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Immediate placement of implants in periapical infected sites: A prospective randomized study in 50 patients

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Objective. To determine clinical success when implants are placed in chronic periapical infected sites.
Study design. Fifty patients (25 females, 25 males, mean age 39.7 ± 14.5 years) were included in this prospective controlled study. After randomization, 25 Frialit-2 Synchro implants were immediately placed (IP) after extraction, and 25 Frialit-2 Synchro implants were placed after a 3-month healing period (DP). Thirty-two implants were placed in the anterior maxilla and 18 implants were placed in the premolar region. Implant survival, mean Implant Stability Quotient (ISQ) values, gingival aesthetics, radiographic bone loss, and microbiologic characteristics of periapical lesions were evaluated for both groups.
Results. Overall, 2 implants belonging to the IP group were lost, resulting in a survival rate of 92% for IP implants versus 100% for DP implants. Mean ISQ, gingival aesthetics and radiographic bone resorption, and periapical cultures were not significantly different with the IP and DP implants.
Conclusions. Immediate implant placement in chronic periapical lesions may be indicated.
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Immediate postextraction implant placement is a well-accepted protocol due to the preservation of aesthetics, shorter total treatment time, maintenance of socket walls, reduced surgical time, and better actual implant placement.[1] The concept of immediate placement of dental implants after removal of a tooth with periapical pathology, however, is a matter of debate. Only a few studies on this subject have been published, and no prospective randomized studies have been conducted to determine the feasibility of this approach. The placement of implants into the sockets of teeth with periapical lesions offers advantages: it minimizes the number of surgical procedures by combining extraction, implant placement, and bone grafting in 1 appointment. The disadvantage of the technique is the potential for implant contamination during the initial healing period due to remnants of the infection.

Periapical lesions are areas of inflammatory reactions to various antigens present in infected root canals; histological examination of these lesions reveals the presence of granulation tissue infiltrated by immunocompetent cells such as lymphocytes, plasma cells, macrophages, polymorphonuclear leukocytes, and mast cells.[2] Macrophages and lymphocytes are the predominant inflammatory cells. Microorganisms located at the apical part of the root canal system are usually delineated from the inflamed periradicular tissues, either by a dense accumulation of polymorphonuclear neutrophils or by an epithelial plug at or near the apical foramen.[3]

Novaes and Novaes[4] reported that, in immediate implant placement for replacement of teeth with periapical lesions, success can be achieved if certain preoperative and postoperative measures are followed, such as antibiotic administration, meticulous cleaning, and alveolar debridement, before surgical procedure. In histomorphometric evaluations of immediate implantations in dogs with induced periapical lesions, investigators

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reported that osseointegration occurred in both the experimental and control sites.[5]

The purpose of this prospective randomized study was to evaluate the outcome of immediate placement of Frialit-2 Synchro (Dentsply Friadent Ceramed, Mannheim, Germany) implants when used in the replacement of teeth with chronic periapical lesions.

PATIENTS AND METHODS

The present study was performed within the guidelines of the Helsinki Declaration for biomedical research involving human subjects. The study was conducted at the department of Oral and Maxillofacial Surgery, Academic Medical Center, Amsterdam.

All patients were given emphasis-placed detailed explanations of the study protocol and were asked to sign surgical consent forms. The primary indication for placement of implants was a maxillary anterior or premolar single-tooth replacement. Fifty consecutive patients (25 females and 25 males) ranging in age from 19-69 years (mean 39.7 $\pm$ 14.5 years) were included. All patients in this study were at least 18 years old and physically able to tolerate the procedure. Patients had to be in good health, with no chronic disease or smoking habits. In addition, primary stability (torque $>$25 N/cm) of the implants had to be achieved during surgical procedure. Patients were excluded if any of the following were evident: untreated caries or uncontrolled periodontal disease; smoking; any disease, condition, or medication that might compromise healing or osseointegration; or inability or unwillingness to return for follow-up visits. All implants in this study were Frialit-2 Synchro implants. All treated teeth demonstrated radiographic signs of chronic periapical periodontitis. Preliminary diagnostic procedures consisted of a panoramic radiographic evaluation supplemented with periapical radiographs.

Patients were randomly allocated (computer randomization program) to an immediate placement or a delayed placement protocol.

