Alveolar Ridge Preservation:

Preserving and Building up the Bony Structures after Extraction

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Introduction

This field study was conducted on the initiative of the scientific advisory board (WiB) of the DGZI (German Association of Dental Implantology). The main objective of the study was to evaluate possible differences in the resorption of alveolar bone after the extraction of teeth while simultaneously initiating measures for building up and preserving the bony structures, and to compare the results with studies described in the literature concerning bone resorption and alveolar collapse.

"Alveolar Ridge Preservation" is the term used for measures preserving the alveolar crest, particularly for dental implant therapy. Hardly any information is available on this topic in German or other European literature of today.Insufficient residual bone height, and not medical or financial reasons, prevents the insertion of dental implants in nearly 95% of potential cases. This circumstance makes implantation possible only by employing difficult and expensive measures for building up the bony structures, such as autologous transplants from the iliac crest, hip or mandible. This can be avoided if the alveolus is augmented with bone graft material immediately after the tooth is extracted.

If required, a membrane for "Alveolar Ridge Preservation" (Salama 1993) can be used to facilitate and improve the bony healing of the deficiency. It is well known that the alveolar bone collapses after extraction. Bone healing, i.e., healing of the socket, in many aspects is similar to healing by secondary intention. The alveolar bone loss in height and width within the first 6 months is 3-4mm and, thus, the bone is insufficient for a subsequent implantation procedure and to achieve excellent aesthetic results of the final prosthetics (Sclar 1999). Without bone preservation measures, the resorption of alveolar bone is 40-60% within the first 2-3 years. This study shows the effects of initiating bone preservation measures simultaneously at the time of extraction. The extraction sockets are filled with a bone graft material and covered with a membrane to enable a bony healing of the deficiency without the risk of soft tissue migration

into the socket. For this research data was collected by a study group of experienced implantologists in their private practices.

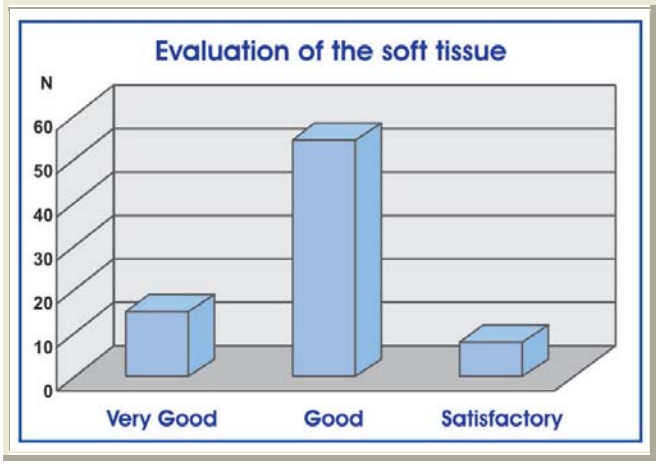
In the future, these results should support the dentist in his implantation protocol and can be used for quality assurance and support for this procedure.

Material and methods

In this prospective survey, nine private practices of the DGZI "Alveolar Ridge Preservation" study group participated. The clinical procedure was performed in an identical manner on the basis of a predetermined observation schedule. The findings were documented on prepared documentation forms. All cases that required the extraction of teeth were included. Patients with contraindications due to general medical reasons were not included in this study. Standardized x-rays were taken before the extraction of teeth. Periodontal diseases were treated first to minimize and control inflammation at the time of extraction. According to extensive extraction and inflammatory processes, a pre- and postoperative antibiotic treatment was recommended.

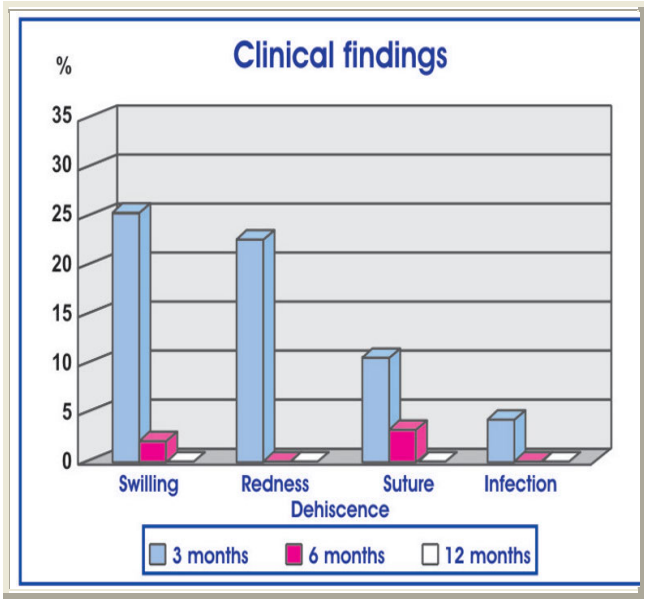
The following procedure was recommended: The teeth had to be extracted as gently as possible - generally with periotomes and elevators - to preserve a maximum volume of the vestibular and oral bony lamellae. The persisting part, as well as the loss of the bony lamellae, was documented.

