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Comparison of two different methods of socket preservation following tooth extraction

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Abstract:
Background*: Post-extraction alveolar ridge resorption can hinder proper denture fabrication and dental implant placement, which requires a specific minimum bone dimension. Socket preservation techniques, including bone grafts and barrier membranes, aim to mitigate this bone loss. However, the individual roles of bone grafts and barrier membranes in preserving ridge dimensions remain unclear. This study aimed to evaluate whether socket preservation using a collagen membrane alone is as effective as the conventional technique involving both a bone graft and a membrane in preserving alveolar ridge height and width following tooth extraction.*
Materials and Methods*: Eighteen extraction sites were randomly assigned to three groups:*

- *G+M Group: Socket preserved with demineralized freeze-dried bone allograft (DFDBA) and collagen membrane.*
- *M Group: Socket preserved with collagen membrane alone.*
- *N Group: Socket allowed to heal naturally.*
- *Ridge width was measured using dental casts at baseline and 6 months post-extraction. Ridge height was assessed via intraoral periapical radiographs at baseline, 1 month, and 6 months post-extraction. Statistical analyses included ANOVA for inter-group comparisons and paired t-tests for intra-group comparisons over time.*

Results*: Both ridge height and width decreased in all groups over time. However, no significant difference was observed in ridge height among the groups. A statistically significant difference was found in ridge width, with the G+M group showing less resorption compared to the M and N groups.*
Conclusion: *Using a collagen membrane alone may adequately preserve vertical bone height. However, combining a bone graft with a membrane appears superior in preserving alveolar ridge width.*
Key Word*: Socket preservation, DFDBA with collagen membrane, collagen membrane*

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I. Introduction

Teeth are the pillars which maintain adequate bone in alveolar region. Since bone is a tissue with high metabolic rate in human body, tooth loss causes more alveolar bone resorption which eventually leads to compromised dental rehabilitation later [1]. The loss of alveolar structure is reported, on an average, to be 3.87mm in width and 1.67mm in height after 3 months of healing period.[2] Socket preservation or ridge preservation methods to overcome this alveolar bone resorption, have mainly three objectives: filling the extraction socket, preservation of the ridge volume and new bone formation.

A classical socket preservation procedure would involve bone grafting of the extraction socket, followed by placement of a barrier membrane and attaining soft tissue closure.[3,4] Bone allografts and membranes are most commonly used methods for socket preservation methods. Even though bone preservation in extraction sites has been done successfully with these materials, the precise role of the bone graft and the barrier membrane individually have not been clearly elucidated.

Several options available in allogenic materials include freeze- dried bone, fresh frozen bone and demineralized freeze- dried bone. There have been positive reports with the exclusive use of bone grafts with membrane, membrane alone and with natural healing without any interventions for socket preservation. But a comparative study to assess the proportional impact of each, is lacking. This study aims to determine the relative success of using 'membrane alone' method for socket preservation by comparing the results with the technique of using both bone graft and membrane and with natural healing. The study objective is to assess whether socket preservation technique with membrane alone is as efficient as the conventional technique using bone graft and membrane, in preserving height and width of alveolar ridge following tooth extraction.

II. Material And Methods

This prospective comparative study was carried on outpatient section of in Department of Oral and Maxillofacial Surgery, Amrita School of Dentistry, Cochin from May 2018 to January 2020. A total of 18 tooth extraction sites of adult subjects (both male and females) of aged ≥ 18, years were for in this study.

Study Design: Simple randomised controlled pilot study

Study Location: This was a tertiary care teaching hospital- based study done from the outpatient section of in Department of Oral and Maxillofacial Surgery, Amrita School of Dentistry, Cochin following approval and ethical clearance from the Amrita Vishwa Vidyapeetham University.

Study Duration: May 2018 to January 2020

Sample size: 18 tooth extraction sites

Subjects & selection method: The study was carried on outpatient section of in Department of Oral and Maxillofacial Surgery, Amrita School of Dentistry, Cochin from May 2018 to January 2020. 18 tooth extraction sites were randomly placed (coin flip) into three groups equally.

1) G+M group, where the sockets were grafted with bone allograft
2) M group, where the sockets were preserved with collagen membrane alone
3) N group, where the sockets were intended for natural healing.

