons such as endodontic pathology, periodontitis, facial trauma and traumatic extractions. Socket preservation techniques help to preserve the height and width of the edentulous ridge.(Mecall and Rosenfeld, 1991)

From Figure 3, it was found that Bio Oss was the most commonly used bone graft accounting for about 60% of the total population followed by G bone (32%), osseograft (8%). Various types of materials are used for socket preservation such as autogenous bone, allograft bone, alloplast materials and xenograft materials.(Darby, Chen and Buser, 2009) Bio oss is a deproteinized bovine cancellous bone with a similar structure to human bone. It is a natural, non-antigenic and porous bone mineral matrix. It has a higher space-maintaining capacity and the potential to heal in a greater dimension.(DeNicolo*et al.*, 2015)

From Figure 4, it was found that in this study, GTR with PRF was the most commonly used membrane accounting for about 50% of the total population followed by GTR (20.83%), PRF (16.67%), PRF with CGF (4.17%), CGF (4.17%) and CGF with GTR (4.17%). GTR allows healing by new connective tissue attachment accompanied by regeneration of new cementum and bone.(Patil and Patil, 2013) Platelet-rich fibrin (PRF) are autologous platelet concentrates prepared from a patient's own blood and it enhances osteoprogenitor cells in the host bone and bone graft.(Preeja and Arun, 2014)

From Figure 5, it was found that among maxillary anteriors, Bio Oss was the most commonly used accounting for about 52% followed by G bone graft (12%). Among maxillary posteriors, G bone graft was most commonly used accounting for about 20% followed by bio oss (4%) and osseograft (4%). Among mandibular anteriors, osseograft was used (4%). Among mandibular posteriors, Bio Oss was used (4%). Association between the site of socket preservation and types of bone graft in the Chi-square test was found to be statistically significant. (Chi square value: 21.713; p-value: 0.001).

From Figure 6, it was found that among maxillary anteriors, GTR with PRF was the most commonly used membrane accounting for about 26.92% followed by GTR (15.38%), PRF (11.54%), PRF with CGF (3.85%), and CGF with GTR(3.85%). Among maxillary posteriors, GTR with PRF was the most commonly used membrane (19.23%) followed by GTR (7.69%) adn CGF (3.85%). Among mandibular anteriors, GTR with PRF was used (3.85%). Among Mandibular posteriors, PRF was used (3.85%). Association between the site of socket preservation and types of membranes in the Chi-square test was found to be statistically not significant. (Chi square value: 10.534; p-value: 0.569).

In this study, 8.34% of patients placed with bio oss showed postoperative complications in which 4.17% of patients showed membrane exposure and 4.17% showed wound dehiscence. Membrane exposure was noted in 4.17% of patients placed with GTR membrane and wound dehiscence was noted in 4.17% of patients having GTR with PRF membrane. Membrane exposure usually affects healing of the site, plaque and infection control are clearly impeded by the exposed membrane surfaces.(Machtei, 2001)

Various studies in literature have evaluated whether alveolar ridge resorption after tooth extraction could be reduced by use of socket preservation bone grafting materials and membranes into the socket right after the extraction. Barone et al in a histological study found that after 6 months of socket preservation, there was new bone formation evident that was well-structured, mineralized and mature. The sites preserved with bone grafts showed good preservation

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of buccolingual alveolar ridge width.(Barone *et al.*, 2008) Robert horowitz et al found that socket grafted extraction sites showed less amount of bone loss when compared to non-grafted extraction sites. There was a presence of vital bone ingrowth into socket grafted extraction sites.(Horowitz *et al.*, 2009)Faria et al in a systematic review stated that socket preservation can decrease the dimensional reduction of the alveolar ridge that normally occurs after tooth extraction, which was confirmed based on clinical, radiological and histological findings.(Faria-Almeida *et al.*, 2019)

The various grafts and membranes used for socket preservation were well-known and documented. The present study was done to evaluate various grafts and membranes used for socket preservation. In this study, Bio Oss was the most commonly used graft. The results of this present study were contradicted in a study done by Kao et al., which concluded that the most common graft used for socket preservation was allograft.(Kao and Scott, 2007; Misch*et al.*, 2015). Carmagnola D et al., in his study stated that autograft results in faster bone healing compared with any other bone substitute material such as Bio-oss.(Carmagnola, Adriaens and Berglundh, 2003)Geistlich Pharma in North America stated that Bio-oss provides a stable scaffold for bone formation leading to long-term volume preservation.(Geistlich, Eckmayer and Schlösser, 2004) GTR combined with PRF was the most commonly used membrane in this study. In a study done by Nunez et al., in 2019, it was concluded that use of PRF in combination with different grafting materials produced favourable results thus enhancing new bone formation.(Núñez Muñoz and Castro-Rodríguez, 2019) Contradictory to this, Areewong et al., in his study stated that that use of PRF in alveolar socket preservation does not enhance new bone formation after tooth extraction.(Areewong, Chantaramungkorn and Khongkhunthian, 2019)

The limitation of the present study were it was performed for the available smaller population in a single dental hospital during a specific period of time. So, furthermore studies should be done in a general population with a larger sample size to analyse the most commonly used grafts and membranes in socket preservation with their outcomes.

