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# Does preservation of the socket decrease marginal bone loss in the mandible after extraction of first molars?

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**Abstract**

The quality of the bone plays an important part in marginal bone loss (MBL) around dental implants. The aim of this study was to compare MBL around implants the sockets of which had been preserved with the bone around healed sites in the mandible after extraction of first molars. It was a prospective, cohort study in which subjects were divided into three groups (n = 30 in each): dental implants were placed six months after preservation of the socket in the first group, eight weeks after tooth extraction in the second, and six months after tooth extraction in the third. The changes between the marginal bone level after loading of the implant and 12, 24, and 36 months later were considered to be the MBL. Age and sex were the variables studied, the condition of the bone (healed socket or preservation) was a predictive factor, and MBL was the outcome. Analysis of variance was used to compare MBL and age among groups. There were no differences in the mean MBL among the three groups 12, 24, and 36 months after loading ($p = 0.55$, $p = 0.22$, $p = 0.38$, respectively). Preservation of the socket did not seem to affect MBL of the first molar of the mandible.


*Keywords:* Dental implants; Bone resorption; Osseointegration; Alveolar bone grafting

## Introduction

Marginal bone loss (MBL) is an important factor in the long-term success and survival of dental implants.[1] Formation of bone in the tooth socket is a natural event when surrounding alveolar walls are intact, but volumetric contraction of the alveolar ridge is unavoidable. Considerable bone loss is associated with healing of the socket. Bone healing and remodelling affect the inner and outer surface of the tooth socket,[2] and socket preservation techniques are indicated to reduce the loss of ridge volume that typically follows tooth extraction.[3] The quality of bone around the dental implant plays an important part in MBL.[4] Grafted sockets generally have more mineralised tissue (including both new vital bone and remaining graft particles) after three or more months.[5] The effect of techniques to preserve the socket on MBL before placement of a dental implant, compared with MBL in healed sockets, is not clear.

The aim of this study was to find out whether preservation of the socket helps to stabilise the MBL after placement of a dental implant. We hypothesised that socket preservation decreases MBL under these circumstances, so we compared MBL around implants at socket preservation sites with that around healed sites in the mandible after extraction of first molars.

## Patients and methods

This was a prospective cohort study. The study sample was derived from the population of patients who presented to GD Clinic and Khanevadeh Clinic between 1 January 2015 and

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31 December 2017. All patients completed the study without deviations from the protocol. The research was approved by the committee of the medical ethics group of Shahid Beheshti University of Medical Sciences. Subjects eligible for inclusion in the study needed a dental implant in the mandible after extraction of a first molar, assuming sufficient bone was available (width 6 mm or more and height 12 mm or more). Subjects were excluded if they needed bony augmentation or had a bony defect or systemic disease that could result in asymmetrical bony metabolism.

Subjects were divided into three groups: dental implants were placed six months after socket preservation in the first group, eight weeks after tooth extraction in the second group, and six months after tooth extraction in the third group. All teeth were removed by sectioning the mesial and distal halves, without raising a flap. A maxillofacial surgeon extracted all the teeth and inserted all the implants, being careful to avoid injuring bone around the tooth socket.

All implants were at tissue level with a microtextured surface (Zimmer Dental). The implant size was 4.8 × 10 mm, with a 3.0 mm internal octagon. All implants were loaded three months after placement. None of the subjects needed further soft or hard tissue manipulation during follow-up. Cemented crowns were used in all subjects. Radiographs were taken immediately after loading and repeated 12, 24, and 36 months after loading. MBL was assessed on the mesial and distal surfaces of the implants with a long-cone paralleling technique. The subjects were imaged with a standard periapical film (no. 2, type E) with exposure variables of 70 kV, 8 mA, and 0.250 seconds. To confirm the reproducibility of the radiographic views (after loading and on follow-up), all imaging was done with individual bite blocks attached to the beam-guiding device (XCP, Rinn).

To individualise the bite blocks, bites were recorded using silicone impression material (Polyvinylsiloxane, Kerr) and located on the individual bite blocks. A 5.5 mm spherical metal bearing was placed on the buccal surface of the neighbouring tooth as a reference guide to measure the magnification. A digital scanner at an input resolution of 2400 dots/inch and a 256-Gy scale was used for digitisation of films. The images were magnified six times and analysed by a maxillofacial radiologist using Adobe Photoshop 5 (Adobe, San Jose). The bone level was measured on the mesial and distal surfaces of the implants, and the shoulder of the implant was used as a reference point. The vertical distance between the shoulder of the implant and the crest of alveolar bone was used to ascertain the MBL. When the amount of bony resorption was different on the mesial and distal sides, the mean MBL was used (Fig. 1). The change between MBL after loading the implant and after 12, 24, and 36 months was considered the accurate MBL. All patients were followed up for 36 months after loading, and age and sex were the variables studied. The condition of the bone (healed socket or socket preservation) was a predictive factor in the study, and MBL the outcome.