Surgical procedure

One hour before surgical procedure, patients began a prophylactic regimen of 600 mg clindamycin. All procedures were performed by using local anesthesia with epinephrine. In the immediate implant group, implant surgical procedure was immediately performed after extraction of the involved tooth and thorough degranulation of the socket. Samples of granulation tissue were collected for microbiologic analysis. Subsequently, 2 sterile paper points (Fine, UDM, West Palm Beach, FL) were inserted in the apical defect and left in place for 10 seconds. The material was transferred to a vial containing 2 mL of RTF[6] and sampled for bacterial growth. In the delayed group, the implant procedure was carried out after a healing period of 12 weeks.

Implant surgical procedure. A pedicled mucoperiosteal flap was raised to expose the maxilla, after which osteotomies were prepared with the 2.0 and 3.0 drills with maximum use of the bone apical to the extraction socket to achieve primary stability. Subsequently, osteotomies were pushed in the osteotomy site while using a rotatory action. After completion of site preparation, a Frialit-2 Synchro implant was placed with a minimal torque of 25 Ncm by using a torque controller. Selection of implant diameter was based on both primary stability and fill of the socket. The implant was placed 2 mm below the cervical junction of the adjacent teeth. Because of the apical infection, part of the buccal plate had been lost, and bone augmentation utilizing autogeneous corticocancellous bone from either the trigonum retromolar or chin regions was harvested. The corticocancellous block was grinded in a bone mill and placed buccally to totally cover the implant. After adaptation of the mucoperiosteal flap to achieve tension-free wound closure, a bioresorbable collagen membrane (Bio-Gide®, Geistlich AG, Wolhausen, Switzerland) was placed and the wound was closed by means of 5-0 Ethilon sutures (Johnson & Johnson Gateway, LLC, Piscataway, NJ).

Postoperative management

After surgical procedure, chlorhexidine rinses were used for 7 days, and patients were seen on a weekly basis for 4 weeks. After 2 weeks, a removable provisional partial denture with clasps was placed. A nonloaded healing period of 6 months was allowed for all placed implants.

Follow-up

Following the healing period, second-stage surgical procedure was performed with the placement of a healing abutment on the implant. Implant mobility assessment and resonance frequency measurements were performed when the implant was uncovered after 6 months. The study protocol required the removal of any implant determined to be mobile or symptomatic. These implants were scored as failures.

Prosthetic rehabilitation started 2 weeks after second-stage surgical procedure. The crowns were cemented with temporary cement. Follow-up evaluation was conducted at 1 year and radiographs were taken to determine changes in bone level. In addition, assessment of gingival aesthetics was performed.

Data collection

The following variables were recorded: culture results at extraction, ISQ at 6 months, implant success or failure at 6 months after implant placement, and

marginal radiographic bone level, mid-buccal gingival level, and papilla level at 1 year.

Implant success criteria. Implant success criteria included: no clinically detectable implant mobility at second-stage surgical procedure or follow-up evaluations, no radiographic evidence of peri-implant radiolucency, no sign or symptoms of infection, and no bone loss in excess of the bone loss criteria reported by Albrektsson et al.[7]

ISQ measurements. The ISQ was measured by the Ostell apparatus with a commercially available transducer adapted to the Frialit implants. The transducer was maintained perpendicular to the implant and was hand-screwed into the implant body as recommended by the manufacturer.[8] Subsequently, ISQ values were registered in the database.

Assessment of gingival aesthetics. For assessment of the interproximal gingival papillae, the classification described by Jemt[9] was used. These ranged from 0-4, representing (in order) 0 = no papillae, 1 = less than one half of the gingival embrasure, 2 = at least one half of the height, 3 = complete closure of the proximal space, and 4 = overgrowth. The mid-buccal gingival level was assessed by measuring the difference with the buccal gingival outline of the adjacent teeth. The classification ranged from 0-4, representing 0 = no difference in gingival level, 1 = less than 1 mm difference, 2 = less than 2 mm difference, 3 = less than 3 mm difference, and 4 = differences in buccal gingival outline greater than 3 mm.