CONCLUSION:

From the present study, it can be concluded that patients in the age group of 19-30 years had highly undergone socket preservation procedure. The procedure was carried out mostly in males than females. Maxillary anteriors was the most common site. Bio-oss was the most commonly used bone graft and GTR with PRF was the most commonly used membrane among patients who had undergone socket preservation procedure. It is important for a dental practitioner to know about the various bone grafts, membranes and their use in combination in order to get better treatment outcomes after the socket preservation procedure.

AUTHOR CONTRIBUTIONS:

First author (Ashik Ahamed A) performed the analysis, interpretation and wrote the manuscript. Second Author (Balaji Ganesh S) contributed to conception, data design, analysis, interpretation and critically revised the manuscript. Third author (Rakshagan V) participated in the study and revised the manuscript. All the three authors have discussed the results and contributed the final manuscript.

CONFLICT OF INTEREST:

The authors are thankful to Saveetha Dental College for providing permission to access the database and for giving a platform to express our knowledge.

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REFERENCES:

1. Areewong, K., Chantaramungkorn, M. and Khongkhunthian, P. (2019) 'Platelet-rich fibrin to preserve alveolar bone sockets following tooth extraction: A randomized controlled trial', *Clinical implant dentistry and related research*, 21(6), pp. 1156–1163. doi: 10.1111/cid.12846.
2. Avinash, K., Malaippan, S. and Dooraiswamy, J. N. (2017) 'Methods of Isolation and Characterization of Stem Cells from Different Regions of Oral Cavity Using Markers: A Systematic Review', *International journal of stem cells*, 10(1), pp. 12–20. doi: 10.15283/ijsc17010.
3. Barone, A. *et al.* (2008) 'Xenograft versus extraction alone for ridge preservation after tooth removal: a clinical and histomorphometric study', *Journal of periodontology*, 79(8), pp. 1370–1377. doi: 10.1902/jop.2008.070628.
4. Carmagnola, D., Adriaens, P. and Berglundh, T. (2003) 'Healing of human extraction sockets filled with Bio-Oss®', *Clinical oral implants research*. Wiley Online Library, 14(2), pp. 137–143. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1034/j.1600-0501.2003.140201.x.
5. Chapple, I. L. C. and Wilson, N. H. F. (2014) 'Manifesto for a paradigm shift: periodontal health for a better life', *British dental journal*, 216(4), pp. 159–162. doi: 10.1038/sj.bdj.2014.97.
6. Darby, I., Chen, S. T. and Buser, D. (2009) 'Ridge preservation techniques for implant therapy', *The International journal of oral & maxillofacial implants*, 24 Suppl, pp. 260–271. Available at: https://www.ncbi.nlm.nih.gov/pubmed/19885449.
7. DeNicolo, P. J. *et al.* (2015) 'Histologic Evaluation of Osseous Regeneration Following Combination Therapy With Platelet-Rich Plasma and Bio-Oss in a Rat Calvarial Critical-Size Defect Model', *The Journal of oral implantology*, 41(5), pp. 543–549. doi: 10.1563/AAID-JOI-D-12-00075.
8. Dimova, C. (2014) 'Socket preservation procedure after tooth extraction', in *Key Engineering Materials*. Trans Tech Publ, pp. 325–330. Available at: https://www.scientific.net/KEM.587.325.
9. Dohan Ehrenfest, D. M., Rasmusson, L. and Albrektsson, T. (2009) 'Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leucocyte- and platelet-rich fibrin (L-PRF)', *Trends in biotechnology*, 27(3), pp. 158–167. doi: 10.1016/j.tibtech.2008.11.009.
10. Faria-Almeida, R. *et al.* (2019) 'Extraction Socket Preservation with or without Membranes, Soft Tissue Influence on Post Extraction Alveolar Ridge Preservation: a Systematic Review', *Journal of oral & maxillofacial research*, 10(3), p. e5. doi: 10.5037/jomr.2019.10305.
11. Geistlich, P., Eckmayer, Z. and Schlösser, L. (2004) 'Membrane for in guided tissue regeneration', *US Patent*. Available at: https://patentimages.storage.googleapis.com/84/81/28/c454ee6664769d/US6752834.pdf (Accessed: 8 June 2020).
12. Helmy, M. A. (2017) 'Review of Socket Preservation Technique', *EC Dental Science*.
13. Horowitz, R. A. *et al.* (2009) 'Clinical evaluation alveolar ridge preservation with a beta-tricalcium phosphate socket graft', *The Compendium of continuing education in dentistry*, 30(9), pp. 588–90, 592, 594 passim; quiz 604, 606. Available at: https://www.ncbi.nlm.nih.gov/pubmed/19998726.

