# Evaluation of Guided Tissue Regeneration Following Third Molar Extraction by Bone Scintigraphy Using Tc99m-MDP

Orit Oettinger-Barak, Eli E. Machtei, Zohar Keidar, Dan Mahler, Imad Abu EL-Naaj, Micha Peled

Extraction of impacted third molars is a well-established and documented procedure. Guided tissue regeneration can be used to aid in wound healing and increase osseous tissue formation. To assess the regenerative treatment outcome, several variables are routinely used; these include primarily histology and direct measurement of bone. Other proxy measurements, such as radiographic analysis, clinical attachment level and periodontal pocket depth are commonly used. This report describes the use of an ePTFE membrane following extraction of an impacted wisdom tooth, and the subsequent use of bone scan using Tc99m-Methylene Diphosphonate (MDP) to monitor the regenerative response.

Key words: GTR, third molar, extraction, membrane, scintigraphy, Tc99

Extraction of impacted third molars is a well-established and documented procedure. Potential side effects of this procedure include pain, bleeding, swelling, dry socket, etc. Additionally, in 44% of patients over the age of 26 a residual infra-bony defect is left distal to the second molar (Kugelberg et al, 1991) associated with periodontal pockets exceeding 7 mm (Kugelberg et al, 1985). The use of guided tissue regeneration to prevent epithelial and connective tissue cells from downgrowing into the extraction site was suggested to improve wound healing and greater bony tissue formation.

Pecora et al (1993) compared 10 patients who underwent extraction of horizontally impacted third molars where the extraction site was covered by an ePTFE membrane, to 10 patients who underwent extraction of a wisdom tooth without the use of membrane or filling materials. The patients were randomly allocated to either the study or the control group. At the end of a one-year follow-up the study group showed a reduction in pocket depth and a gain in clinical attachment level of 5.7 and 4.3 mm respectively, compared to improvements of only 4 and 1.9 mm in the control group. The differences between the two groups were statistically significant.

Assessment of the regenerative treatment is necessary for the evaluation of success. The primary methods used for this evaluation include histology and direct measurement of bone. Other proxy measurements, such as radiographic analysis, clinical attachment level and periodontal pocket depth are commonly used (Reddy and Jeffcoat, 1999). Tc99m is a short-lived element with a six-hour physical half-life. Technetium is characterized by its ability to complex with carrier agents to create tissue-specific radiopharmaceuticals (Johnes et al, 1976). In order to image osseous structures, the Tc99m is complexed with tin and diphosphonate moieties, which gives the resultant radiopharmaceutical its bone-seeking quality (Johnes et al, 1976). After intravenous injection the bone-seeking radiopharmaceutical is taken up by the calcifying portion of the forming bone (Johnes et al, 1976). Since bone resorption is usually coupled with formation behind the resorbing front, nuclear medicine techniques may be used to detect alterations in bone metabolism in diseases of bone resorption as well as formation. Bone-seeking agents such as Tc99m-MDP

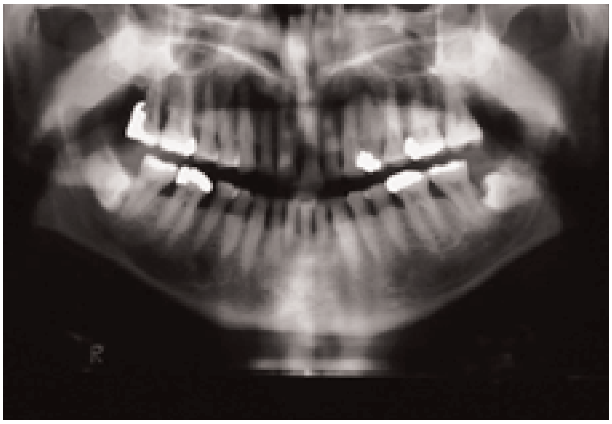

Fig. 1 Panoramic view at initial examination. Teeth #38 and 48 are impacted.