Fig. 1. Measurement of marginal bone loss when it differed at the mesial and distal side of a dental implant.

*Technique for preservation of the socket*

After the local anaesthetic (4% articaine with 1:200,000 epinephrine) had been given, the teeth were sectioned into mesial and lateral roots. Each segment was gently luxated with a dental elevator and removed with extraction forceps. The extraction sockets were carefully curetted to remove granulation tissue. The socket was then filled with a xenograft material (Cerabone; Botiss) and covered with a resorbable membrane (Jason® membrane; Botiss). Soft tissue was sutured with 4/0 polyglactin 910 (Vicryl, Ethicon) without attempting primary closure. Subjects were instructed to avoid wearing any prostheses in the grafted area during healing.

*Statistical analysis*

Analyses were made using the statistical package IBM SPSS Statistics for Windows (version 21, IBM Corp). Analysis of variance was used to compare the effect of differences in MBL and age between groups. We considered probabilities of $< 0.05$ as significant. The chi squared test was used to assess the influence of sex. Pearson's correlation coefficient was used to identify associations between age and MBL in each group, and the independent *t* test was used to compare MBL between male and female patients.

## Results

The comparison of age and sex among the groups is shown in Table 1, and we found no association between age and MBL

Table 1
Age and sex of patients. Data are number or mean (SD).

| Variable | Age (years) | Sex (M/F) |
|---|---|---|
| Group: | | |
| Six months after socket preservation | 35 (8) | 17/13 |
| Eight weeks after tooth extraction | 34 (8) | 16/14 |
| Six months after tooth extraction | 35 (9) | 16/14 |
| p value (ANOVA/chi squared test) | 0.88 | 0.96 |

F ratio 0.13; df 2.

Table 2
Marginal bone loss after loading. Data are mean (SD).

| Marginal bone loss (mm) | Men | Women | p value | df |
|---|---|---|---|---|
| At 12 months | 0.35 (0.15) | 0.33 (0.15) | 0.55 | 85.39 |
| At 24 months | 0.48 (0.15) | 0.44 (0.14) | 0.22 | 86.79 |
| At 36 months | 0.57 (0.15) | 0.54 (0.18) | 0.38 | 78.30 |

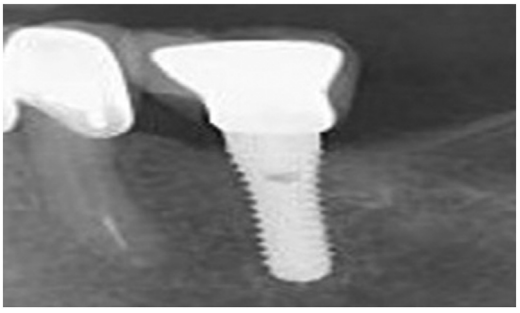

Fig. 2. A dental implant that was placed six months after the tooth had been removed without preservation of the socket. The radiographic view three years after loading shows 0.75 mm of marginal bone loss.

at 12, 24, and 36 months after loading (p = 0.71, p = 0.63, and p = 0.79, respectively) nor did the mean MBL differ between male and female patients at 12, 24, and 36 months after loading (p = 0.55, p = 0.22, and p = 0.38, respectively) (Table 2).

The mean MBL 12, 24, and 36 months after loading did not differ among the three groups (p = 0.22) (Table 3, Figs. 2 and 3).

## Discussion

Preservation of the socket is thought to prevent buccal or lingual (palatal) collapse and to maintain the width of the ridge after removal of a tooth.[6] Use of various materials can affect bony quality,[7] which is reportedly associated with MBL.[8] Other associated factors may include interleukin

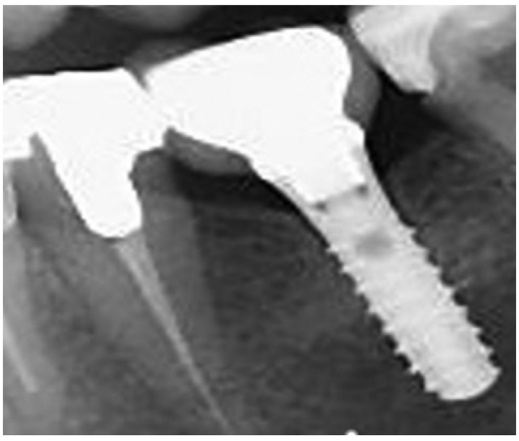

Fig. 3. A dental implant that was placed six months after the tooth had been removed and the socket preserved. The radiographic view three years after loading shows 0.70 mm marginal bone loss.

1 polymorphism,[9] smoking, characteristics of the implant (such as platform switching or connection type),[10] prosthetic design, and diameter and surface of the implant.[11] We assessed dental implantation at the first molar of the mandible to prevent any bias related to implant site or characteristics. Age and sex were treated as variables.