July-August 2020
ISSN: 0193-4120 Page No. 2324 - 2337

14. Irinakis, T. (2006) 'Rationale for socket preservation after extraction of a single-rooted tooth when planning for future implant placement', *Journal* , 72(10), pp. 917–922. Available at: https://www.ncbi.nlm.nih.gov/pubmed/17187706.
15. Kao, S. T. and Scott, D. D. (2007) 'A Review of Bone Substitutes', *Oral and maxillofacial surgery clinics of North America*, 19(4), pp. 513–521. doi: 10.1016/j.coms.2007.06.002.
16. Kavarthapu, A. and Thamaraiselvan, M. (2018) 'Assessing the variation in course and position of inferior alveolar nerve among south Indian population: A cone beam computed tomographic study', *Indian journal of dental research: official publication of Indian Society for Dental Research*, 29(4), pp. 405–409. doi: 10.4103/ijdr.IJDR_418_17.
17. Khalid, W. *et al.* (2016) 'Role of endothelin-1 in periodontal diseases: A structured review', *Indian journal of dental research: official publication of Indian Society for Dental Research*, 27(3), pp. 323–333. doi: 10.4103/0970-9290.186247.
18. Khalid, W. *et al.* (2017) 'Comparison of Serum Levels of Endothelin-1 in Chronic Periodontitis Patients Before and After Treatment', *Journal of clinical and diagnostic research: JCDR*, 11(4), pp. ZC78–ZC81. doi: 10.7860/JCDR/2017/24518.9698.
19. Lekovic, V. *et al.* (1998) 'Preservation of alveolar bone in extraction sockets using bioabsorbable membranes', *Journal of periodontology*, 69(9), pp. 1044–1049. doi: 10.1902/jop.1998.69.9.1044.
20. Machtei, E. E. (2001) 'The effect of membrane exposure on the outcome of regenerative procedures in humans: A meta-analysis', *Journal of periodontology*. Wiley Online Library, 72(4), pp. 512–516. Available at: https://aap.onlinelibrary.wiley.com/doi/abs/10.1902/jop.2001.72.4.512.
21. Mecall, R. A. and Rosenfeld, A. L. (1991) 'Influence of residual ridge resorption patterns on implant fixture placement and tooth position. 1', *The International journal of periodontics & restorative dentistry*, 11(1), pp. 8–23. Available at: https://www.ncbi.nlm.nih.gov/pubmed/2071325.
22. Misch, C. M. *et al.* (2015) 'Vertical bone augmentation using recombinant bone morphogenetic protein, mineralized bone allograft, and titanium mesh: a retrospective cone beam computed tomography study', *The International journal of oral & maxillofacial implants*, 30(1). Available at: http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=08822786&AN=100780911&h=jEapzbC59hBoqjX7ajIoJx3kf5EPA1OqGe51h8ON%2FgMEp57QdX1t1PVJcIkTD2eKTipjX3tkCOtOkVEwyRZEYQ%3D%3D&crl=c.
23. Mootha, A. *et al.* (2016) 'The Effect of Periodontitis on Expression of Interleukin-21: A Systematic Review', *International journal of inflammation*, 2016, p. 3507503. doi: 10.1155/2016/3507503.
24. Núñez Muñoz, M. and Castro-Rodríguez, Y. (2019) 'Results of the use of fibrin rich in platelets and bone fillers in guided bone regeneration. Systematic Review', Spanish Journal of Oral and Maxillofacial Surgery. SciELOEspana, 41(3), pp. 126–137. Available at: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1130-05582019000300006.
25. Nyman, S. *et al.* (1982) 'New attachment following surgical treatment of human periodontal disease', *Journal of clinical periodontology*, 9(4), pp. 290–296. doi:

July-August 2020
ISSN: 0193-4120 Page No. 2324 - 2337

10.1111/j.1600-051x.1982.tb02095.x.