The granulation tissues in the alveolus had to be removed gently by curettage and rose-head bur, and the residual bone in the alveolus refined. The bone deficiency (width and height) was measured in two dimensions with a periodontal probe. Cerasorb (synthetic, pure-phase 6-TCP; Curasan Company, Kleinostheim, Germany) with a granule size of 500-1,000 and/or 1,000-2,000 pm, was used as bone graft material. Compared to materials of biological origin (human, animal), no potential immunological and infection risks are to be expected. Most important was the cleaning of the socket with a rose-head bur, as described, and mixing the Cerasorb granules with fresh blood from the defects before the application into the alveolus.



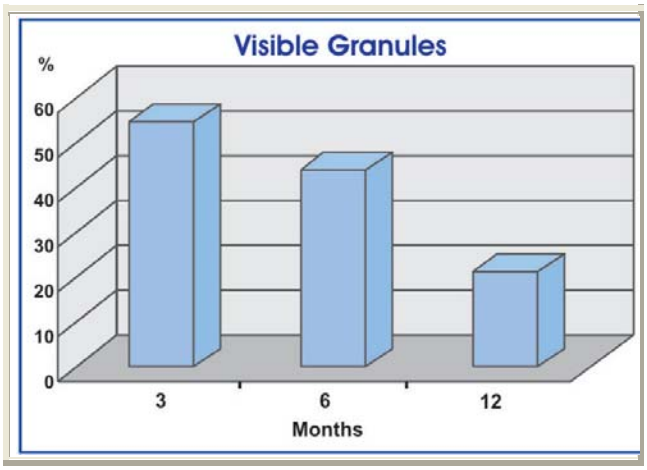
» **(Fig. 1)**

Evaluation of the soft tissue healing 1–2 weeks post-OP.



» **(Fig. 2)**

Clinical findings 3, 6 and 12 months after tooth extraction and alveolar augmentation.



» **(Fig. 3)**

Resorption of the bone augmentation materials as seen in the x-rays after 3, 6 and 12 months. Clear reduction after 12 months. Granules visible only in approx. 30 % of the patients.

A 2-3mm large mucoperiosteal flap had to be prepared around the defect for the membrane. Two types of membranes were used in this study. When the defects could be closed with the soft tissues until a maximum opening of only 4mm was left, resorbable membranes were used (Epi-Guide). However, when the residual openings were more than 4mm, non-resorbable membranes were used (TefGen). The defect was closed with button stitches or mattress sutures.

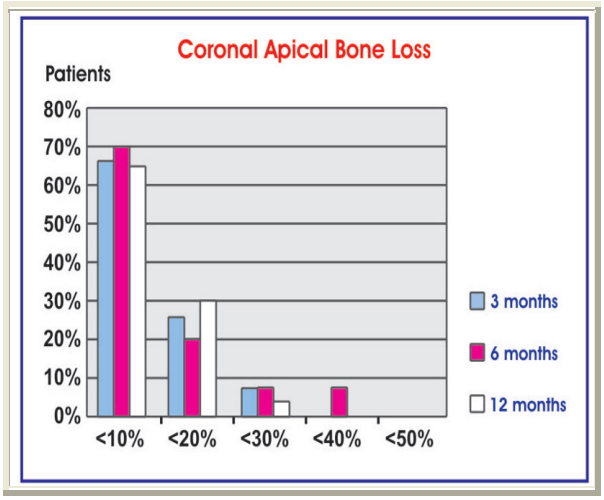
After 1-2 weeks, an examination of the clinical findings was conducted. The non-resorbable membranes were to be removed after 4 to 6 weeks. Standardized x-rays were taken after 3, 6 and, if required, 12 months to evaluate the progress of bone regeneration and determine the exact schedule for inserting the implant. At the end of the study, the documentation was subjected to a quality control and checked for completeness. A purely descriptive evaluation was carried out after the data were entered a second time.