Different types of radiographs have been used to evaluate MBL. Both the conventional intraoral periapical and the direct digital radiograph techniques (Radio-Visio-Graphy, RVG) underestimated bone loss by 1.5–2.5 mm. The direct digital technique seems to be superior to the intraoral periapical technique for the assessment of interdental bone loss.[12] Intraoral radiographic techniques can only evaluate mesial and distal bone loss. Cone-beam computed tomography (CT) is useful for evaluation of labial bone changes.[13] However, the dose of radiation in cone-beam CT is more than in the digital and intraorbital techniques.[14] We used an intraoral parallel technique for detection of MBL around dental implants, and the inability of intraoral radiographs to evaluate the labial or buccal bone changes was a limitation of the study.

Three different times for insertion of the implant ("delay immediate", "delay with socket preservation" and "delay without socket preservation") were studied. We considered the "delay immediate" group for assessment of the possible effect of healing time before insertion of the dental implant on MBL in non-grafted bone, and found no differences in MBL around dental implants placed at socket preservation sites and healed sockets two and six months after extraction. It may be that "delay immediate" and delayed implant place-

Table 3
Marginal bone loss in the three groups. Data are mean (SD).

| Variable | Marginal bone loss at 12 months | Marginal bone loss at 24 months | Marginal bone loss at 36 months |
|---|---|---|---|
| Group 1: six months after socket preservation | 0.35 (0.15) | 0.47 (0.15) | 0.58 (0.19) |
| Group 2: eight weeks after tooth extraction | 0.36 (0.13) | 0.50 (0.13) | 0.57 (0.14) |
| Group 3: six months after tooth extraction | 0.31 (0.16) | 0.43 (0.16) | 0.52 (0.15) |
| p value (ANOVA) | 0.55 | 0.22 | 0.38 |
| F ratio | 0.94 | 1.39 | 1.03 |

ment did not affect MBL. Healed sockets (six months after tooth removal), with or without socket preservation, may have the same MBL.

The degree of change in bone quality reportedly depends on the resorption rate of the grafting material and its ability to induce formation of new bone.[15] After xenografting, about 30% of the graft material is still present.[16,17] Bony quality may affect the success of the implant by increasing primary stability and through bone-implant contact.[15] The amount of bone:implant contact is important for the long-term success of a dental implant, and the amount around dental implants after osseointegration ranges between 42% and 96%.[18] Ibanez et al reported that lower MBL was associated with type IV bone.[8] Meijndert et al studied bone quality after augmentation of the maxillary anterior ridge with chin grafts and xenografts. They concluded that xenograft material was still present six months after grafting. Clinical results were similar in the two groups despite differences in histological evaluation after a year.[19] The results of their study were similar to ours, with no differences in MBL between various implant sites.

Zitzmann et al studied xenografts in augmentation of the ridge.[20] Their histological analysis showed that xenograft particles occupied 31% of the total biopsy area 6-7 months after grafting. Close contact between woven bone and Bio-Oss® was found on 37% of the particle surfaces. They found that mixed bone consisted of woven and parallel-fibre bone that had evidence of remodelling. Resorption of the grafting material was apparent in the histological sections, indicating that xenografted materials were involved in the remodelling process.[20]

It has been suggested that MBL is more commonly associated with biological failure rather than occlusal overload or discipline-driven causes of periodontal disease.[21] Qian et al found no evidence that primary infection caused MBL.[22] They stated that large areas of peri-implantitis in clinical reports were not supported by the data. Clinical evidence suggested that combined factors (clinical handling, implant hardware, and patients' characteristics) may be associated with MBL,[22] and the surface and design of dental implants in various implant systems may also have a role.[23]

We used xenografting for socket preservation, and using other materials such as allografts and alloplasts may yield different clinical results (which was a limitation of the study). Underestimation of MBL may also be a limitation. We focused on the first molar of the mandible, but other implant sites such as the aesthetic zone are more susceptible to bony resorption than the posterior site of the jaws. Kassim et al reported that socket preservation techniques are effective in the aesthetic zone in the reduction of resorption of the alveolar ridge after extraction.[24] However, there was not enough evidence to recommend that the use of socket preservation in conjunction with dental implants improves the outcomes of those implants. Socket preservation does not essentially abolish the need for further simultaneous bony augmentation at the time of implant placement. Macbeth et al mentioned that socket preservation significantly reduces dimensional change in the vertical bone after tooth extraction compared with socket healing without augmentation. The decline in dimensional resorption of horizontal alveolar bone was variable.[25] We did not study the presence or absence of the second molars, which may be further limitations of the study that could affect MBL around the dental implants at the first molar sites.

## Conclusion

Within the limits of this prospective study, socket preservation did not seem to affect MBL at the first molar of the mandible.

## Ethics statement/confirmation of patients' permission

The research was approved by the committee of the medical ethics group of Shahid Beheshti University of Medical Sciences. All patients signed the permission form for participation in the study

## Conflict of interest

We have no conflicts of interest.

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