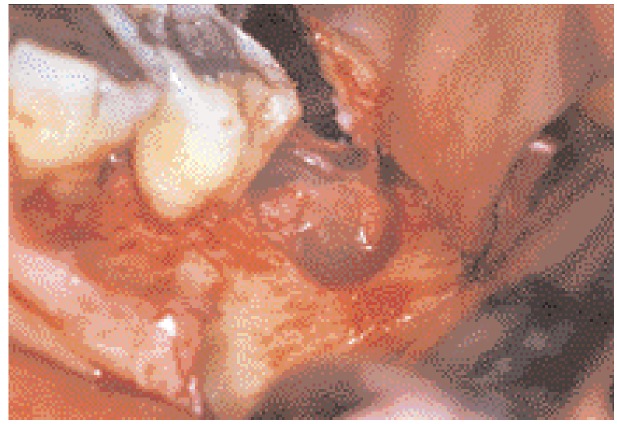

Fig. 2 After full mucoperiosteal flap reflaction, a bony defect is exposed.

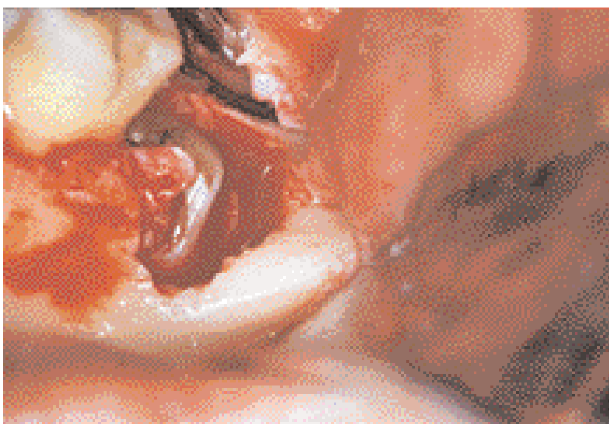

Fig. 3 Tooth #38 is visualized after debridement and bone removal.

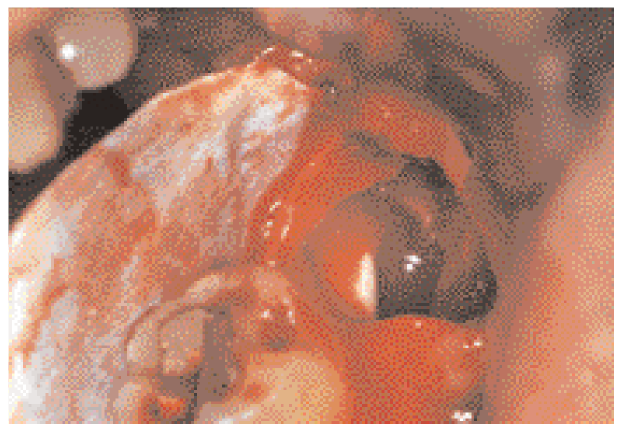

Fig. 4 The membrane is in place posterior to the bony bridge.

may thus accumulate in various bone conditions such as infection, fracture, tumor growth and healing process. This report describes the use of an ePTFE membrane following extraction of an impacted wisdom tooth, and the subsequent use of Tc99m to follow up on the regenerative response.

## CASE DESCRIPTION AND RESULTS

A 56-year-old male was referred to our clinic by his dentist for periodontal treatment. His medical condition was good, with no known allergies, medications or smoking. His plaque-control was poor, and deep periodontal pockets were scattered throughout his mouth. Bone loss was mild to advanced. At that time he was diagnosed with 'adult periodontitis' (generalized severe chronic periodontitis according to the AAP 1999 classification). Both lower third molars were impacted. After cause-related initial periodontal treatment, his plaque control improved dramatically, and deep periodontal pockets were limited to the posterior sextants of both jaws. These sites were then treated with open flap debridement procedure. Tooth #48, which was horizontally impacted, was left untreated, as there was complete bony coverage, the tooth was asymptomatic, and the distal aspect of #47 was not involved. Tooth #38 was also horizontally impacted. Radiographically, the roots seemed fused, with superposition of the mandibular canal (Fig. 1). A bony defect covered the tooth crown, descending down to the apical third of tooth #37. A periodontal pocket at 37D measured 7 mm. The distal part of the crown was not covered with bone.