G+M and M groups were the study groups and N group was the control group. Alveolar ridge dimensions measured using IOPAR (ridge height) and ridge mapping (ridge width).

Inclusion criteria:

1. Age group 20-60 years
2. Anterior and premolar teeth extraction cases
3. Planned to receive implants/fixed partial denture in future

Exclusion criteria:

1. Uncontrolled systemic disorders
2. Immuno- compromised patients
3. Known allergic cases for allograft and collagen membrane
4. Pregnant and lactating women
5. Poor periodontal health
6. Un co-operative patients

Procedure methodology

After written informed consent was obtained, Extraction of the indicated teeth (Fig 1.) was carried out with minimal trauma to the surrounding soft and hard tissues, followed by immediate socket preservation done in randomly selected test sites and control sites (Fig 2. And Fig 3.). Water tight flap closure done with silk suture (3-0) material.

1) G+M group, where the sockets were grafted with bone allograft (ColoGenesis Colo Cast demineralized bone matrix 300 microns granules, Made in India) with overlying collagen membrane (ColoGenesis Colo Gide GTR membrane 15x20, Made in India)
2) M group, where the sockets were preserved with collagen membrane alone (ColoGenesis Colo Gide GTR membrane 15x20, Made in India)
3) N group, where the sockets were intended for natural healing.

Fig 1- Carious teeth indicated for extraction

Fig 2- Graft placed after atraumatic extraction

Fig 3 -Membrane placed and closure done

Oral antibiotic (amoxicillin 30mg/kg for 5 days) and analgesic (paracetamol 30mg/kg SOS) were prescribed. Adequate post op instructions regarding oral hygiene maintenance and to avoid smoking and hard foods were given. Suture removal was done after 7 days of the healing period.

Site evaluation was done by ridge mapping on casts and IOPAR with grid. Alveolar ridge width was measured by ridge mapping. For that 3mm and 6mm points from the gingival margin of adjacent mesial tooth was taken as reference. To prepare the cast for ridge mapping, an impression with irreversible hydrocolloid was done. This has been done pre-surgically and post-surgically after 6 months (Fig 4.). Vertical alveolar ridge height was measured using an IOPAR with grid. Radiograph was taken in paralleling technique. Reference points were adjacent mesial and distal teeth crowns. Actual length of adjacent mesial and distal teeth of extraction indicated tooth from IOPAR was measured. Line was drawn through the occlusal/incisal aspects in traced IOPAR as reference. A perpendicular line drawn from the reference line to the ridge crest through the mid- point of the distance between adjacent teeth marginal ridges (Fig 5.). IOPAR was taken pre-surgically and after 1 and 6-month time periods.

Fig 4- Ridge mapping

Fig 5- traced IOPAR with grid

Patient was recalled after 1 month from the surgery time. IOPAR was taken to assess the vertical bone changes in this first post op visit. After 6 months from the surgery period, patient was recalled for the final records. The vertical bone changes were assessed using IOPAR and the horizontal bone changes were assessed with ridge mapping in this second post op visit. The data recorded were then statistically analysed. Summarised in Table 8.

Statistical analysis

Out of 18, only 15 subjects completed the study. After 1- month evaluation, one sample in each group not reported back. To test the statistical significance of the difference in changes, on an average among the three groups ANOVA was applied. Bonferroni's multiple comparison test was applied to identify statistically significant pair of groups. To test the statistical significance of the change from the pre op period to post op periods 1 month and 6 months after extraction in each group, paired t-test was performed. Analysis and comparison of the difference in ridge height both clinically and radiographically at different intervals that is pre op baseline and post op 1 month and 6months was done. All the results obtained with $P < 0.05$ were considered to be statistically significant within all pairs thus justifying that there is no significant reduction in loss of ridge height in 3 groups at regular intervals. To evaluate the mesial and distal crestal bone loss, mesial and distal tooth lengths were measured both clinically and radiographically while the mid crestal bone loss was assessed radiographically alone in all 3 groups.