26. Panda, S. *et al.* (2014) 'Platelet rich fibrin and xenograft in treatment of intrabony defect', *Contemporary clinical dentistry*, 5(4), pp. 550–554. doi: 10.4103/0976-237X.142830.
27. Patil, V. A. and Patil, S. T. (2013) 'A novel approach in root coverage - Coronally repositioned flap with GTR membrane and frenotomy', *Journal of Indian Society of Periodontology*, 17(2), pp. 261–264. doi: 10.4103/0972-124X.113094.
28. Preeja, C. and Arun, S. (2014) 'Platelet-rich fibrin: Its role in periodontal regeneration', *The Saudi Journal for Dental Research*, 5(2), pp. 117–122. doi: 10.1016/j.ksujds.2013.09.001.
29. Priyanka, S. *et al.* (2017) 'Detection of cytomegalovirus, Epstein-Barr virus, and Torque Teno virus in subgingival and atheromatous plaques of cardiac patients with chronic periodontitis', *Journal of Indian Society of Periodontology*, 21(6), pp. 456–460. doi: 10.4103/jisp.jisp_205_17.
30. Ramamurthy, J. and Mg, V. (2018) 'Comparison of effect of hiora mouthwash versus chlorhexidine mouthwash in gingivitis patients: A clinical trial',*Asian Journal of Pharmaceutical and Clinical Research*, p. 84. doi: 10.22159/ajpcr.2018.v11i7.24783.
31. Ramesh, A., Varghese, S. S., *et al.* (2016) 'Chronic obstructive pulmonary disease and periodontitis – unwinding their linking mechanisms', *Journal of Oral Biosciences*, pp. 23–26. doi: 10.1016/j.job.2015.09.001.
32. Ramesh, A., Varghese, S. S., *et al.* (2016) 'Herbs as an antioxidant arsenal for periodontal diseases', *Journal of intercultural ethnopharmacology*, 5(1), pp. 92–96. doi: 10.5455/jice.20160122065556.
33. Ramesh, A. *et al.* (2019) 'Esthetic lip repositioning: A cosmetic approach for correction of gummy smile - A case series', *Journal of Indian Society of Periodontology*, 23(3), pp. 290–294. doi: 10.4103/jisp.jisp_548_18.
34. Ramesh, A., Ravi, S. and Kaarthikeyan, G. (2017) 'Comprehensive rehabilitation using dental implants in generalized aggressive periodontitis', *Journal of Indian Society of Periodontology*, 21(2), pp. 160–163. doi: 10.4103/jisp.jisp_213_17.
35. Ravi, S. *et al.* (2017) 'Additive Effect of Plasma Rich in Growth Factors With Guided Tissue Regeneration in Treatment of Intrabony Defects in Patients With Chronic Periodontitis: A Split-Mouth Randomized Controlled Clinical Trial', *Journal of periodontology*, 88(9), pp. 839–845. doi: 10.1902/jop.2017.160824.
36. Seibert, J. and Nyman, S. (1990) 'Localized ridge augmentation in dogs: a pilot study using membranes and hydroxyapatite', *Journal of periodontology*, 61(3), pp. 157–165. doi: 10.1902/jop.1990.61.3.157.
37. Stumbras, A. *et al.* (2019) 'Alveolar Ridge Preservation after Tooth Extraction Using Different Bone Graft Materials and Autologous Platelet Concentrates: a Systematic Review', *Journal of oral & maxillofacial research*, 10(1), p. e2. doi: 10.5037/jomr.2019.10102.
38. Tal, H. (1999) 'Autogenous masticatory mucosal grafts in extraction socket seal procedures: a comparison between sockets grafted with demineralized freeze-dried bone and deproteinized bovine bone mineral', *Clinical oral implants research*. Wiley Online Library, 10(4), pp. 289–296. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1034/j.1600-0501.1999.100405.x.
39. Tatum, O. H., Jr (1996) 'Osseous grafts in intra-oral sites', *The Journal of oral implantology*, 22(1), pp. 51–52. Available at:

July-August 2020
ISSN: 0193-4120 Page No. 2324 - 2337

https://www.ncbi.nlm.nih.gov/pubmed/8957891.

40. Thamaraiselvan, M. *et al.* (2015) 'Comparative clinical evaluation of coronally advanced flap with or without platelet rich fibrin membrane in the treatment of isolated gingival recession', *Journal of Indian Society of Periodontology*, 19(1), pp. 66–71. doi: 10.4103/0972-124X.145790.
41. Varghese, S. S. *et al.* (2015) 'Estimation of salivary tumor necrosis factor-alpha in chronic and aggressive periodontitis patients', *Contemporary clinical dentistry*, 6(Suppl 1), pp. S152–6. doi: 10.4103/0976-237X.166816.