Perio 2004: Vol 1, Issue 2: 165–170

Fig. 5 The membrane was fitted to cover the bony defect so that it reached beyond the external oblique ridge.

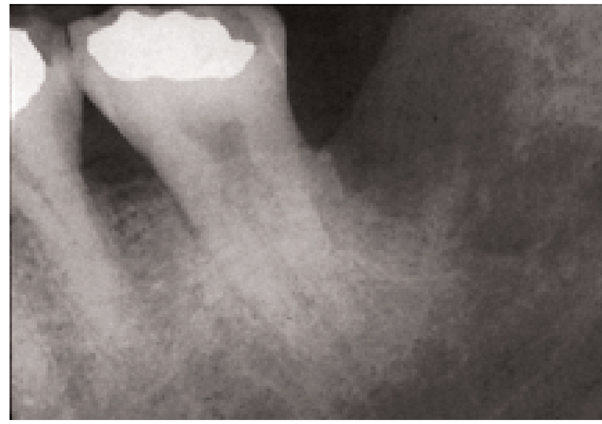

Fig. 6 Periapical view postoperatively.

Fig. 7 At membrane retrieval 2 months later, reddish osteoid-like tissue fills the entire void.

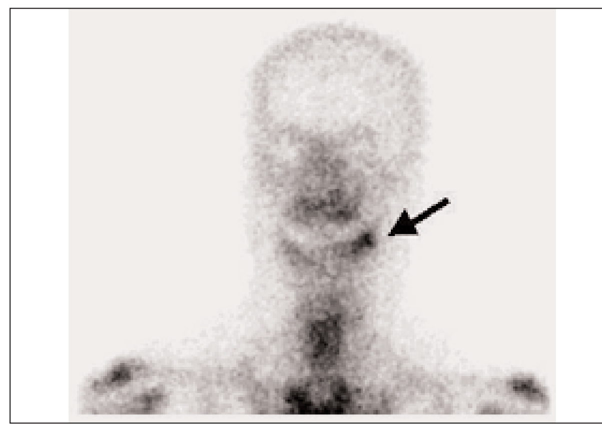

Fig. 8 Bone scintigraphy (2 hours after intravenous injection of 24 mCi Tc99m-MDP) shows increased focal uptake of the tracer in the left aspect of the posterior mandibular bone.

A full mucoperiosteal flap was elevated to evaluate this problem. A bony defect filled with granulation tissue occlusal to the tooth was exposed (Fig. 2). After thorough debridement and bone removal from the buccal and distal walls, the tooth was visualized (Fig. 3). The crown was then separated, and the roots extracted. A bony defect was left, with two orifices: one occlusal-buccal opening; and one lingual opening, separated by a narrow bony bridge. The depth of the osseous defect was 9 mm. It was decided to cover the defect with an ePTFE membrane to promote regeneration. Figure 4 shows the membrane in situ posterior to the bony bridge. The membrane was fitted to cover the bony defect so that it reached beyond the external oblique ridge (Fig. 5). Figure 6 shows the postoperative radiographic view. Healing was uneventful. At membrane retrieval 2 months later, reddish osteoid-like tissue filled the entire void (Fig. 7).

Four months after surgery the patient underwent bone scintigraphy (2 hours after intravenous injection of 24 mCi Tc99m-MDP). The scan showed increased focal uptake of the tracer in the left aspect of the posterior mandibular bone (Fig. 8). This finding is consistent with a highly active metabolic focus caused by the bone healing process.

At 2-year follow-up, the defect was fully filled with bone (Fig. 9), with healthy periodontal tissues surrounding tooth 37 (Fig. 10). Pocket depth distal to tooth 37 was 2 mm. At the distal aspect of tooth 37, plaque index (Silness and Löe, 1964) decreased from 2 pre-operatively to 0, and gingival index (Löe and Silness, 1963) decreased from 2 to 1.