Study design (Table 8)

Selection of eligible patients

⇩

Study sample n=18 (6 in each group)

⇩

Atraumatic tooth extraction

- G+M group sites– allograft with collagen membrane
- M group sites – collagen membrane alone
- Control sites – natural healing

Primary closure

⇩

Alveolar ridge dimensions evaluation

- Ridge width - ridge mapping, pre-surgically and post surgically after 6 months
- Ridge height- IOPAR, pre-surgically and post surgically after - 1 month and 6 months

⇩

Sample size after 6 months – 15 (5 in each group)

⇩

Statistical analysis

- ANOVA- to test the statistical significance of the difference
- in changes, on an average among the three groups.
- Bonferroni's multiple comparison test- to identify statistically significant pair of groups.
- Paired t-test - To test the statistical significance of the change from the pre op period to post op periods 1 month and 6 months after extraction in each group
- Statistically significant $p< 0.05$

III. Result

To evaluate the mesial and distal crestal bone loss, mesial and distal tooth lengths were measured both clinically and radiographically while the mid crestal bone loss was assessed radiographically alone in all 3 groups. Alveolar ridge with and vertical changes were assessed both clinically and radiographically in all 3 groups. Vertical changes were evaluated by measuring the mesial bone loss, the distal bone loss and the mid-crestal crestal height.

Mesial bone loss analysis

In G+M group, mesial bone loss noted to be static clinically, showing that no bone loss occurred in either 1 month or 6 months post op period but radiographically showed 0.4mm loss after 6 months even though no bone loss noted after 1 month. In M group, mesial tooth length clinically increased showing that 0.2mm loss is there in first 1 month which is stood same after 6 months also. Radiographically mesial bone loss noted were 0.2mm in first 1 month and 0.4mm by 6 months. In N group clinical mesial bone loss noted was 0.6mm after 1 month and 6 months and radiographically 0.2mm after 1 month and 0.8mm after 6 months. Even though there is bone loss noticed in all 3 groups, no values were statistically significant. (Table 1, Table 2).

Table -1 Mesial tooth length- clinical							
Time period	G+M		M		N		p-value
	Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value	
Pre op	9.60±2.302	-	10.20±2.387	-	11.20±3.033	-	**0.627**
Post op 1 month	9.60±2.302	-	10.40±2.510	**0.374**	11.40±2.966	**0.374**	**0.565**
Post op 6 months	10.00±2.121	**0.374**	10.60±2.608	**0.178**	12.00±3.000	**0.016**	**0.481**

Table- 2 Mesial tooth length- radiological							
Time period	G+M		M		N		P-value
	Mean ± SD	P-Value	Mean ± SD	P-value	Mean ± SD	P-value	
Pre op	8.80±1.789	-	9.60±1.140	-	7.80±2.775	-	**0.397**
Post op - 1 month	8.80±1.789	-	9.80±1.095	**0.374**	8.40±2.510	**0.07**	**0.503**
Post op- 6 months	8.80±1.789	-	9.80±1.095	**0.374**	8.40±2.510	**0.07**	**0.503**

Distal bone loss analysis

In G+M group, clinically and radiographically distal bone loss noted in first month and after 6 months are 0.4mm and 0.2mm respectively. In M group, distal bone loss clinically and radiographically noted were 0.6mm and 0.2mm respectively by first 1 month which is stood same after 6 months also. In N group clinically distal bone loss was noted as 0.4mm after 1 month and 0.8mm after 6 months and radiographically 0.8mm in first month and 1.6mm after 6 months. Even though there is bone loss noticed in all 3 groups, this parameter also showed no statistically significant values. Mean bone loss in control group seems to be high due to individual variations. (Table 3, Table 4).

Table- 3 Distal tooth length- clinical							
Time period	G+M		M		N		p-value
	Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value	
Pre op	7.60±1.342	-	6.60±1.673	-	7.40±2.510	-	**0.688**
Post op 1 month	7.60±1.342	-	7.20±1.095	**0.208**	7.80±2.490	**0.178**	**0.86**
Post op 6 month	8.00±1.414	**0.374**	7.20±1.095	**0.208**	8.20±2.168	**0.099**	**0.601**

Table -4 Distal tooth length- radiological							
Time period	G+M		M		N		p-value
	Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value	
Pre op	9.8±2.683	-	9.40±2.966	-	11.00±3.317	-	**0.688**
Post op 1 month	9.8±2.683	-	9.60±2.881	**0.374**	11.80±3.834	**0.099**	**0.5**
Post op 6 month	10±2.449	**0.704**	9.60±2.881	**0.374**	12.60±4.037	**0.035**	**0.308**

Mid-crestal bone loss analysis

Mid crestal bone loss evaluation in three groups done radiographically. In G+M group 0.6mm loss in first month and 1.2mm loss after 6 months noticed. In N group 0.8mm and 1.4mm loss noted in first month and 6 months respectively. In contrast to these values, in M group 0.4mm increase in bone height noted in first month but it got reduced to 0.2mm after 6 months. Like other parameters evaluated in ridge height, this one also not showed any statistically significant values (Table 5). Overall vertical changes are given in Table 6.