Patients

The complete documentation of 80 patients (41 female, 39 male) in the age range of 26-81 years (mean age of 54 years) was available for the evaluation. In 80% (64 cases) of the

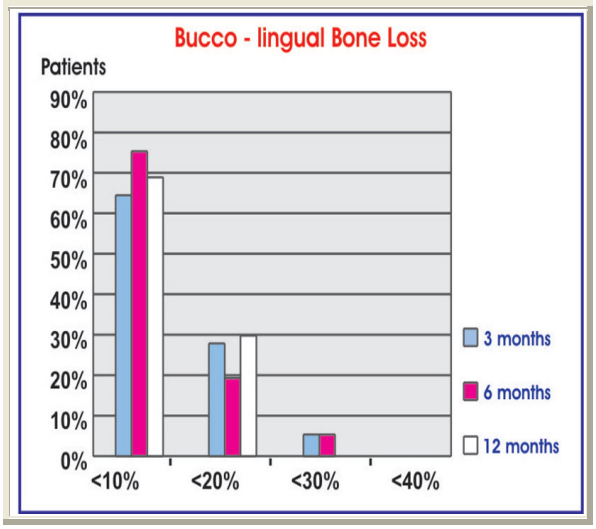
patients, the reason for the extractions and the described surgical procedures was because of marginal and apical periodontitis. Furthermore, root and crown fractures were diagnosed in 6 cases (7.5%), osteolyses in toothless jaw regions in 4 cases (5%), one implant fracture and a secondary caries in another case.

The number of patients that suffered from general medical problems was noted as follows: cardiac insufficiency (6), autoimmune diseases (3), osteoporosis (2) and diabetes (1). Other factors included severe marginal periodontitis (17) and the number smokers (20). Ten out of the 20 smokers smoked more than 10 cigarettes daily and the remaining 10 smoked less than 10 cigarettes a day.



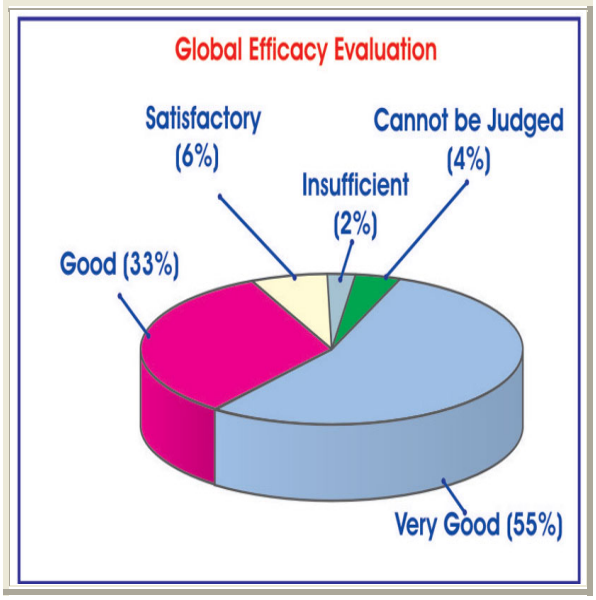
» **(Fig. 4a)**

Coronal-apical bone loss after 3, 6 and 12 months as compared to the original findings on the OP day.



» **(Fig. 4b)**

Bucco-lingual bone loss after 3, 6 and 12 months as compared to the original findings on the OP day.



» **(Fig. 5)**

Global evaluation of the efficacy at the last point of observation.

Results

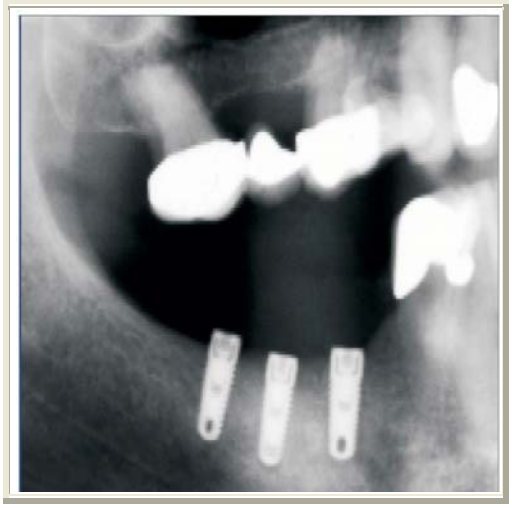
The observation period was 17 months (July 2002–November 2003). In total, 97 teeth were removed from 80 patients. As expected, the lower (n = 36) and upper molars (n = 16) were extracted in most cases, followed by the lower and upper premolars (n = 10 each), front teeth (n = 14) and canines (n =11).

