Effects of Immediate Loading with Threaded Hydroxyapatite-Coated Root-Form Implants on Single Premolar Replacements: A Preliminary Report

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Purpose: *This prospective study evaluated the immediate loading of single, threaded, root-form implants placed in the maxillary premolar area.* ***Materials and Methods:*** *Ten human subjects were included in this preliminary report. In all cases, a screw-retained temporary acrylic resin crown was placed immediately after implant surgery. The definitive screw-retained metal-ceramic crown was placed 6 months later.* ***Results:*** *Standardized radiographs demonstrated 0.58, 0.73, 0.84, and 0.90 mm mean marginal bone loss at 1, 3, 6, and 12 months after implant surgery, respectively. Implant mobility was evaluated with the Periotest device. At the day of surgery, mean mobility was −3.3, while minor changes were observed thereafter: mean values of −3.77, −3.47, and −3.63 were recorded at 3, 6, and 12 months after implant surgery, respectively. Sulcus depth appeared relatively stable after the 3rd month when the implant platform was used as a reference. Recession of 0.43 mm was recorded between the 3rd and 12th month; when the depth of the peri-implant sulcus was measured from the implant platform, 0.1 mm of change was seen between the 3rd and 12th month. Probing depth measurements revealed that 3 months after implant placement, average probing depth was 3.60 mm, while at 12 months it was 3.20 mm.* ***Discussion:*** *The peri-implant soft tissue parameters (bleeding on probing, probing depth, peri-implant soft tissue level), mobility, and marginal bone level appeared to be similar to findings of previous studies regarding the conventional 2-stage loading protocol.* ***Conclusion:*** *Results of the current study provided evidence that, under the condition of this investigation, single root-form implants can be immediately loaded when placed in the maxillary premolar area.* (INT J ORAL MAXILLOFAC IMPLANTS 2002;17:567–572)

Key words: *dental implants, immediate loading, osseointegration, temporary denture*

Dental implants have become a predictable treatment option for the completely[1,2] or partially[3,4] edentulous patient. A 3- to 6-month healing period is usually recommended for machined-surface root-form implants to achieve osseointegration before loading the implants with a prosthesis.[5]

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Immediate loading of endosseous root-form implants to eliminate the 3- to 6-month healing period is a technique that has been described in the literature in combination with mandibular bar-retained overdentures,[6–10] complete-arch implant-supported maxillary and mandibular prostheses,[11–18] and in partial edentulism.[19–21] Various techniques have been described for immediate loading of single root-form implants.[21,22] The purpose of the current study was to evaluate the potential of immediate loading of single root-form implants supporting maxillary premolar restorations.

MATERIALS AND METHODS

Ten consecutively treated human subjects were included in this preliminary report of patients in an ongoing prospective study. Subjects were recruited to the study based on their need for the restoration of a single missing maxillary first or second premolar. All

Fig 1 A limited flap design is applied during implant placement.

subjects were treated at the Center of Prosthodontics and Implant Dentistry at Loma Linda University School of Dentistry and signed the appropriate informed consent form approved by the Institutional Review Board.

Inclusion criteria included existing single partially edentulous space in the maxillary premolar region. Natural teeth needed to be present mesially and distally to the edentulous space. Opposing occlusion (natural teeth or removable prosthesis) was necessary. The patients were required to have a habit of tooth brushing at least 2 times per day and daily use of dental floss. The patients had to be of legal age and able to read and sign the corresponding informed consent.

Habitual cigarette smokers were excluded.[23] Treatment was precluded if general health compromising prognosis would prohibit implant surgery (eg, stroke, recent infarction, severe bleeding disorders, diabetes, osteoporosis, cancer). Patients with a history of bruxism were also excluded, as were surgical sites consisting of Type IV bone[24] as assessed during surgery.

Periapical and panoramic radiographs were obtained preoperatively for all patients. Hydroxyapatite (HA) -coated, threaded, root-form implants (Replace, Nobel Biocare, Yorba Linda, CA) were placed in all patients with the use of a surgical template. A full-thickness limited flap design was utilized for implant placement (Fig 1).[25] In all patients, a provisional screw-retained, implant-supported prosthesis was placed immediately after stage I surgery according to a technique that has been previously described.[21]

Standardized periapical radiographs were obtained after implant placement by using a bite block. Implant mobility was evaluated with the Periotest device (Siemens, Munich, Germany).[26,27] Implant mobility was recorded immediately after surgery with a 5-mm healing abutment in place. Patients were asked to consume a soft diet for 1 month after surgery and to return in 2 weeks for suture removal.