Table -5 Crestal height

Time period	G+M		M		N		p-Value
	Mean ± SD	P –value	Mean ± SD	p-value	Mean ± SD	p-value	
Pre op	10.40±1.817	-	10.40±2.408	-	11.80±3.421	-	**0.635**
Post op 1 month	11.00±1.581	**0.07**	9.80±1.924	**0.208**	12.60±3.209	**0.016**	**0.208**
Post op - 6 months	11.60±1.140	**0.178**	9.60±1.673	**0.178**	13.20±3.271	**0.025**	**0.072**

Table- 6 Vertical bone changes

Bone changes in mm	G+M				M				N			
	clinical		radiological		clinical		radiological		clinical		radiological	
	0-1 m	0-6 m	0-1 m	0-6 m	0-1 m	0-6 m	0-1 m	0-6 m	0-1 m	0-6 m	0-1 m	0-6 m
Mesial	0	0	0	-0.4	-0.2	-0.2	-0.2	-0.4	-0.6	-0.6	-0.2	-0.8
Distal	0	-0.4	0	-0.2	-0.6	-0.6	-0.2	-0.2	-0.4	-0.8	-0.8	-1.6
Mid crestal	0	0	-0.6	-1.2	0	0	0.4	0.2	0	0	-0.8	-1.4

G+M- graft with membrane group, N- no intervention group, M- membrane alone group, m-months

Alveolar ridge width analysis

Analysis and comparison of the difference in ridge width from pre op baseline to post op 6 months in 3 groups were evaluated. All the results were obtained with $P < 0.05$ were found to be statistically significant within all pairs. Thus, justifying that there is a significant reduction in loss of ridge width at regular intervals in control group when compared to the two test groups (Table 7).

Table -7 - Ridge width

Time period	G+M			M			N			p-value	
	3mm	6mm	p-value	3mm	6mm	p-value	3mm	6mm	p-Value	3mm	6mm
Pre op	9.20±1.924	10.6±2.074	**0.005**	8.8±1.643	10.8±2.588	**0.022**	8.2±0.837	9.6±1.949	**0.052**	**0.599**	**0.667**
Post op	9.20±1.924	10.8±2.168	**0.016**	8.2±1.789	10.4±2.966	**0.04**	5.8±1.095	7.2±1.304	**0.025**	**0.019**	**0.051**

Reduction of the ridge width in G+M group after 6 months were nil at 3mm distance from crest and 0.2mm at 6mm distance from the crest, whereas in M group after 6 months the width loss noticed about 0.6mm at 3mm distance from crest and 0.4mm at 6mm distance from the crest. Reduction of the ridge width in N group noticed after 6 months was 2.4mm at both 3mm and 6mm distance from the crest which is statistically significant.

Thus, the loss of ridge height and ridge width was noticed in both test groups and control group but on comparing the groups, there was no significant statistical difference between groups in ridge height. No statistical difference noted between the two test groups both in ridge height and width. Only ridge width was statistically significant between the test groups and the control group.

IV. Discussion

With this randomized control trial pilot study conducted, we compared the effectiveness of two different methods of socket preservation after tooth extraction, compared to that of a control group. Our goal was to evaluate whether collagen membrane alone is adequate to preserve the extraction socket during the healing period. We took only the hard tissue changes into account not the soft tissue changes.

Lammie suggested that resorption of residual ridges may be due to an atrophying overlying mucosa which seeks a reduced area after healing of extraction sockets. [5]Atwood was who first described in detail about post extraction alveolar bone resorption.[6]

50% width reduction occur by first 1 year (horizontal buccal and lingual bone loss is 56% and 30% respectively and 50% is the overall measurement). 2/3rd of this reduction occur in first 3 months.[7] Our study also shows evidence of bone resorption after tooth extraction, but the amount of resorption is much lesser (2.4mm in width and 1.4mm in height after 6 months).