Radiographic analysis. The radiographic examinations, consisting of intraoral radiographs taken with a standardized long-cone paralleling technique with a commercial Rinn XCP holder (XCP post bite blocks 54-0862, Dentsply, Elgin, IL) were performed after implant placement and at consecutive controls at 4 weeks, 24 weeks, and 1 year after surgical procedure. Radiographs obtained 12 months after implant placement were used to assess the distance from a fixed reference point of the implant (the neck of the implant) to the marginal bone crest at the mesial and distal surfaces of each implant. The radiographs were scanned and analyzed by using the Meazure 2.0 program (C Thing Software, Sunnyvale, CA). This program was used to calibrate each image so that measurements could be made. A known measurement of each implant was used as a standard for calibration. Comparative measurements of the mesial and distal bone crest levels adjacent to the implants were made to the nearest 0.1 mm.

Microbiologic analysis. Serial 10-fold dilutions of the samples were prepared, and 100 μL of dilution was inoculated on blood agar plates supplemented with 5% horse blood (Oxoid no.2, Oxoid Limited, Basingstoke, UK), 5 mg/L haemin, and 1 mg/L menadione.[10] Anaerobic plates were retained in the anaerobic chamber for incubation at 37°C and held for 7 days. After incubation, the total colony forming units (CFU) and the different colony morphotypes were counted with the use of a stereomicroscope at 16× magnification (Zeiss, Oberkochen, Germany). All colony morphotypes were streaked to purity, incubated in air and 5% CO2 (BBL Gaspak CO2 systems, Becton Dickinson and Company, Cockeysville, MD) anaerobically to determine strict anaerobic and facultative anaerobic growth. Bacterial colony-types were enumerated, isolated, and identified. Identification of pure cultures was done according to established procedures as described previously.[10,11] The blood agar plates with the total samples were kept incubated under anaerobic conditions for up to 14 days to allow slow-growing species to develop. Newly emerging colonies were also streaked to purity and identified.

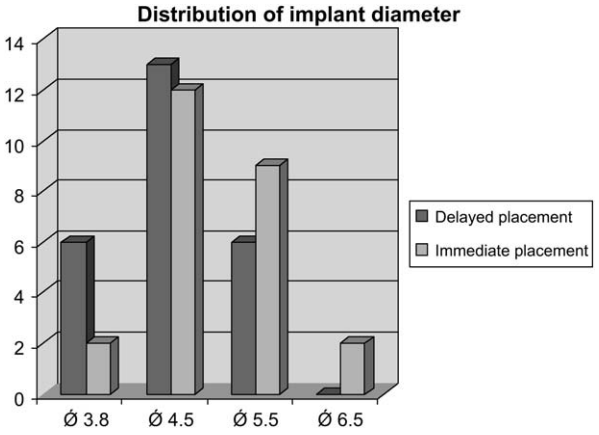

Fig. 1. The distribution of implant diameters in IP and DP group.

Statistical analysis. We assumed that both treatment modalities were equivalent. To demonstrate bioequivalence, 25 implants in each group would be needed to reject the null hypothesis (with a power of 80% and a type I error rate of 0.05) that the treatments were not equivalent. Non-equivalence was defined as a difference in mean ISQ between trial arms of 10 or more assuming a common standard deviation of 15. Differences between immediately and delayed placed Frialit implants on continuous endpoints was statistically tested using independent samples *t*-test or, in case of non-normally distributed variables, the Mann-Whitney test. Descriptive statistics were used for categorical variables. All analyses were performed with SPSS (SPSS version 12.0, SPSS Inc, Chicago, Ill) and $P < .05$ was used as the statistical significance level.

RESULTS

Fifty implants were placed in 50 patients. Mean age in female patients was 39.2 ± 16.1 years versus 40.2 ±

Table I. Assessment of mid-buccal aesthetic score

Mid-buccal aesthetic score	*Gingival mid-buccal aesthetics*	*Immediate implant placement*	*Delayed implant placement*	*Total*
0	No difference in marginal buccal	14	21	35
1	Difference between 0-1 mm	7	4	11
2	Difference between 1-2 mm	2	0	2
3	Difference between 2-3 mm	0	0	0
4	Difference >3 mm	0	0	0

Table II. Assessment of interdental papilla according to Jemt[9]

Score		*Immediate implant placement*	*Delayed implant placement*	*Total*
2	At least one half of the height	5	7	12
3	Complete closure of the proximal space	18	18	36
Total		23	25	48

12.9 years for males ($P = 0.8$). The mean age in the immediate-placed implant group (IP) was 39.9 ± 16.2 years compared with 39.5 ± 12.9 for the delay-placed implants group (DP; $P = 0.92$). Figure 1 shows the length and the diameter of the implants in the 2 groups. In the IP group, larger diameter implants (5.5 and 6.5) were placed, compared with those placed in the DP group.