At 1, 3, and 6 months after implant placement, standardized radiographs were taken with the provisional crown in place. At 3 and 6 months after implant surgery, the provisional crown was removed and the following parameters were recorded: probing depth, Bleeding Index,[28] distance from the implant platform to the depth of the sulcus (PDS), and distance from the implant platform to the gingival crest (PGC). All data collection and measurements were performed by 2 investigators. A calibration process was performed before collecting the data. Four measurements were recorded with a periodontal probe for each implant: mid-buccal, mid-mesial, mid-palatal, and mid-distal. The 4 measurements were averaged and the average number corresponded to each parameter. A 5-mm healing abutment was then placed and hand-tightened. With the healing abutment in place, mobility of the implant was recorded with the Periotest instrument.[26,27]

The final impression for the definitive screw-retained, metal-ceramic restoration was made 6 months after implant surgery (Fig 2). Soft tissue architecture that was obtained through the provisional crown (Fig 3) was duplicated in the laboratory. The definitive screw-retained, metal-ceramic crown was placed 2 weeks later and torqued at 32 N/cm (Fig 4).

Standardized radiographs were obtained, and mobility, probing depth, PDS, and PGC were recorded 12 months after implant surgery (6 months after placing the definitive prosthesis). The definitive prosthesis was removed, and all data were collected similarly to the 3- and 6-month re-evaluation periods. The results were evaluated according to implant success criteria as defined by Smith and Zarb in 1989.[29] The current report included only the 10 patients who completed the 12-month recall protocol. A total of 12 patients were included in the study; however, 2 patients had implants placed 6 months prior to reporting these data.

RESULTS

In all patients evaluated in this study, the implants healed uneventfully with no complications. Periodic radiographic examination revealed 0.58 ± 0.20 mm of marginal bone loss at 1 month postoperatively, as compared to the radiograph taken immediately after

Fig 2 The provisional screw-retained acrylic resin crown had been in place for 6 months. An impression was made by using an open-tray technique through the temporary crown.

Fig 3 The soft tissue architecture has been created with the use of the temporary crown.

surgery (Table 1). The average corresponding marginal bone loss at 3, 6, and 12 months after surgery was 0.73 ± 0.23 mm, 0.84 ± 0.30 mm, and 0.90 ± 0.32 mm, respectively. Examination with the Periotest unit revealed –3.30 ± 1.7 average mobility at the day of surgery, while mobility was recorded as –3.77 ± 1.24, –3.47 ± 1.04, and –3.63 ± 1.19 at 3, 6, and 12 months postoperatively, respectively (Table 2). The average PGC distance was 2.80 ± 0.93 mm at 3 months postoperatively, 2.37 ± 0.73 mm at 6 months postoperatively, and 2.37 ± 0.46 mm at 12 months postoperatively (Table 2). Average PDS measurements revealed a distance of 0.82 ± 0.44 mm 3 months postoperatively, while the corresponding numbers for the 6- and 12-month postoperative measurements were 0.90 ± 0.46 mm and 0.92 ± 0.37 mm, respectively (Table 2). Average peri-implant probing depths were 3.60 ± 1.02 mm, 3.27 ± 0.57 mm, and 3.20 ± 0.45 mm at 3, 6, and 12 months, respectively. Mean Bleeding Index scores were 0.40 ± 0.36, 0.35 ± 0.32, and 0.45 ± 0.42 at 3, 6, and 12 months postoperatively, respectively.

Fig 4 The definitive metal-ceramic, screw-retained crown in place.

DISCUSSION

The results of this short-term clinical study demonstrated that threaded, HA-coated, root-form implants placed in the maxillary premolar area can be immediately loaded. The success rate for the implants evaluated in this study was 100% at 1 year post-loading. The peri-implant soft tissue parameters (bleeding on probing, probing depth, peri-implant soft tissue level), mobility, and marginal bone level appeared to be similar to findings of previous studies regarding the conventional 2-stage loading protocol.[30–34]

Immediate loading of dental implants has been generally described for the completely edentulous mandible by application of either a bar-retained overdenture[6–10] or a complete-arch implant-supported fixed prosthesis.[11–16] It has been suggested that splinting of dental implants is required when immediate loading is planned.[12] In addition, it has been shown that early micromotion of implants can lead to differentiation of cells into fibroblasts.[35–38] It may be hypothesized that cross-arch stabilization in the reported completely edentulous cases could have provided the necessary stability.