Leblebicioglu et al have shown that loss of alveolar bone height is greater in mandibular sites, and alveolar bone width loss is greater on the buccal plate in both arches.[8] Pagni et al explained that following tooth extraction bone resorption occurs in two phases. In first phase bundle bone is resorbed rapidly, replaced with newly formed immature woven bone and then with mature lamellar bone within 180 days. In second phase periosteal surface of the bone remodels which leads to the overall horizontal and vertical tissue reduction.[9]

Farmer et al reported that in 42% patients buccal cortical plate resorbs in V - shaped pattern with loss of >4mm in the middle of alveolar crest within 6-8 weeks after tooth loss in maxillary anterior region.[10] Wood et al showed that elevating a full thickness mucoperiosteal flap may be associated with crestal bone loss up to 0.6mm following tooth extraction.[11] This bone resorption leads to thinner and shorter alveolar ridge which affects the retention of future denture. This is more significant if dental implants are to be placed.

Socket preservation methods aim to preserve the bone surrounding the extraction sockets by various methods. [3] Autografts are derived from the body of the same individual. It is the best graft option available. [12] Autogenous grafts can be 3 types: cortical, cancellous, or cortico-cancellous. Cancellous autogenous bone is generally preferred, as it is easily re-vascularized. [13] Autogenous bone can be can be used in block or particulate forms. Possible intra-oral donor sites are the maxillary tuberosity, edentulous ridges, and exostoses for particulate autografts, and the symphysis and mandibular ramus for the block grafts. Autogenous bone can be used alone or in the form of composite grafts. But the donor site morbidity and limited amount of bone materials are the main problems. Common extra-oral sites include the iliac crest (most common), rib, and tibia. [3]

Allografts are taken from different individuals of the same species (cadaveric bone) and is sterilized with radiations. They can be fresh-frozen, FDBA or DFDBA. Fresh frozen bone is used less frequently because of its risk of immunogenicity. Several chemical and physical processing techniques have been used to avoid disease transmission from allografts.[14]

Whittaker et al. showed that allografts have both osteoinductive and osteoconductive properties,[15] while Wetzel et al. claimed that allografts have only osteoinductive properties.[16] Studies suggested that FDBA is only or more osteoconductive, while DFDBA can be both osteoconductive and osteoinductive.[13,17,18,19,20] The use of demineralised bone grafts in extraction sockets is questioned if dental implant placement is planned at the site in the future. [21]

Xenografts are osteoconductive grafts from another species originally used to treat periodontal infrabony defects and the bovine xenografts are the most commonly used among them. [14,22]

Alloplasts are synthetic materials with osteoconductive properties used for bone grafting. Hydroxyapatite material resorbs slowly over a period of years, and can be used for long-lasting ridge preservation. [14]TCP exist in both α and β phases and β-TCP is usually the preferred biomaterial. [22] Froum et al compared extraction sockets grafted with bioactive glass and demineralized freeze- dried bone allograft histologically and observed more vital bone with bioactive glass.[23]

Usage of the barrier membranes in periodontal practice shows it prevents the epithelial ingrowth into the periodontal space leaving the field open for bone formation. Barrier membranes can be resorbable (Type I and III collagen, acellular dermal matrix grafts, polylactide, polyglycolide) or non- resorbable (PTFE, e-PTFE, Ti, Ti PTFE). Non-resorbable membranes were the choice in the past, and have been replaced by resorbable membranes considering the second surgery to remove them and risk of infection in case of exposure. Soft tissue grafts such as connective tissue grafts are also used as barrier membranes.[3,14]

Barone et al noticed no histological or histomorphometrical differences in bone volume reduction in flap and flapless groups irrespective of graft material and membrane used.[24] Al-Hezaimi et al conducted a study with double barrier technique (nonabsorbable polytetrafluoroethylene and absorbable collagen membrane) which was originally described by Yun et al and reported excellent clinical outcome in ridge volume preservation with this technique.[25] Faria Almeida compared articles where membranes and soft tissue grafts used for socket preservation along with grafts and concluded that membranes are showing better results than grafts.[26] Oghli and Steveling stated some bone resorption does occur whether or not socket is preserved with soft tissue membrane or bone

graft. [27] Implants placed with both non- resorbable membranes and resorbable membranes have similar survival rates as shown by Jung et al.[21]