The extraction alveoli were measured to determine the size of the defect. The defect depth was found to be 4-17mm (mean value 10mm) with a width of 3-16mm (mean value 7mm). The residual bone height documented by the x-ray was 0-19 mm in the mesial region (mean value 9 mm), 2-19mm (mean value 8mm) in the distal region, 0-18mm (mean value 7mm) in the buccal/vestibular region, and 2-18mm (mean value 9mm) in the lingual/palatinal region.
In 82 alveoli, the defect was augmented with the synthetic bone graft material Cerasorb. In 68 alveoli, granule sizes between 500-1,000 pm were applied, and in 14 alveoli, granule sizes between 1,000-2,000 pm were applied. On average, 0.78 g Cerasorb was used per patient. Membranes were used in 74 cases, mostly nonresorbable Tef-Gen membranes (53 cases, 66%). Exactly 21 patients were treated with resorbable membranes, and out of these, 20 (25 %) with Epi-Guide membranes and only I with a Bio-Gide membrane. In 36 cases, the wound could be closed completely, and in 38 cases the membrane was exposed. There were 6 patients who were treated without using a membrane. The wound was closed with different suture materials, partially with resorbable and partially with non-resorbable materials.

In 53 patients (66%) antibiotic medication was required, in 16 only preoperative, in 23 only postoperative, and in 14 pre - as well as postoperative. The following antibiotics were used: Clindamycin in 23 cases and Azithromycin in 4 cases. The mean time of antibiotic medication was 6.3 days.

» **(Fig. 6a)**

58 year old female patient, situation after the removal of a fractured ceramic implant in region 45 and augmentation with Cerasorb granules.



» **(Fig. 6b)**

Situation after inserting 3 implants 6 months later. Completely regenerated bone – no more granules visible.

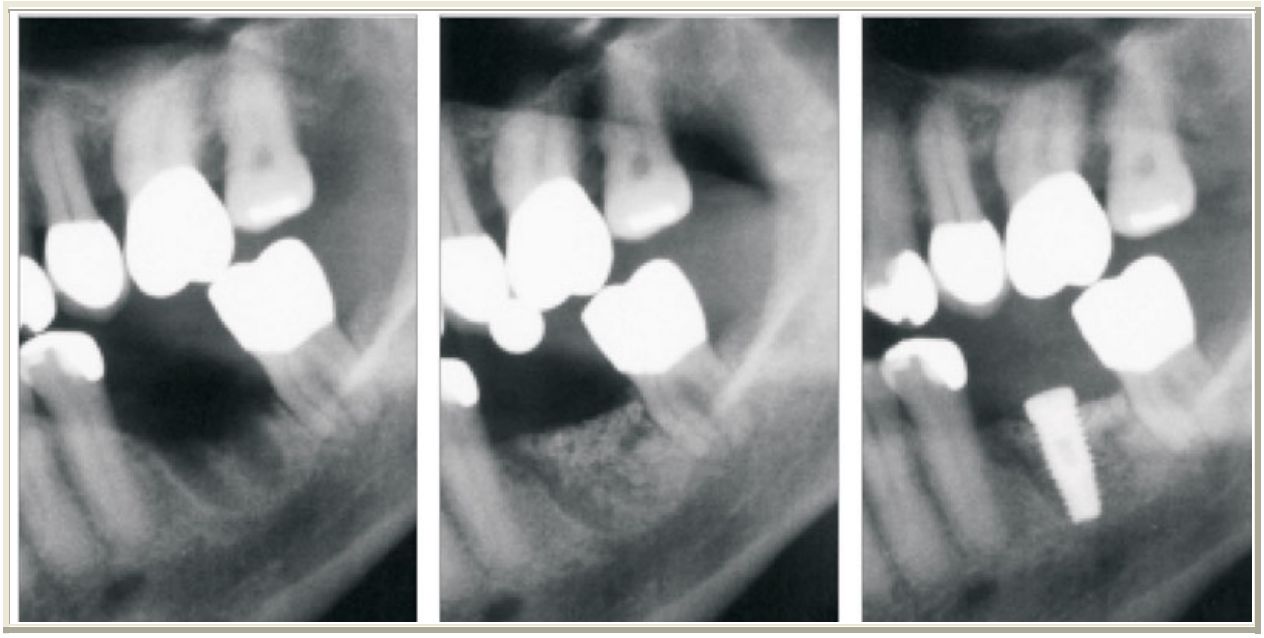
During the clinical check one to two weeks after treatment, the healing of the soft tissues, the condition of the membranes, and the inflammatory effects were observed. The healing of the soft tissues was rated 'good' to 'very good' in 87% of the cases **(see Fig. 1)**, and there was no or only little inflammation in 81% of the cases. There were 67 patients (84%) who rinsed their mouth regularly, and 62 patients used solutions with Chlorohexidine content. The membranes were removed after 1 to 12 weeks. The average retention period was 4.2 weeks. Two membranes had to be removed due to general infection (not caused by the material), one after only one day and the other after 5 days.