Thirty-two (64%) implants were placed in the anterior maxilla and 18 (36%) implants in the premolar region. Seventeen (34%) implants were placed in the anterior maxilla in the IP group versus 15 (30%) implants in the DP group. In all cases, buccal bone augmentation was necessary and 34 chin and 16 mandibular ramus bone grafts were harvested.

Cumulative implant success rates after 6 months in the IP group and DP group were 92% and 100%, respectively. Two implants in the immediate placement group showed mobility at second-stage surgical procedure and were removed. At the 1-year follow-up, all survived implants were still functional.

Mean mesial bone resorption at 1 year after implant placement was 0.49 ± 0.11 mm in the IP group versus 0.52 ± 0.16 mm in the DP group ($P = 0.54$), while mean distal bone resorption was 0.53 ± 0.12 mm in the IP group versus 0.52 ± 0.14 mm in the DP group ($P = 0.79$).

Table I shows the result of the gingival mid-buccal aesthetics and Table II the papilla regeneration for the both groups. Sixty-one percent of the IP group had an ideal gingival marginal level versus 84% of the DP group. In both groups, 72% full regeneration of the papilla was observed.

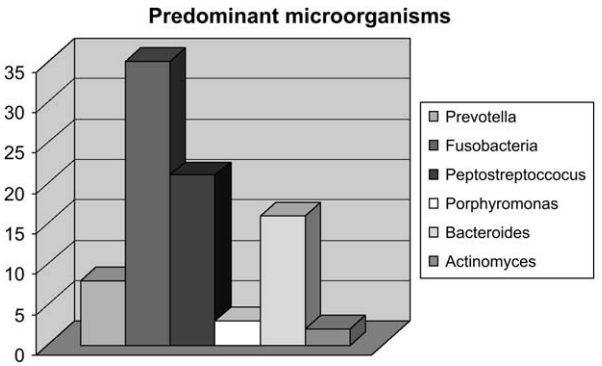

Fig. 2. No differences were found between the IL and DL group, and in the majority of cases, a polymicrobial flora was cultured consisting predominantly of *Fusobacterium nucleatum* and *Peptostreptococcus micros* species.

Mean ISQ at 6 months was 64.5 ± 3.9 for the IP group versus 64.5 ± 4.4 for the DP group ($P = 0.97$).

In the periapical specimens obtained for culture, no growth was seen in 9 of the 50 extracted teeth. In 21 cases of IP and 20 cases of DP, microorganisms were cultured. The most prevalent bacteria were *Fusobacterium nucleatum* (70%) and *Peptostreptococcus micros* (42%; Fig. 2). In the majority of the cases (62%) the specimens yielded a polymicrobial flora, while in 20% of the cases only 1 microorganism was isolated. A polymicrobial flora was found in 16 cases of the DP group versus 15 cases of the IP group. In one of the failures in the IL group, a polymicrobial flora was cultured consisting mainly of *Fusobacterium nucleatum* and *Peptostreptococcus micros*, whereas in the other failure, no microorganisms were cultured. The remainder of the immediate implant-placed group yielded 20 bacterial infected sites, whereas in 3 cases no bacteria were cultured.

DISCUSSION

Immediate placement of endosseous implants into extraction sockets to reduce the process of alveolar bone resorption and treatment time has been propagated by several authors.[1,12] However, few clinical data are available on the immediate placement in chronic periapical

infected sites. To our knowledge, the present study was the first controlled comparison between immediate and delayed placement of implants for replacement of teeth with periapical lesions. Some authors consider placement of implants in chronic apical lesions a contraindication,[13,14] but the results from a case study[4] supported the feasibility of the immediate placement of implants in infected sites. In a dog study on immediate-placed implants in infected sites, the percentage of osseointegration for experimental implants was not significantly different from the control implants.[5] In our study, no differences were found between a delayed and immediate approach of placing implants in sockets with chronic periapical infected lesions at the 1 year follow-up. Only maxillary anterior and premolar locations were included in the study, and the conventional healing time of 6 months for the maxilla was followed. At implant placement, a torque of 25 Ncm was necessary to fulfill the inclusion criterion of initial stability. Norton[15] demonstrated that an implant inserted with a torque of 25 Ncm or higher had a stability quotient (ISQ) value of at least 60.

