Qualitative and Quantitative assessment of bone healing in mandibular third molar extraction sockets after Intramembranous Non-Vascularized Bone Grafting with Mucosal and Myomucosal Closure: A Prospective Study

A I Raj[1], Aparna Murugan[2], R S Neelakandan[3]

1-Senior Lecturer, Department Of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College, Chennai. 2-PG Trainee, Department Of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College, Chennai. 3-Professor and HOD, Department Of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College, Chennai.

Correspondence to: *Dr. A I Raj, Senior Lecturer, Department Of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College, Chennai.*
Contact Us: www.ijohmr.com

ABSTRACT

Introduction: The reconstruction of continuity defects in the maxillofacial area with bone grafts and the subsequent sequelae of graft healing has been an area of extensive research in maxillofacial surgery. In the present study, an attempt has been made to assess the bone induction ability of intramembranous non-vascularized bone graft in the healing of extracted third molar socket after transalveolar extraction and to analyze if the socket healing is influenced with or without flap closure. **Materials and Methods:** 23 patients and 34 extraction sockets were studied with 12 sockets in control group, 11 each in Test group I (Mucosal flap used for closure after filling the post extraction socket with cortico-cancellous bone graft) and Test group II (Myomucosal flap raised distal to the third molar socket region, and pedicled posterosuperiorly was used for closure after filling the post extraction socket with cortico-cancellous bone graft). Healing in all sockets was assessed with radiovisiography using grayscale values and statistically analyzed. **Results:** The mean grayscale values measured in all the three groups were found to steadily increase in the second, fourth and sixth postoperative month with subjects in Test Group II showing the highest grayscale values and subjects in Control Group showing the lowest grayscale values. **Conclusion:** The intramembranous non-vascularized bone graft with muscle coverage has a better bone induction effect in socket healing than with mucosal closure. This finding can have a clinical application in improving the survival of non- vascularized bone grafts by coverage with adjacent muscle.
KEYWORDS: Bone Graft, Maxillofacial surgery, Transalveolar extraction, Surgical reconstruction.

INTRODUCTION

Reconstruction of maxillofacial continuity defects has always been a challenge in both functional and aesthetic aspects for the maxillofacial surgeons including a diverse range of defects varying from small periodontal defects to large segmental defects resulting from trauma or tumor excision. Such defects typically have a complex three dimensional structural deficit, usually difficult to restore. Jaw continuity defects not only demand the restoration of mechanical integrity, Temporomandibular joint function, and maintenance of occlusion but also acceptable facial esthetics. Bone grafting is an established and reliable method used for repair of these kinds of defects and remains the gold standard with the versatile options of use like implanting as cortico-cancellous blocks or particulate cancellous bone carried within a titanium mesh tray or as a length of alloplastic rib bone.[1-5]

The reconstruction of maxillofacial continuity defects has been attempted with various donor sites like anterior and posterior ilium, proximal tibia, rib, mandibular symphysis, and calvarial bone in the past with varying degrees of success. The rate of successful graft uptake has been found to decline sharply when the size of the defect exceeds 9cms[1]. Unfortunately, the field of maxillofacial surgery often presents defects of larger dimensions for correction and thus paving the way for further research in the area of bone grafting.[6]

The successful incorporation of bone grafts not only depends on the osteogenic potentiality of the osteoblasts and undifferentiated mesenchymal cells of periosteum, endosteum, and the bone marrow but also on the existing osteogenic cells presents in the host environment (Urist, 1980). This co-existing potential of the bone graft and the host environment is known as osteoconduction. The ability of these potential osteogenic cells to lay down new bone is known as osteoinduction which forms a major contributing factor to the integration of the graft with the host bone.[7]

In the present study, an attempt has been made to assess the bone induction ability of intramembranous non-

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vascularized bone graft in the healing of extracted third molar socket after transalveolar extraction and to analyze if the socket healing is influenced with or without flap closure.

MATERIALS AND METHODS

This study was carried out in the Department of Oral and Maxillofacial Surgery, Meenakshi Ammal Dental College after obtaining ethical board approval and informed consent from all the patients. A total of 23 patients and 34 extraction sockets were selected for the study based on the inclusion criteria of ASA I category patients requiring transalveolar extraction of third molars and willing to participate in the study. Patients with systemic diseases like Diabetes, Malignancies or any other debilitating conditions that contraindicate extractions were excluded from the study group.

Among the 23 patients included in the study, 12 were male and 11 female in the age range of 20-40 years. Out of the 34 sockets studied, 12 sockets served as the control group in whom the conventional transalveolar extraction technique and closure with sutures were carried out. The remaining 22 sockets from 11 patients constitute the test groups I and II.

Control group- standard technique of closure after trans-alveolar extraction of third molars (N=12)

Test Group I- Mucosal flap used for closure after filling the post extraction socket with cortico-cancellous bone graft (N=11)

Test Group II - Myomucosal flap raised distal to the third molar socket region and pedicled posterosuperiorly was used for closure after filling the post extraction socket with cortico-cancellous bone graft (N=11).