Fig. 9 At 2-year follow-up, the defect is fully filled with bone.

Fig. 10 At 2-year follow-up. Note healthy periodontal tissues surrounding tooth #37.

## DISCUSSION

This case report describes the use of guided tissue regeneration immediately following extraction of an impacted third mandibular molar. Pecora et al (1993) reported significant improvement of both periodontal pocket depth and clinical attachment level following the same procedure. Grondahl and Lekholm (1973) reported pocket depth improvement of 1.1 mm following impacted third molar extraction, with minimal improvement in the alveolar bone. Karapataki et al (2000) described 20 patients in whom a third molar was extracted and treated with either a polylactic membrane placed on one side or only flap debridement on the contralateral side. Most defects improved by 10–20% of the root length (about 3 mm vertical bone height improvement), with no significant difference between membrane and flap coverages. The authors attributed these findings to the fact that the distal portion of the second molar (adjacent to the extraction) was not affected in all cases. Thus, the membrane could not have any additional effect on the healing process of that aspect of the tooth. In our patient, 5 mm pocket reduction was achieved, as well as improvement of plaque control and gingival index. The latter two are to be expected, as a result of the improved accessibility to the distal aspect of the second molar following the third molar extraction, as reported by Grondahl et al (1973). The improvement in pocket depth, on the other hand, would probably have been small if it was not for the use of the membrane (Pecora et al, 1993; Laurell et al, 1998). Another factor that might have enhanced the outcome is the order in which the procedures were performed. All the necessary periodontal treatments (both conservative and surgical) were performed prior to the third molar extraction, thus eliminating any potential foci of infection which is important for optimal results in GTR, as reported by Nowzari et al (1996).

Bone scintigraphy using Tc99m-MDP showed positive correlation with the clinical and radiographic response. Positive correlation with periodontal disease activity was previously demonstrated both in animal models and in humans (Reddy and Jeffcoat, 1999). Nevertheless, this is the first time that bone scintigraphy has been used to demonstrate bone healing following membrane placement.

Several methods are routinely used to assess the regenerative responses. Histology is the ultimate standard to assess periodontal regeneration. However, once the regenerative potential of a treatment modality has been established, proxy clinical and radiographic variables are used (Reddy and Jeffcoat, 1999). Bone sounding has been commonly utilized in periodontal surgery to assess bony topography without reflection of the soft tissues. Bone sounding eliminates many of the errors associated with attachment level measurements that occur due to a change in connective tissue resistance to a periodontal probe. However, bone sounding was found to be within ±1 mm of the surgical measurements in only 60% of the measurements, which is probably associated with differences in the architecture and angulation of a defect (Mealey et al, 1994).

To overcome this problem, direct bone measurement using re-entry surgery is employed. This second surgical procedure is usually performed 6–12 months after the initial regeneration procedure, and is among the most common methods used to evaluate regeneration (Machtei, 1997). Hence, although re-entry surgery has the advantage of visual assessment of the regenerative results, the major disadvantage is that it involves a second session of surgery. Furthermore, some measurements may be difficult to compare since the remodeling and regeneration process may change the shape of the defect over time. The second surgical procedure is time consuming and may interrupt the regenerative process if healing is still ongoing. The re-entry surgery itself is associated with morbidity (Reddy and Jeffcoat, 1999).

Conventional radiography offers the simplest and most cost-effective radiographic method for assessing alveolar bone changes. It is most useful in evaluating alveolar bone changes expressed as the linear distance from a fixed reference point to the alveolar bone crest on radiographs. In order to improve reproducibility and accuracy, standardized radiographs using intra-oral and extra-oral mounting / docking devices that establish a reproducible source-tooth-film geometry are used. Since most regenerative treatments involve the infra-bony component of the defects, crestal bone changes have little significance. Image processing techniques have been developed to help facilitate detection of minute osseous changes following periodontal treatment. Both techniques have a common shortcoming: angulation and projection distortion.