Growth factors are the signaling molecules having major roles in cell proliferation, migration, and extracellular matrix formation. Growth factors from platelet concentrate like platelet derived growth factor, platelet-rich plasma, platelet-rich fibrin, Transforming growth factor (TGF)- β 1, TGF- β2, Fibroblast growth factor, Vascular Endothelial Growth Factor, Bone Metallo Proteases 2, enamel matrix proteins (emdogain) showed good bone preservation when combined with other grafts. [14,28]

Initially graft alone was used for socket preservation. [4,27,29,30] Later it was noticed that a barrier membrane over the bone graft is more useful for preserving the alveolar bone. [17,18,19,24,31,32] Afterwards some clinicians noticed that normal bone is formed inside the socket even without any graft suggested that the membrane alone is sufficient for bone preservation. [25,33,34,35] But the real uncertainty still in the scientific world is whether the bone formation is with membrane or due to graft.

Tarnow et al mentioned that placing a graft material into extraction socket can preserve natural tissue contours. Graft materials can be placed along with barrier membranes in order to retain the material in place.[36] Iasella et al found significant difference in vertical and horizontal bone loss in extraction sites with and without bone grafting after 6 months. They noticed 1.2mm bone width reduction with ridge preservation (freeze- dried bone allograft and collagen membrane placed without achieving primary flap closure) and 2.7mm bone loss without any preservation. They also noticed a 1.3mm gain in vertical dimensions with graft and membrane and the major resorption occurred in the buccal side and maxillary sites lost more width than mandibular sites. Also shown that FDBA with membrane preserves bone better than natural healing. They suggested to use additional extrasocket buccal and coronal overlay graft as mentioned by Caiazzo et al. in anterior regions especially in maxilla to preserve original aesthetic contour. In posterior sites, intrasocket grafting is enough for bone preservation.[31,37] Vittorini Orgeas et al noticed in his review article that barriers alone produce better results than grafts with barriers and grafts alone.[34]

Primary closure after socket preservation with resorbable membranes is still debatable. Vittorini Orgeas et al and Barone et al mentioned that socket preservation techniques are effective regardless of whether primary flap closure is achieved or not. [25,34]

We used bone allograft DFDBA (ColoCast) and bovine derived collagen membrane (ColoGide) for the study and the results are very much similar to Guarnieri et al study which used porcine-derived bone graft and collagen membrane. They concluded that in good volumetric sockets porcine derived collagen membranes alone will do the purpose unlike other sockets which actually require graft for bone preservation. [35]

No other literature was found comparing these parameters with these materials. We noticed that there is bone resorption after 1 month and 6 months post op periods in sockets preserved with both graft + membrane and membrane alone but very minimal when compared with naturally healing /no intervention sockets.

More relevant vertical bone loss was projected using radiographic method rather than clinical method. Clinically there was no resorption noticed in mid-crestal region of sockets in any group after 6 months. Radiographically 1.2mm bone loss noticed in G+M group and 1.4mm in N group, but contrary to this scenario we noticed 0.4mm bone formation by first 1 month in M group which got reduced by 0.2mm after 6 months. Horizontal bone loss seems to be significant in naturally healing group even though it was noted in M group after 6 months. Maximum upto 0.6mm bone loss was noted in M group while 2.4mm bone loss noted in N group. 2 individual sites in G+M group shows more vertical bone loss than M group can be explained by their smoking and hard foods intake. All patients have maintained good oral hygiene. This study reveals that membranes alone is sufficient to preserve the alveolar bone in similar to graft with membrane. Even though alveolar ridge height preservation is similar in both groups, better bone preservation is noticed with group M (membrane alone). Ridge width is preserved in both test groups but superior results noted with graft with membrane group.

V. Conclusion

Irrespective of the technique used the post extraction alveolar bone resorption cannot be totally prevented, and some amount of bone loss is inevitable. Factors such as patients' co-operation, medical conditions, habits, oral hygiene, parafunctional habits should be taken into account. This study reveals that the use of collagen membrane alone effectively preserves the vertical dimension of alveolar bone after tooth extraction. Bone grafting of the socket (with placement of barrier membrane) gives an additional advantage of conserving the ridge width. Follow up studies need to be conducted with a larger sample size, double blinded method to avoid investigator bias and with improvised three- dimensional radiographic modalities such as CBCT.

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