After 3, 6 and, if required, 12 months, the surgeons evaluated the clinical process and the bone regeneration, and compared the results to the status on the day of surgery. The number of participating patients decreased over the research period. After 3 months, 53 cases (66%) could be evaluated on the basis of general clinical specifications; after 6 months, 45 cases (59%); and after 12 months, 32 cases (40%). In some patients, effects such as redness, swelling, inflammation and dehiscence were observed after 3 months. These patients continued the treatment, and after 12 months these effects had disappeared completely **(Fig. 2)**.

The regeneration and resorption of the augmented granules were evaluated on the basis of the

x-rays. After 12 months, granules were found in the x-rays of less than 30% of the cases **(Fig. 3)**. The bone loss could be evaluated after 3 months in 43 cases (54%), after 6 months in 44 cases (55%), and after 12 months in 23 cases (29%). The coronal-apical bone resorption after 12 months was less than 10% in most cases and below 20% in 95% of the cases, the buccolingual bone loss was mostly below 10% and, after 12 months, less than 20% in 100% of the evaluated cases **(Figs. 4a, 4b)**. The success of the therapeutical measures and the tolerability of the procedures and materials used were evaluated on the last day of the observation period of the patient concerned. One to two weeks after the check-up, three patients failed to show up for follow-up and hence, an evaluation of the effectiveness could not be made.

In 88% of the cases, the efficacy of the therapeutical measures was assessed as 'good' to 'very good' on the basis of the bone regeneration due to augmentation with Cerasorb **(Fig. 5)**. The tolerability was also assessed globally. The evaluation showed that there were no complications such as allergic reactions, problems with wound healing or pain, etc. In 89% of the cases, the tolerability was assessed as ‘good’ to ‘very good’.



Starting from left: (Fig. 7a): 66 year old female patient, situation after extraction of tooth 36 due to periodontitis and peri-radicular osteolysis subsequent augmentation with Cerasorb® and closing with TefGen™ membrane.
(Fig. 7b): Check after 4 months – granules visible.
(Fig. 7c): Situation after inserting an implant in the regenerated bone 5 months post- OP, granules no longer visible.

The membranes used were also subject to a separate evaluation:
53 patients were treated with a non-resorbable TefGen membrane, 28 women and 25 men (mean age 54years). In 66% of the patients antibiotics were used. In the clinical check one to two weeks after the treatment, the healing of the soft tissue, condition of the membranes and the inflammatory effects were observed. The healing of the soft tissue was ‘good’ to ‘very good’ in 93% of the cases, and there was no inflammation in 88% of the cases.

20 patients were treated with a resorbable Epi-Guide membrane, 9 women and 11 men (mean

age 52 years). In 65% of the patients antibiotics were used. In the clinical check one to two weeks after the treatment, the healing of the soft tissue was ‘good’ to ‘very good’ in 75% of the patients, and there was no inflammation in 75% of the cases.

After 3 months in a slightly higher number of patients with Epi-Guide membranes, redness (n=7), swelling (n=6) and dehiscence (n=3) were observed compared to patients with TefGen membranes, who showed redness (n=4), swelling (n=7) and dehiscence (n = 2). The patients continued the treatment, and after 12 months these effects had totally disappeared.

The non-resorbable TefGen membrane was assessed in the global assessment at the end of the observation period ‘good’ to ‘very good’ in 83% of the cases regarding the effectiveness and with ‘good’ to ‘very good’ in 85% of the cases regarding tolerability. The resorbable Epi-Guide membrane was evaluated as ‘good’ and ‘very good’ in 90% of the cases regarding the effectiveness and in 70% of the cases regarding tolerability.