In the current study, interproximal contacts may have provided this kind of stability. Szmukler-Moncler and associates[39] stated that there is a range of micromovement within which implants can still achieve osseointegration. Beyond a certain level of micromovement ("deleterious micromovement"),[16,39] fibrous tissue will surround the implant and osseointegration will not occur. This level of "critical micromovement" needs to be assessed and further investigated. It has been demonstrated that controlled

Table 1 Radiographic Bone Loss (in mm) from Baseline (Day of Surgery)

Subject	1 month	3 months	6 months	12 months
1	0.52	0.75	0.80	0.85
2	0.45	0.65	0.85	0.92
3	0.62	0.65	0.70	0.70
4	N/A	0.85	1.10	1.20
5	0.72	0.94	1.05	1.25
6	0.30	0.35	0.40	0.45
7	0.75	0.90	0.95	1.00
8	0.55	0.65	0.77	0.80
9	0.35	0.42	0.45	0.45
10	0.95	1.12	1.35	1.40
Average	0.58	0.73	0.84	0.90
Range	0.30–0.95	0.35–1.12	0.40–1.35	0.45–1.40
SD	0.20	0.23	0.30	0.32

Table 2 Average Peri-implant Measurements

Parameter	Day 0	1 month	3 months	6 months	12 months
Radiographic bone loss (mm)	N/A	0.58	0.73	0.84	0.90
Mobility (Periotest value)	–3.30	–3.77	–3.47	–3.47	–3.63
Distance from the platform to the gingival crest (mm)	N/A	N/A	2.80	2.37	2.37
Distance from the implant platform to the depth of the sulcus (mm)	N/A	N/A	0.82	0.90	0.92
Probing depth (mm)	N/A	N/A	3.60	3.27	3.20
Bleeding index	N/A	N/A	0.40	0.35	0.45

micromotion can even stimulate bone growth.[40,41] This has also been supported by histologic evidence in humans from retrieved implants that had been immediately loaded and in which sustained osseointegration was observed after long-term function.[42] Further research is needed to assess the potential of dental implants to achieve and maintain osseointegration when they are immediately loaded.

In the current study, threaded, HA-coated implants were used. Human[43] and animal studies[44–46] have demonstrated that rough-surfaced, HA-coated implants can become osseointegrated faster than conventional machined-surface titanium implants. In addition, histologic evaluation in humans has shown stability and biocompatibility of an HA coating under long-term function.[47–49] Nevertheless, conventional titanium implants have also been used successfully for immediate loading.[11] Further research is needed to assess the necessity of using rough-surfaced implants for immediate loading.

Placement of a provisional restoration at the time of implant surgery offers esthetic, psychologic, and functional advantages as compared to the use of a temporary removable prosthesis. It also eliminates second-stage surgery, thereby reducing patient discomfort and additional procedural cost. In addition, the length of the treatment can be reduced, since soft and hard tissues heal concurrently. It has been reported that ideal soft tissue contours can be achieved if a provisional restoration is placed during[50,51] or after[52,53] second-stage surgery. Provisional restorations in partially edentulous patients help confirm esthetics, soft tissue contours, and accessibility for oral hygiene, and they duplicate the results sought in the definitive restoration. A provisional restoration can develop a solid level of communication between patient, dentist, and technician. The soft tissue around the implants can heal according to the contours of a provisional restoration. However, if the provisional restoration is placed after the implant becomes osseointegrated, an additional 3- to 6-month healing period is needed for soft tissue healing.[50–53] The protocol followed in this study eliminates the period necessary for soft tissue healing and contouring. Permanent restoration and soft tissue contouring of the maxillary premolars were feasible 6 months after implant placement.

It should be mentioned that in the current study, temporary screw-retained crowns were removed and replaced by healing abutments during measurements to enhance consistency of data collection. Definitive restorations were also removed at 12 months for the same reason.

SUMMARY

The current study demonstrated that threaded HA-coated implants placed in the maxillary premolar area may be immediately loaded by placing a screw-retained acrylic resin crown at the time of implant surgery. Nevertheless, results of the current study need to be cautiously evaluated before immediate loading of single implants can be applied on a routine basis. Long-term clinical evaluation and a larger sample are needed before definitive conclusions can be made.

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