The goal of digital subtraction radiography is to facilitate visualization of small osseous changes that occur between radiographic examinations, by using three-dimentional image analysis. The importance of radiographic image processing for regeneration therapy lies not only in the ability to detect a small lesion but also in the ability to detect and define that lesion in terms of length, area, volume and mass of bone gain. A significant correlation was found between clinical and radiographic measurements of bone level (Eickholz and Hausmann, 1997; Falk et al, 1997). However, all radiographic examinations expose the patient to some, albeit small, levels of ionizing radiation.

The weakness of all the above used methods lies in the fact that the measurements are anatomically based. In contrast, scintigraphy is based on biological processes, thereby enabling the detection of active processes at the time of examination, with the possibility of predicting expected success. Furthermore, if no changes can be observed by scintigraphy 3 months after surgery, it is unlikely that new bone formation will ever occur, thereby allowing this method to serve as an easy predictor for regenerative outcome. The clinician might use this technique to establish prognosis and / or elect to perform further corrective treatment based on these early results.

## REFERENCES

Eickholz P, Hausmann E: Evidence for healing of class II and III furcations after GTR therapy: digital subtraction and clinical measurments. J Periodontol 1997; 68: 636–644.

Falk H, Laurell L, Ravald N, Teiwik A, Persson R: Guided tissue regeneration therapy of 203 consecutively treated intrabony defects using a bioabsorbable matrix barrier. Clinical and radiographic findings. J Periodontol 1997; 68: 571–581.

Grondahl H, Lekholm U: Influence of mandibular third molars on related supporting tissues. Int J Oral Surg 1973; 2: 137–142.

Johnes AG, Francis MD, Davis MA: Bone scanning. Radionuclidic reaction mechanisms. Semin Nucl Med 1976; 6: 3–17.

Karapataki S, Hugoson A, Kugelberg CF: Healing following GTR treatment of bone defects distal to mandibular 2nd molars after surgical removal of impacted 3rd molars. J Clin Periodontol 2000; 27: 325–332.

Kugelberg CF, Ahlstrom U, Ericson S, Hugoson G: Periodontal healing after impacted lower third molar surgery. A retrospective study. Int. J Oral Surg 1985; 14: 29–40.

Kugelberg CF, Ahlstrom U, Ericson S, Hugoson G, Thailander H: The influence of anatomic, pathophysiological and other factors on periodontal healing after impacted lower third molar surgery. A multiple regression analysis. J Clin Periodontol 1991; 18: 37–43.

Laurell L, Gottlow J, Zybutz M, Persson R: Treatment of intrabony defects by different surgical procedures. A literature review. J Periodontol 1998; 69: 303–313.

Loe H, Silness J: Periodontal disease in pregnancy. I. Prevalence and severity. Acta Odontol Scand 1963; 21: 533–51.

Machtei EE: Outcome variables for the study of periodontal regeneration. Ann Periodontol 1997; 2: 229–239.

Mealey BL, Neubauer MF, Butzin CA, Waldrop TC: Use of furcal bone sounding to improve accuracy of furcation diagnosis. J Periodontol 1994; 65: 649–657.

Nowzari H, MacDonald ES, Flynn J, London RM, Morrison JL, Slots J: The dynamics of microbial colonization of barrier membranes for guided tissue regeneration. J Periodontol. 1996; 67: 694–702.

Pecora G, Celletti R, Davarpanah M, Covani U, Etienne D: The effects of guided tissue regeneration on healing after impacted third-molar surgery: 1-year results. Int J Periodont Rest Dent 1993; 13: 397–407.

Reddy MS, Jeffcoat MK: Methods of assessing periodontal regeneration. Periodontology 2000 1999; 19: 87–103.

Silness P, Loe H: Periodontal disease in pregnancy. II. Correlation between oral Hygiene and periodontal condition. Acta Odontol Scand 1964; 22: 121–35.

Reprint requests:
Dr. Orit Oettinger-Barak
Periodontal Unit
Department of Oral and Maxillofacial Surgery
Rambam Medical Center 31096
P.O. Box 9602
Haifa, Israel
Fax: + 972 4 8543057
E-mail: o_o-barak@rambam.health.gov.il