The cumulative implant survival rate for immediate-placed implants was 92% versus 100% in the delay-placed implants at 1 year follow-up. Two implant failures occurred in the immediate implant placement group. These implants were not osseointegrated and showed mobility at second-stage surgical procedure. No obvious risk factors could be identified for failure of the 2 implants because all implants were placed with a minimal torque of 25 Ncm, and all sockets required bone grafts to cover the buccal bone fenestrations. After removal of the implants, the areas were allowed to heal before other additional prosthetic rehabilitation was performed. All other implants showed clinical stability, reflecting functional ankylosis without detectable mobility, and mean ISQ at 6 months was not significantly different for the immediate-placed and delay-placed implants ($P = 0.97$). The use of resonance frequency analysis (RFA) provides the possibility of clinically measuring implant stability and osseointegration.[16] It provides information on implant stability on a 1-100 scale, the higher the value the stiffer the implant. Stability quotient values of 50 and 60 are seen in osseointegrated implants in maxillary bone, and 60 to 80 in mandibular bone.[17] The mean value of 65 found in our study was in accordance with previous studies on the application of RFA for determining implant osseointegration.[8,16]

The radiographic evaluation of bone levels during the first year of evaluation showed no differences between the IP and DP implant groups. The mean bone resorption of 0.5 compared favorably with other reports on radiographic changes in Frialit-2 Synchro implants.[18] This difference can be explained by the method used to assess bone loss because bone resorption in our study was comparable with the results of the study of Norton,[15] who used the same technique to assess changes in crestal bone level.

Gingival recession was more prominent in the immediate-placed implant group and clinically significant. The sample size in the present study, however, is not large enough to perform meaningful statistical testing for gingival aesthetics in this study. Differences in marginal gingival level in the anterior aesthetic zone in the immediate-placed implant group compared negatively with neighboring teeth, which led to nonoptimal aesthetics. The most predictable aesthetic results can be accomplished only when underlying labial and interproximal osseous support is provided.[19] The better clinical marginal buccal gingival level in the delay-placed implant group might be explained by the gain in attached gingiva mucosa after complete mucosal wound healing. No differences in interdental papilla aesthetics between the immediate and delayed placement of implants were found in this study. Extraction, socket degranulation, and immediate implant placement may be beneficial in maintaining the integrity of the extraction sockets and contribute to the maintenance of the interdental papillae around implant restorations.[20]

Primary endodontic infections are mixed infections dominated by anaerobic bacteria, of which a restricted set is more frequently present in the infected root canal. Culture studies have revealed that species belonging to genera *Fusobacterium, Prevotella, Porphyromonas, Actinomyces, Streptococcus,* and *Peptostreptococcus* are commonly associated with primary endodontic infections.[21] The most dominant species in our study were *Fusobacterium nucleatum*, *Peptostreptococcus micros* and *Prevotella intermedia*. These species are commonly found in root canal infections.[10,21] Extraction of the involved tooth led to eradication of the cultured microorganisms, but no significant difference was found between the 2 groups with regard to periapical flora at the start of treatment. In the immediate placement group, implants were placed after removal of the tooth and thorough debridement of the socket. As stated by Novaes et al,[5] the placement of immediate implants in chronically infected sites may not be necessarily contraindicated if appropriate clinical procedures like antibiotic administration, meticulous cleaning, and alveolar debridement are performed before implant surgical procedure. In immediate implant placement, an incongruity between the implant diameter and the morphology of the alveolus exists that is worsened by the presence of a bone defect due to the periapical infection. Many of the implants used in this study were 4.5 or 5.5 in diameter, and in the IP group, larger diameter implants

were used more frequently than in the DP group. Studies have shown that wide-diameter implants are associated with increased removal torque and that the load on cortical bone decreases with increasing implant diameter.[22,23]

Osseointegration of implants in this study was predictably achieved in endosseous implants placed immediately in extraction sites where chronic periapical infection existed; therefore, implants can, in general, be placed in this clinical setting, especially if aesthetic requirements are not a high priority.

CONCLUSION

Within the limits of the present study, immediate placement of single tooth implants for replacement of teeth with periapical lesions was a predictable treatment. Implant success, mean ISQ, and radiographic bone level at 1-year follow-up were not related to the periapical microbial flora. However, a delayed implant protocol might be considered in the aesthetic zone due to the recession at the level of the mid-buccal gingiva.

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