Histologic and Histomorphometric Assessment of Implants and Periapical Tissues When Placed in the Sockets of Extracted Teeth, Teeth With Periapical Lesions, and Healed Lesions: A Canine Study

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Eighteen canine mandibular premolars were divided into 3 groups. In group 1, implants were inserted in periapical lesions. In group 2, implants were inserted when lesions were radiographically healed. In group 3 (control), implants were inserted immediately after extraction. There was no significant difference in average bone implant contact between the 3 groups. Considering the limitations of this study, immediate placement of dental implants in tooth sockets with periapical lesions should be proposed only under special circumstances.

**Key Words:** implant, osseointegration, histomorphometric

**INTRODUCTION**

Immediate implant placement is considered a suitable treatment for replacing missing teeth.1–3 The significant advantage of this treatment approach over delayed implantation is the preservation of the alveolar ridge, which allows for more ideal positioning of the implants. This, in turn, contributes to improved esthetics, biomechanics, and long-term survival of the functioning implants. This method decreases the number of surgeries required and also increases patient satisfaction.4,5 However, some researchers recognize periapical and periodontal lesions as contraindications for such treatment.6–8 Furthermore, a large number of the teeth extracted for replacement with an implant are infected teeth that should not receive immediate implant insertion.

One of the problems that may arise as a result of this treatment is an infectious and inflammatory response in the apex of the implant called “periapicalimplantitis” or “periapical implant lesion” (PIL).9 Cases of PIL have been reported after the extraction of teeth with an apical or periodontal lesion followed by immediate implant placement.9 Some researchers even believe that after complete healing of a tooth socket with a periapical lesion, implant placement would still result in treatment failure or PIL.10 Nevertheless, successful cases of immediate implant placement after extraction of teeth with periodontal problems and endodontic...
lesions (such as granulomas and cysts) have also been reported. The purpose of this study was to determine the effect of periapical lesions on the histological, histomorphometric, clinical, and radiographic osseointegration of an implant.

**MATERIALS AND METHODS**

This study was carried out as an experiment on the mandibular premolars of 3 mixed-breed male dogs weighing between 7 and 10 kg. The premolar site was chosen for implant placement because of its ease of accessibility. Six premolar teeth were used as replicates of a particular treatment in each dog. Therefore, a total of 18 teeth were extracted under general anesthesia after taking primary radiographs. Dogs were sedated by acepromazine (Alfasan, Holland). An 11 mg/kg intravenous injection of ketamine (Alfasan) was used for the initiation of anesthesia, and halothane 1%–2% in the form of oral intubation was used to maintain anesthesia. Lidocaine 2% with epinephrine 1:80,000 (Perso-
caine, Darou-Pakhsh, Tehran, Iran) was also used for more effective anesthesia and better control of excessive bleeding.

In the first 2 dogs, the teeth were exposed to the oral cavity and left open for 1 week. In the second session, the access cavities were sealed with Cavisol (Golchai Co, Tehran, Iran) under general anesthesia. Eight weeks later, during the third session, a radiograph was taken to confirm the existence of visible periapical lesions, and the teeth were then extracted. Because of divergence of the premolar roots, the teeth were first sectioned into 2 halves using a surgical turbine, starting from the tooth furcation. The teeth were then extracted. In group 1, an incision was made and the flap was reflected under sterile conditions. The sockets were irrigated with saline solution and prepared for immediate implant placement according to the manufacturer’s instructions (Astra, Molndal, Sweden). Each quadrant of the mandible received 3 implants (a total of 6 implants for each mandible) with a diameter of 4 or 4.5 mm and a length of 11 or 13 mm, depending on the length and diameter of the extracted tooth. Dental implants were placed in angulation similar to that of the extracted teeth.

After installation, a cover screw was placed on top of the implant. The implants were submerged, and the flaps were sutured using absorbable Vicryl threads.

In Group 2, after the periapical lesion was induced, the teeth were extracted, the sockets were irrigated (similar to Group 1), and the sites were sutured. After radiographic healing of the periapical lesion, which took 3 months, an incision was made, and the implants were placed in the same manner used for Group 1. In group 3 (control), healthy premolars (without periapical lesions) were extracted and replaced immediately with 6 implants (with similar diameters and lengths as groups 1 and 2).

The dogs were then provided with a soft diet for the first 4 weeks and a normal diet thereafter. All were under a plaque control program throughout the duration of the experiment. After 3 months, the implants were clinically examined under general anesthesia to detect inflammation or sinus tracts. Periapical radiographs were taken to evaluate the presence of radiolucencies. The animals were subsequently euthanized with intravenous doses of sodium pentobarbital (Nembutal, Abbot Lab, North Chicago, Ill). The jaws were perfused with a mixture of 10% buffered formalin and 80% ethanol via the carotid arteries. Each implant was dissected along with the surrounding osseous tissue. Samples were then mounted in cold cure acrylic blocks (Meliodent, Heraeus Kulzer, Berkshire, UK).