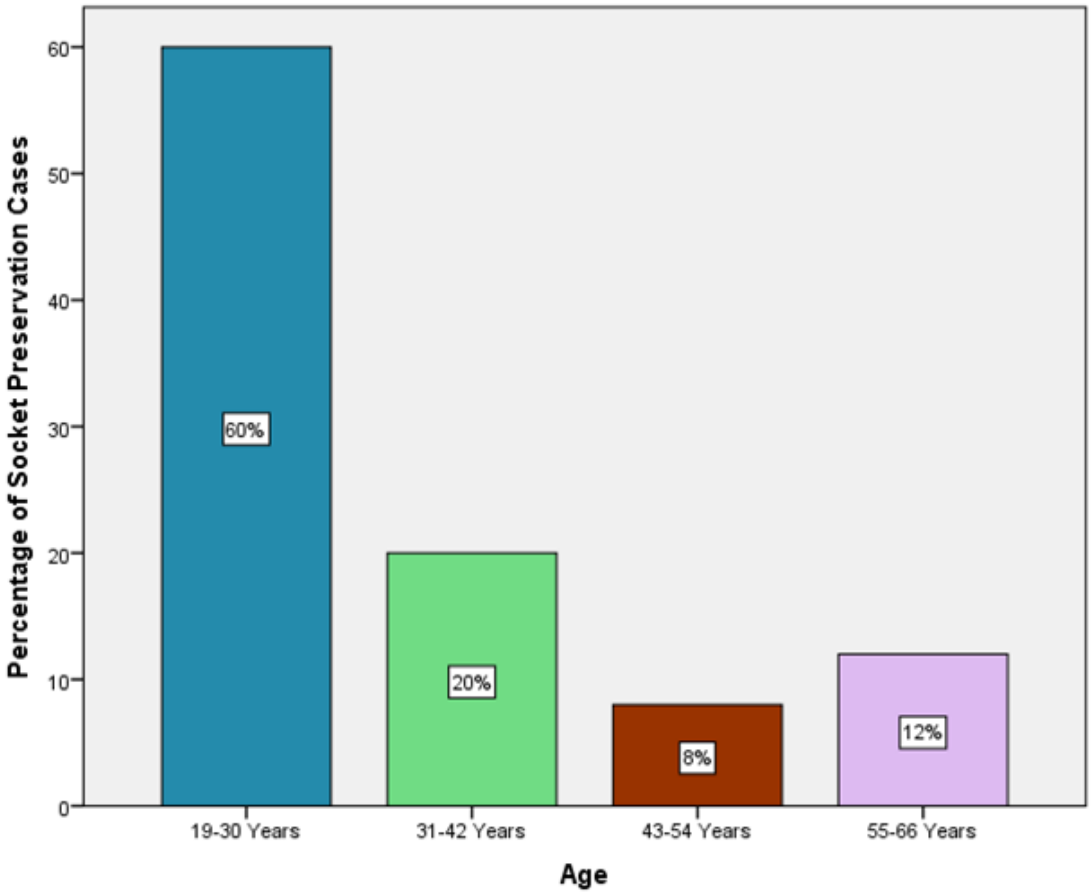

Figure 1: Bar chart showing the frequencies of age groups with respect to socket preservation. X-axis represents the age of the patient and Y-axis represents the percentage of socket preservation cases. Socket preservation was mostly done in patients in the age group of 19-30 years (light blue) compared to the other age groups.

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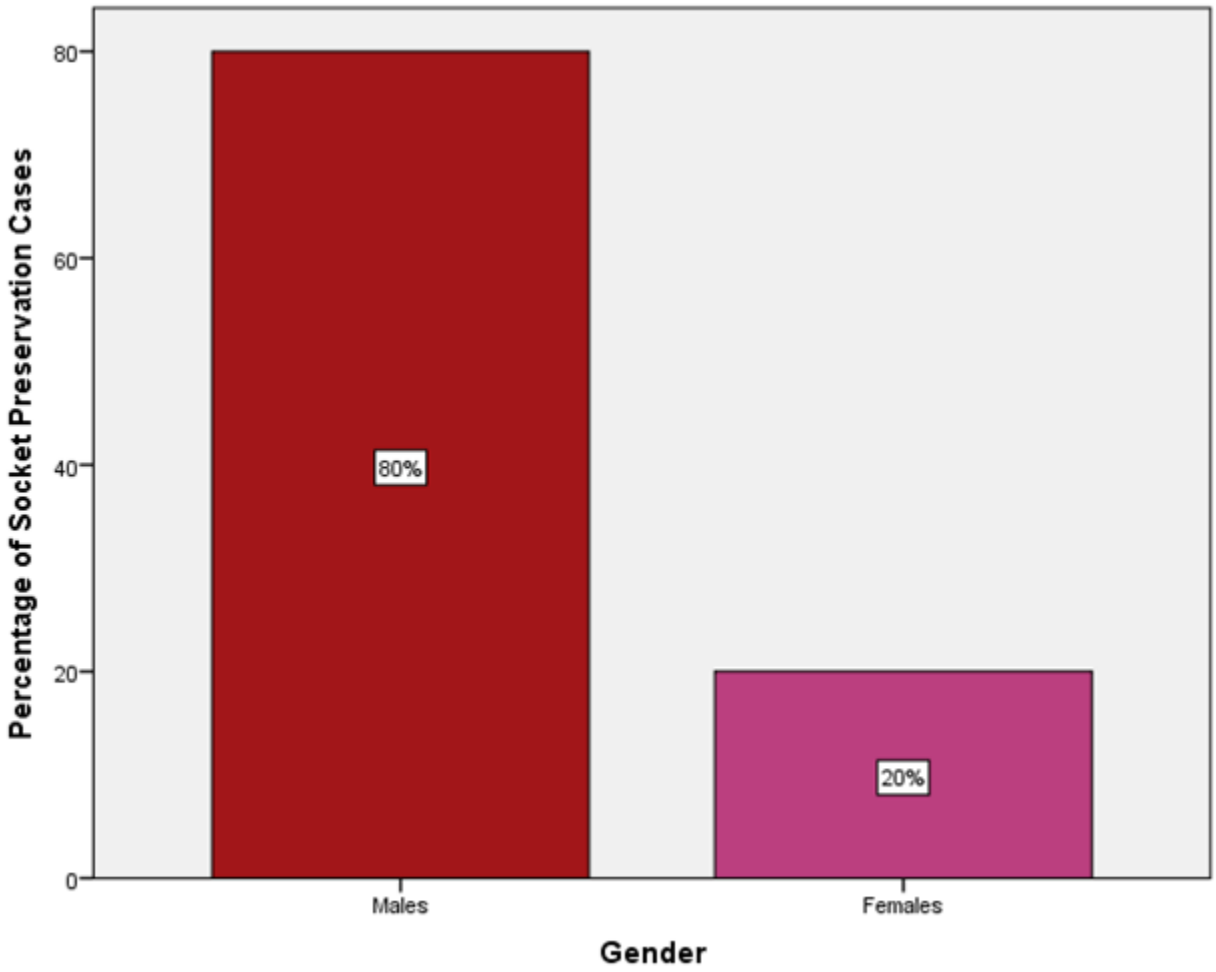

Figure 2: Bar chart showing the frequencies of gender with respect to socket preservation. X-axis represents the gender and Y-axis represents the percentage of socket preservation cases. Socket preservation was mostly done in males (maroon) than females.