In all sockets belonging to the test group I, the third molar sockets post extraction were filled with cortico-cancellous bone graft harvested from the external oblique ridge and primarily closed with a mucosal flap, after de-epithelialisation of buccal and lingual flaps of the third molar socket. Similarly, in all sockets belonging to the test group II the third molar sockets were filled with cortico-cancellous bone graft and closed with temporalis Myomucosal flap that was raised distal to the third molar socket region and pedicled posterosuperiorly (Figure 1-Figure 3).

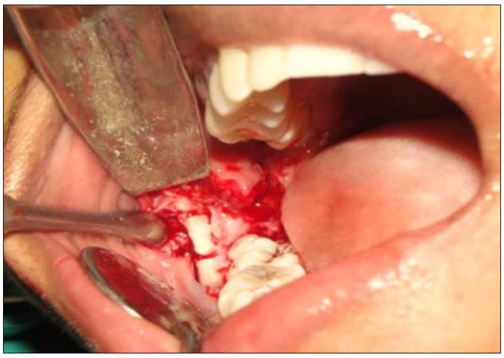


Figure 1- Graft Harvested from External oblique ridge

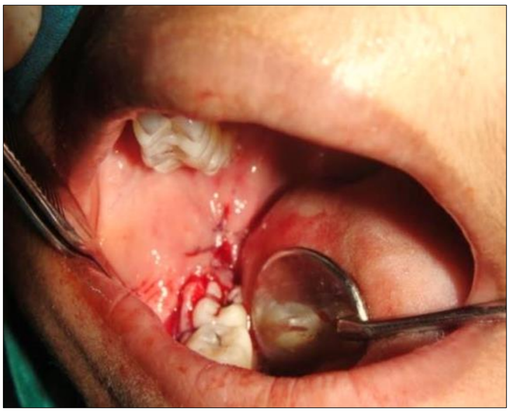


Figure 2- Myomucosal Closure

Figure 3-Mucosal Closure

In all the patients the procedures were simultaneously carried out on both sides by the same surgeon after premedication with 10 mg of Diazepam half an hour before the procedure and postoperative antibiotic coverage and analgesics for 5 days.

Both the control and test groups patients were subjected for radiovisiography of the surgical sites immediately and second, fourth and sixth months postoperatively. For the purpose of standardization, all RVGs were taken by a single operator using a standardized technique of intraoral periapical radiograph with RVG sensors using paralleling cone technique, at an exposure of 20Kvp, 2 mA, 0.40 exposure time and scanned using Adobe software.

In the radio visuographic image of each extraction socket, 10 points were studied at the middle third of the empty socket (Region of interest "ROI"). These points were selected in the middle of the socket to exclude the anatomic landmarks such as sub-mandibular fossa superimposed at one third of apical part of tooth socket, and external oblique ridge superimposed at the one third of coronal part of tooth socket. Similarly, same 10 points were selected in the control group. These were designated as the region of control (ROC). The average of the grayscale values from these points was used as a measure of the bone density of the newly formed bone in the sockets. The values were subjected to statistical analysis. After the analysis of variance was done, the mean and standard deviation of the newly formed bone density of both control and experimental groups were obtained, and Kruskal-Wallis test and Dunn's post hoc test were applied at 0.005 significance level.

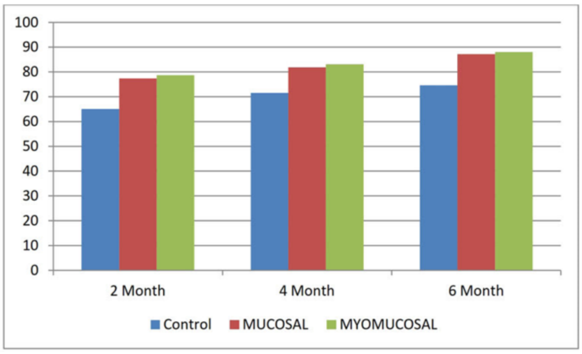
RESULTS

This study on the bone induction ability of intra-membranous non-vascularised bone graft in the healing of extracted third molar sockets was carried out to understand its efficacy in enhancing bone healing. A total of 23 patients and 34 sockets were studied with 12 in control group and 11 each in test group I and test group II. The Mean grayscale values measured, standard deviation and test of significance (P value) between control and experimental groups at second, fourth and sixth months postoperatively are shown in Table 1.

Group	2nd Month			4th Month			6th Month		
	Mn	Std Dev	P Val	Mn	Std Devi	P Val	Mn	Std Dev	P Value
Control Group	65.049	3.259	.005	71.531	1.663	.016	74.654	3.971	.001
Test Group I	77.354	5.438		81.858	5.291		87.172	5.301	
Test Group Ii	78.683	8.018		83.058	8.132		88.051	6.265	

Table 1

The mean grayscale values measured in all the three groups were found to steadily increase in the second, fourth and sixth postoperative month with subjects in Test Group II showing the highest grayscale values and subjects in Control Group showing the lowest grayscale values. The difference between mean grayscale values between control and test groups were observed to be statistically significant in the second, fourth and sixth months, however, the difference between grayscale values was not found to be statistically significant between Test Group I and Test Group II. A comparison of mean grayscale values between the three groups is shown in graph 1.