After polymerization, the specimens were sectioned longitudinally along the long axis of the implant with a high-precision diamond disc at about 150 μm and ground to about 50–70 μm. Samples were stained with hematoxylin-eosin and Masson’s trichrome (Figure 1). Samples were then examined by a pathologist (blindly) under ×40 magnification using a light microscope (Carl Zeiss, Germany) equipped with a gauged, gridded lens. Histomorphometry of the amount of bone-implant contact (BIC), lamellar bone, woven bone, and inflammatory tissue surrounding the implants was determined (Figures 2, 3, and 4). Inflammation was determined by counting the acute and chronic inflammatory cells around the implants in each surface unit with a magnification of ×400. The findings were compared using 1-way analysis of variance (ANOVA) using SPSS (version 11.5).

### Results

Observed histological and histomorphometric characteristics of the samples and the analysis of the data by 1-way ANOVA revealed the following results (Table):

- The amount of BIC for groups 1 and 2 did not exhibit any significant differences compared with
each other as well as compared with group 3 ($P = .687$).

- The amount of lamellar bone surrounding the implants did not differ significantly between any of the groups ($P = .829$).
- The amount of woven bone around the implants did not differ significantly between any of the groups ($P = .344$).
- The amount of inflammation in the implants surrounding tissues did not differ significantly between any of the groups ($P = .670$).

**DISCUSSION**

Some researchers have highlighted chronic periapical lesions as a contraindication for treatments that involve immediate implant placement.\(^1\)\(^-\)\(^6\) Bacterial contamination was believed to be the cause of PIL. The current study showed that even after extraction of the affected tooth, sustained bacterial contamination had caused the lesion around the implant. In another study, Sussman and Moss\(^1\)\(^7\) reported the contamination of tooth sockets and identified insufficient space between the implant and the adjacent tooth as the cause of implant failure. Implant failure and PIL are believed to be associated with trauma during surgery, perforation of the buccal or lingual cortex, contamination of the implant surface by saliva or bacterial plaque during insertion of the implant, smoking, systemic diseases, and excessive tightening of the implant.\(^18\)\(^,\)\(^19\) Casap et al\(^1\)\(^2\) reported a high success rate of 99.6% in immediate implants in a clinical study of 30 implants in 20 patients, replacing teeth with periapical lesions and periodontal problems. Siegwardt et al\(^2\)\(^0\) showed that the placement of an implant to replace a tooth with a periapical lesion does not increase the chance of further complications and can be carried out successfully. Novaes et al\(^2\)\(^1\) concluded that chronically infected sites (such as periapical lesions) may not be a contraindication for immediate implant insertion. This finding is consistent with the results of the current study.

For group 1 samples in the current study, the implants were immediately placed in sockets of teeth with lesions. However, the results showed no significant difference between group 1 and group 3. Therefore, it is not likely that a chronic periapical lesion in the site of an implant installation is the cause of PIL or increased complications. The insignificant difference between groups 1 and 3 could be at least partly caused by the implanting procedure. During drilling (to obtain an installation site), the integrity and structure of the periapical lesion can be modified. Therefore, regenerative activities and reconstruction of the osseous tissues may have been affected after placement of the implant. It has been reported that most periapical lesions consist of granulous tissues, which are considered to be inflammatory lesions, and contain macrophages, plasma cells, and lymphocytes as well as fibroblasts, capillaries, and connective tissues.\(^2\)\(^2\) Also, the periapical lesion is now believed to be sterile in most situations, and an intracanal infection is the main cause of apical periodontitis.\(^2\)\(^3\),\(^2\)\(^4\) It therefore appears that intracanal infection is also the main cause of the periapical lesion. This infection can be removed with the extraction of the tooth and bone regeneration initiated after implant placement in the periapical region and area surrounding the implant.

Finally, group 2 samples (which received implants in the sites with healed lesions) exhibited no significant difference in BIC and inflammation compared with groups 1 and 3.

**CONCLUSION**

Considering the limitations of this study in determining different periapical lesions, it could be concluded that dental implant placement in the site of periapical lesions resulting from intracanal infections may not have any negative effect on the general success of implants. In addition, implant placement in the site of healed lesions is not contraindicated. More studies are required to confirm this finding for practical purposes.

**ABBREVIATIONS**

ANOVA: analysis of variance
BIC: bone-implant contact
PIL: periapical implant lesion

**REFERENCES**