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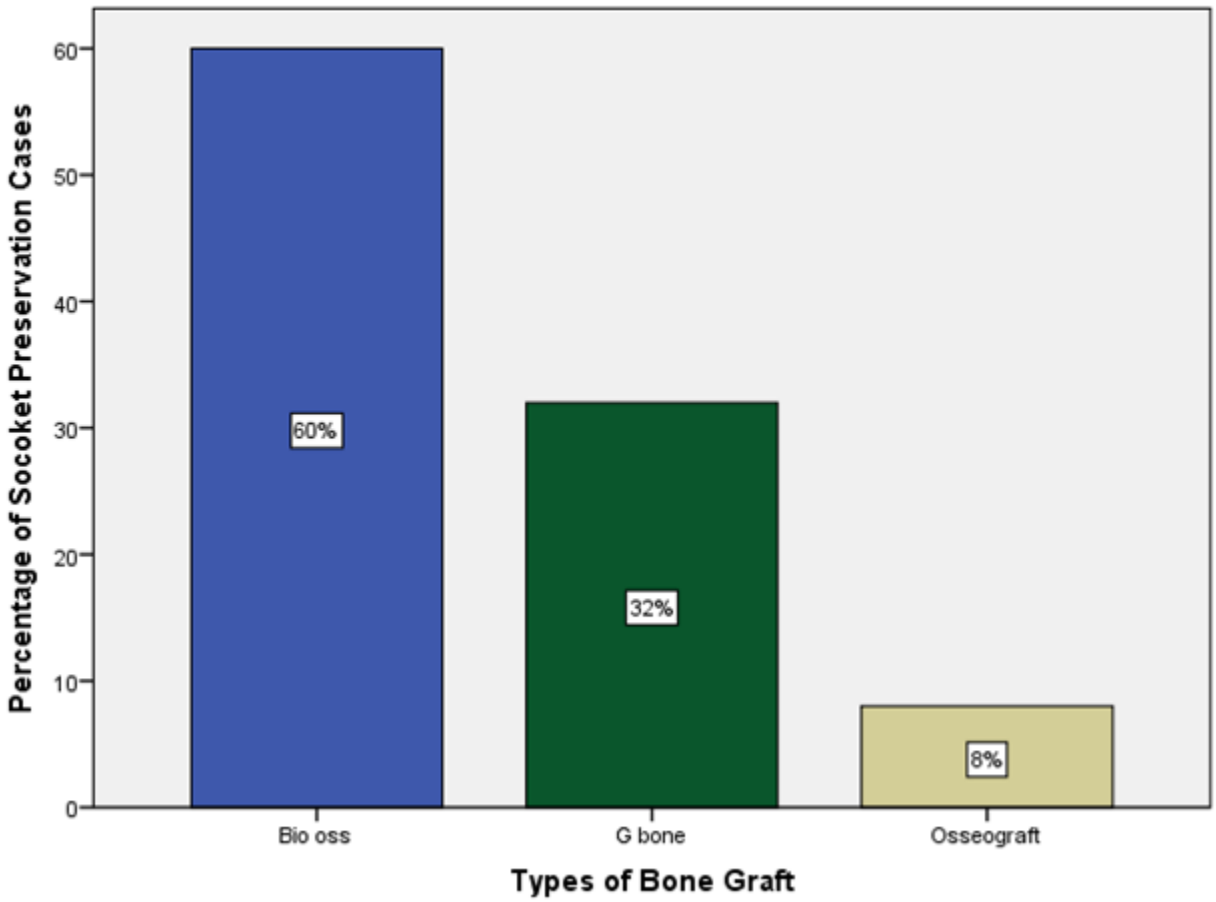

Figure 3: Bar chart showing the frequencies of type of bone grafts used. X-axis denotes types of bone graft and Y-axis denotes percentage of socket preservation cases. Bio oss (Blue) was the most commonly used bone graft 0compared to other bone grafts like G bone (Green) and Osseograft (Beige).