Graph 1

It was observed that the healing process was discretely faster in test groups (mucosal closure and myomucosal closure) than in control group and it was also noticed that the degree of socket healing with myomucosal closure was better compared to mucosal closure, though the difference was not statistically significant.

DISCUSSION

Bone is a dynamic biological tissue composed of metabolically active cells that are amalgamated into a rigid framework. The healing potential of bone, whether in a fracture or fusion model, is affected by a variety of biochemical, biomechanical, cellular, hormonal, and pathological mechanisms. A continuously occurring state of bone deposition, resorption, and remodeling facilitates the healing process.[8 14].

Various bone graft types including autogenous bone grafts and allografts have been used in maxillofacial surgery practice to repair various bone defects. The incorporation of a bone graft is defined as the 'process of enveloping and interdigitation of the donor bone tissue with newly deposited bone by the recipient. During the process of healing, bone grafts are incorporated by an integrated process in which old necrotic bone is slowly resorbed and simultaneously replaced with new viable bone. This incorporation process is called "creeping substitution." Primitive mesenchymal cells differentiate into osteoblasts that deposit osteoid around cores of necrotic bone. This process of bone deposition and constant remodeling eventually results in the replacement of necrotic bone within the graft with new bone deposition.[8 14].

An ideal bone graft should promote all phases of graft incorporation and lend structural support during the process. The ideal graft should be 1) osteoinductive and conductive; 2) biomechanically stable; 3) disease free, and 4) contain minimal antigenic factors. These features are all inherent in autologous bone graft. The disadvantages of autologous grafts include donor site morbidity, increased operating time and blood loss, and the frequent inadequate volume of available bone graft.[8 14].

The advantages of allograft bone are that it circumvents the morbidity associated with donor-site complications and is readily available in the desired configuration and volume. The disadvantages of allografts include delayed vascular penetration, slow bone formation, augmented bone resorption, and delayed or incomplete graft incorporation. In general, allograft bone has a higher incidence of nonunion or delayed union than autograft. Allografts are osteoconductive but are only weakly osteoinductive. Although spread of infection and lack of histocompatibility are potential problems associated with allograft bone, improved tissue-banking standards have greatly diminished their incidence.[8 14].

Bone grafts can also be typed according to their structural anatomy: cortical or cancellous. Cortical bone has less number of osteoblasts and osteocytes, less surface area per unit weight, and provides a barrier to vascular ingrowth and remodeling compared to cancellous bone. The advantage of cortical bone is its superior structural strength. The initial remodeling response to cortical bone is resorptive as osteoclastic activity predominates. Cortical grafts progressively weaken with time because of this bone resorption as well as slow, incomplete remodeling. Conversely, the cancellous bone becomes progressively stronger because of its ability to induce early, rapid, new bone formation.

When selecting a bone graft, the surgeon needs to consider the specific structural and biological demands that will be placed on the graft. If the graft is placed in a compressive mode, cortical bone, either autogenic or allogenic, is necessary. If placed as a graft under tension with lower demands for structural support, and also a lower probability of early vascular ingrowth, a cancellous autograft is preferred.[8 14].

A study on quantitative assessment of the healing of intramembranous and endochondral autogenous bone grafts in European Journal of Orthodontics reveals that intramembranous autogenous bone graft produced more bone than the endochondral bone when grafted in the skull. Clinically it is recommended that intramembranous bone is better option to replace lost membranous bone in the oral cavity, as well as skull defects[2]. Hence in our study, a qualitative assessment of healing of the third molar socket with cortico-cancellous intramembranous bone graft was undertaken.

Another study report on the establishment of an animal model of a pasteurized bone graft, with a preliminary analysis of muscle coverage or FGF-2 administration to the graft, reveals that muscle covering over the pasteurized bone graft shows an increased ability of bone incorporation. The benefit of muscle coverage also seems to be supported by previous research which shows the positive role of muscle stems cells in the bone repair process. Hence in our study, this beneficial effect of muscle closure on the healing of the third molar grafted socket as against mucosal closure was also assessed and we observed that muscle covering over the grafted socket was observed to provide a positive effect on bone incorporation in the form of providing muscle stem cells. The migration of mesenchymal stem cells from the contiguous normal medullary cavity initiates bone formation.

Thus based on the results of our study, we propose that continuity defects in the facial skeleton could best be effectively reconstructed with bone grafts. Review of the available literature suggests that intramembranous bone graft is ideally suited for reconstruction of the facial skeleton. This prompted us to study its efficacy in extracted third molar socket healing. With a higher incidence of non-vascularized bone graft failure in comparison to vascularized bone graft in maxillofacial reconstruction, the role of a positive effect of muscle coverage over the graft should be noted.

CONCLUSION

In conclusion, an intramembranous non-vascularized bone graft with muscle coverage has a better bone induction effect in socket healing than with mucosal closure. This finding can have a clinical application in improving the survival of non- vascularized bone grafts by coverage with adjacent muscle.

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