During a further sub-group analysis, two groups of patients were separately evaluated with respect to the efficiency and tolerability of the therapy: These were the groups of patients with a "severe marginal periodontitis" and the group of smokers.

17 patients with the initial findings of "severe marginal periodontitis" could be evaluated. In 82% of the cases, the efficiency was assessed ‘good’ to ‘very good’ the tolerability in 63% with ‘good’ to ‘very good’ In the 20 smokers who participated in the study, the efficiency and tolerability was evaluated in 16 cases (80%) with `good’ to ‘very good’ No difference was detected between the smokers who smoked less than 10 cigarettes per day, and those who smoked more than 10 cigarettes per day.

Discussion

In the dental practice, the demand for dental implants is constantly increasing. Insufficient bone structures may prevent an implantation in many cases, since expensive and difficult bone regeneration measures are essential. The loss of alveolar bone after the extraction of teeth is not the only consequence. The accumulation of debris and premature contraction of the coagulum can also hamper the regenerative ability of the alveoli (Lang 1998). Epithelium cells proliferate in the new regenerated connective tissue on a more apical level. As a consequence, the natural healing process results in a bone height less than the original crestal height of the alveolar bone (Sclar 1999). The day-to-day experience in implant dentistry shows that the augmentation of alveolar defects at the time of extraction can avoid the loss of the alveolar crest. However, no comparative prospective study on a standardized procedure was available for making valid statements.

Hence, the aim of this study was to discern and describe the possible differences in the process of resorption of the alveolar bone with augmentation of the alveoli using a membrane, and to compare it with the bone loss without augmentation. Over a period of up to 12 months, the results of this study are continuously indicating that following an augmentation with the synthetic -TCP bone regeneration material Cerasorb and covering with an appropriate membrane, the bone loss in most cases is less than 10% and less than 20% in 90-100% of the cases. These figures confirm the advantages of the described augmentation procedure. The residual granules that are still visible in about 30% of the cases during the final x-ray documentation do not affect the clinical findings and stability in anyway.

The applied membranes, resorbable and nonresorbable, were clinically assessed as ‘good’ to ‘very good’ in up to 83-85% of the patients with respect to their efficiency and compatibility.

Levkovic *et al.* (Levkovic 1998) showed that the use of membranes as a barrier to cover the extraction alveoli considerably minimized bone loss in height and width and facilitated a better bone regeneration within the extraction socket. This is one of the important results of this study. The patients with the source diagnosis "severe marginal periodontitis" (17 cases) were assessed in 65% of the cases as ‘good’ to ‘very good’ with respect to the tolerability of the measures. Possibly, severe marginal periodontitis has a higher complication rate. The good healing process observed in the smokers who participated in this study is actually surprising, which contradicts the clinical observation of a high complication rate in smokers. However, these cases are too few for a final evaluation.

Conclusion

The resorption of the alveolar bone after extraction of teeth can be reduced considerably by simultaneous augmentation of the alveoli with Cerasorb and the use of non-resorbable (TefGen) or resorbable (Epi-Guide) membranes as barriers over the extraction alveolus. The tolerability of the described procedures and materials is clinically evaluated as `good’ to`very good’. Thus, this method can be recommended if maximum preservation of the alveolar bone is essential, particularly for implant borne prosthetic reconstructions or because of aesthetic reasons.

References

1) Ashman,A., Bruins,P.:Prevention of alveolar bone loss postextraction with HTR grafting material, presented at a meeting of the Academy of General Dentistry, Miami, Fla., January 1984.

2) Lang N., Becker W., Karring T.: Alveolar bone formation. In Lindhe J (ed): Textbook of Clinical Periodontology and Implant Dentistry, 3rd ed, Copenhagen, Munksgard 1998, pp 906-932.

3) Levkovic V., Camargo PM, Klokkevold PR, et al: Preservation of alveolar bone in extraction sockets using bioresorbable membranes. J Periodontol 69:1044-1049,1998.

4) Salama H., Salama M.: The role of orthodontic extrusive remodeling in the enhancement of soft and hard tissue profiles prior to implant placement: a systemic approach to the management of extraction site defects. Intl Periodontics Restorative Dent 1993,13(4):312-33.

5) SlcarA.G.: Preserving Alveolar Ridge Anatomy Following Tooth Removal in Conjunction with Immediate Implant Placement, ATLAS OF THE ORAL AND MAXILLOFACIAL SURGERY CLINICS OF NORTH AMERICA, Volume 7 Number 2, September 1999.