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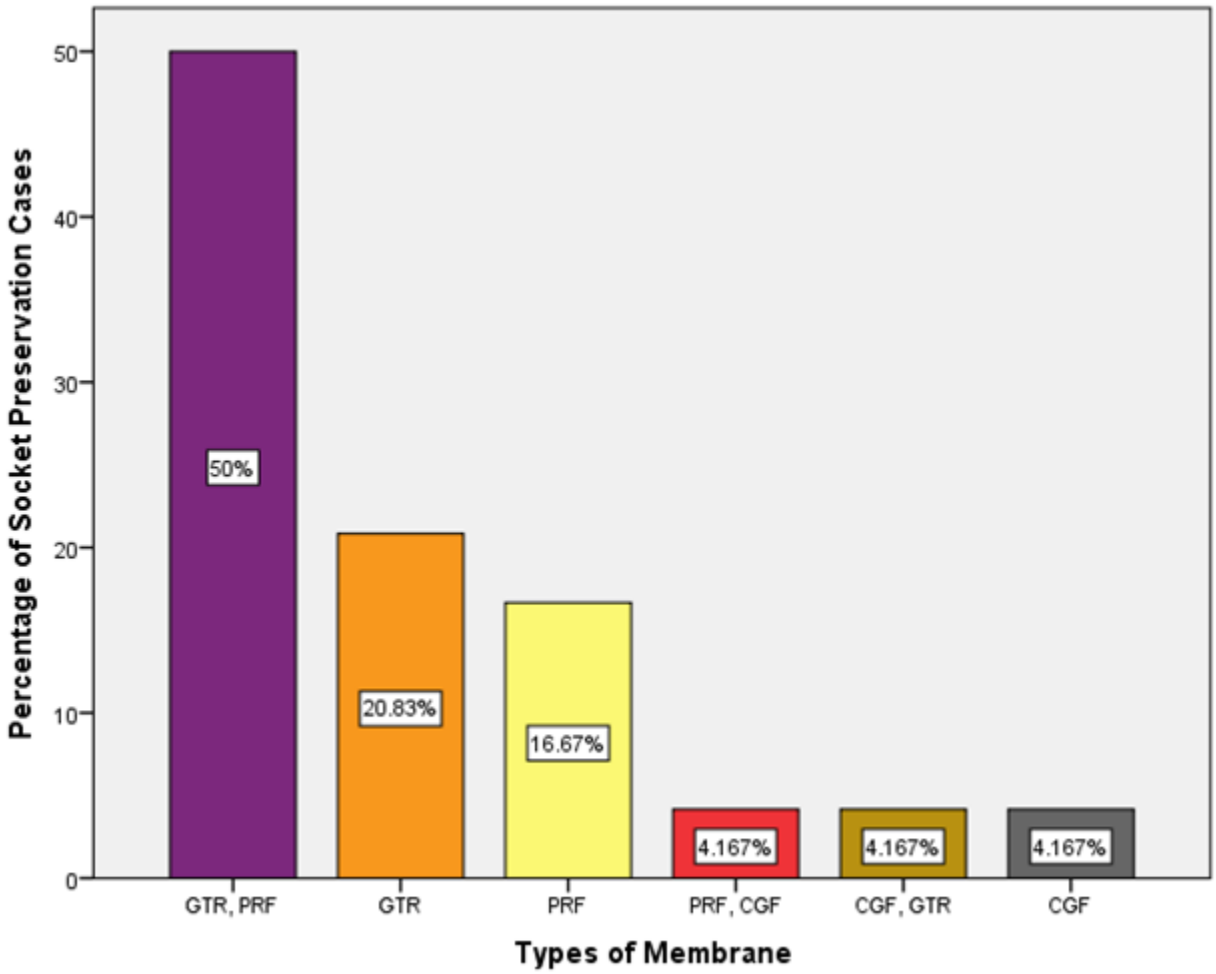

Figure 4: Bar chart showing the frequencies of type of membranes used. X-axis denotes types of membranes and Y-axis denotes percentage of socket preservation cases. GTR with PRF (Violet) was the most commonly used membrane compared to other membranes.

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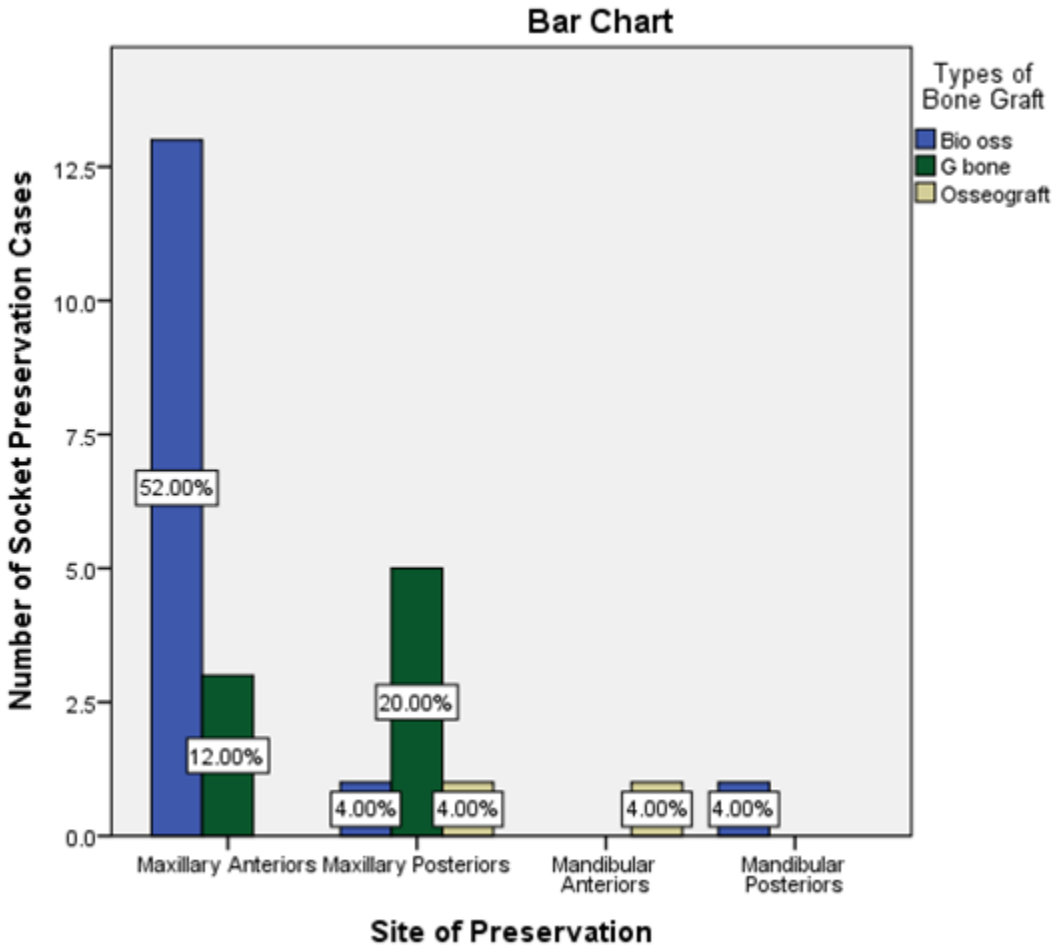

Figure 5: Bar chart showing the association between site of socket preservation and types of bone graft used. X axis represents the site of socket preservation and Y axis represents the number of socket preservation cases. Chi-square test was done and was found to be statistically significant. (Chi square value: 21.713; p-value: 0.001), hence proving that Bio oss was highly used among maxillary anteriors compared to other sites of preservation.

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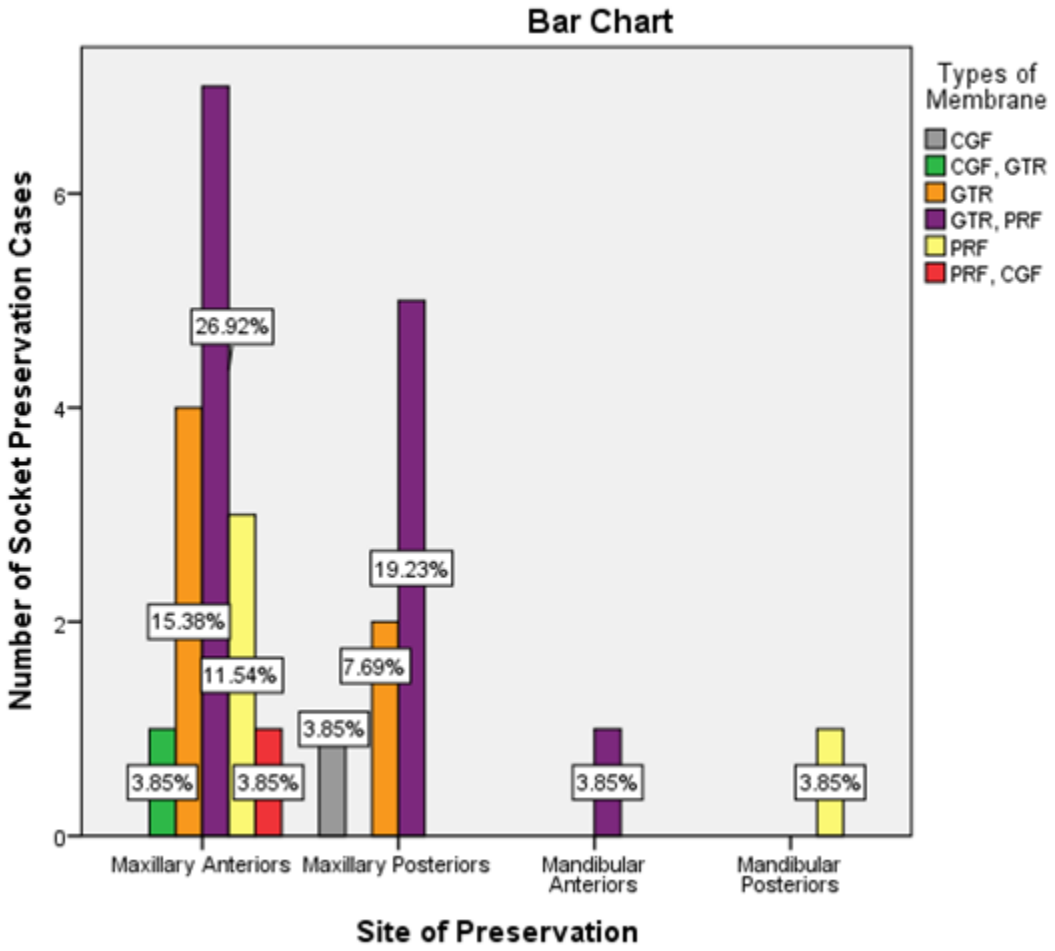

Figure 6: Bar chart showing the correlation between site of socket preservation and types of membrane used. X axis represents the site of socket preservation and Y axis represents the number of socket preservation cases. Chi-square test was done and was found to be statistically insignificant. (Chi square value: 10.534; p-value: 0.569). However, GTR with PRF was highly used among maxillary anteriors and maxillary posteriors compared to other sites of preservation.