Comparison of flap and flapless procedures for the stability of chemically modified SLA titanium implants: an experimental study in a canine model

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Background. Flapless implant surgery has been shown to accelerate recovery and increase the vascularity of the peri-implant mucosa after implant placement.

Objective. The aim of this study was to compare dental implant stabilization patterns between flap and flapless implant surgeries over the first 8 weeks after implant placement.

Study design. In 6 mongrel dogs, bilateral, edentulated, and flat alveolar ridges were created in the mandible. After 3 months of healing, 2 implants (Straumann SLA-active) were placed in each side of the mandible using either a flap or flapless procedure. The implant stability quotient (ISQ) that was obtained from Osstell Mentor was measured at the time of implantation and weekly over the first 8 weeks after implant placement.

Results. Implants stabilized more quickly without flap elevation than with flap elevation. For flapless implants, an increase in stability occurred after 2 weeks without a period of decreasing stability. However, for flap implants, a shift in implant stability from decreasing stability to increasing stability occurred after 2 weeks.

Conclusion. In the canine model, flapless surgical placement of implants may increase the initial stability of implants compared with implants placed after the reflection of the mucoperiosteal flap. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:170-173)

Clinicians have reported success rates for dental implants as high as 90%.1-3 However, this rate is markedly reduced when implants are placed in poor-quality bone. In these cases, there is considerable interest in enhancing the quality and the rate of bone formation around the implants. Improved peri-implant bone formation would influence implant stability. Primary implant stability is a phenomenon that is influenced by bone quality, bone quantity, and implant geometry.4 Secondary implant stability would be achieved by the formation of new bone, followed by bone remodeling. This formation of new bone can be actively influenced by cell-tissue interactions that initiate an active process of bone formation.

Flapless surgery as a method for dental implant placement is gaining popularity among implant surgeons. The increased use of this method can be attributed to improvements in radiologic technologies and dental implant treatment planning software, as clinicians can now acquire 3-dimensional images of potential implant sites before surgery.5-8 Earlier studies have shown that flapless implant surgery accelerates recovery9 and increases the vascularity of the peri-implant mucosa after implant placement.10 It is conceivable that implants would stabilize more quickly without flap elevation than with flap elevation. This hypothesis was tested in this study by comparing implant stabilization patterns between flap and flapless implant surgeries in a canine mandible model over the first 8 weeks after implant placement.

MATERIALS AND METHODS

Animal model
Six adult female mongrel dogs, each weighing ≥15 kg (range 15-20 kg), were used in this experiment. The protocol was approved by the Animal Care and Use Committee of the Yonsei Medical Center in Seoul, Korea.
Edentulated flat ridge induction

All surgical procedures were performed under systemic (5 mg/kg ketamine and 2 mg/kg xylazine IM) and local (2% lidocaine with 1:80,000 epinephrine) anesthesia. All of the mandibular premolars were removed to establish a space for the implants. After 1 month of healing, bilateral flat alveolar ridges were surgically created. Briefly, a mucoperiosteal flap was raised to expose the alveolar bone. Burs were then used to flatten the alveolar crest under sterile saline irrigation so that an appropriate bone width could be created for the placement of the implant. The mucoperiosteal flap was replaced and sutured, and the resulting edentulated flat alveolar ridge was allowed to heal for 3 months.

Implantation procedure

Two implants (Straumann SLAactive, length 10 mm, diameter 3.3 mm; Straumann AG, Basel, Switzerland) were placed within the edentulated ridge in each side of the mandible (Fig. 1). The implants in each side were randomly assigned to one of the following 2 surgical techniques: 1) implantation after piercing the gingiva at the center of the implant site with a 2.5-mm tissue punch (flapless group); or 2) implantation after elevating the mucoperiosteal flap to expose the alveolar ridge (flap group). Healing abutments were connected to the implants. The mucosal tissues in the flap group were secured to the abutments with interrupted sutures. All 6 dogs were placed on a special soft diet to reduce trauma to the surgical sites. A daily meticulous plaque control procedure was initiated immediately after the placement of the implant in the flapless group. In the flap group, local irrigation with a 0.12% chlorhexidine solution was performed for 2 weeks immediately after the placement of the implant. The flap group also had a meticulous daily plaque control procedure implemented after removal of the sutures. Implant stability quotient (ISQ) obtained from Osstell Mentor (Integration Diagnostics, Goteborg, Sweden) was measured at the time of implantation and weekly over the first 8 weeks after implant placement. The mean of the 3 measurements per implant was used as the final ISQ value. To decrease the subject-specific variability and to adjust for subject-specific situations, the ISQ was transformed to normalize the differences relative to the baseline readings. These values were reported as “ISQ difference from baseline.”

Statistical analysis

The nonparametric Mann-Whitney test was used to identify significant differences between the two groups. Values of $P < .05$ were considered to be statistically significant.

RESULTS

Healing after implant placement was uneventful in all animals. Because no implants failed to integrate, none were removed. The stabilities (ISQ) at the time of placement were $63.1 \pm 5.8$ in the flap implant group and $61.4 \pm 4.3$ in the flapless implant group. No significant differences were noted between the 2 groups regarding stability at the time of placement. The mean stability for flap implants showed a similar stability level as that of baseline for the first 2 weeks, then increased at 3, 4, and 5 weeks’ follow-up. The flapless implants reached their highest values at final follow-up at 8 weeks (Table 1). Evaluation of the stabilization patterns over time for flap implants showed a significant change in the pattern

| Table 1. Parameters (mean ± SD) of implant stability quotient differences from baseline when implants were placed either with or without a flap |
|--------------|--------------|----------|
| Flap group   | Flapless group | $P$ value |
| Baseline     | 0            | 0        | —        |
| 1 wk         | $-0.8 \pm 0.8$ | $0.8 \pm 2.0$ | >.05     |
| 2 wk         | $-3.2 \pm 2.4$ | $1.0 \pm 2.2$ | <.05     |
| 3 wk         | $-2.6 \pm 3.3$ | $4.6 \pm 1.7$ | <.05     |
| 4 wk         | $-0.6 \pm 4.3$ | $6.6 \pm 3.1$ | <.05     |
| 5 wk         | $1.0 \pm 4.7$  | $7.4 \pm 2.3$ | <.05     |
| 6 wk         | $1.4 \pm 4.0$  | $7.8 \pm 2.3$ | <.05     |
| 7 wk         | $2.6 \pm 3.7$  | $7.8 \pm 1.8$ | <.05     |
| 8 wk         | $3.4 \pm 3.6$  | $7.9 \pm 1.7$ | <.05     |

Fig. 1. Clinical features after implant placement with and without a flap.
of stability at the 2-week time period. Initial decreasing stability switched to increasing stability at 2 weeks (Fig. 2). This finding is in contrast to that of the flapless implants, in which the increase in stability occurred at the 2-week time period without a period of decreasing stability.

DISCUSSION

Implant stability is a primary consideration for successful osseointegration and is of paramount importance for clinical success. The purpose of the present study was to test the hypothesis that a flapless procedure can improve implant stability compared with a flap procedure. The results of this study showed different stabilization patterns between flap and flapless implant surgeries over the first 8 weeks after implant placement, although the initial stability levels after implantation were similar. For flap implants, there was an initial decrease until week 2, after which time the stability began to increase. Oates et al. reported a similar decrease in implant stability after flap implant surgery. The changes observed in implant stabilization over time are thought to reflect biologic events associated with growth at the bone-implant interface. Increasing stability is associated with bone formation, whereas decreasing stability is associated with bone resorption. The change from decreasing implant stability to increasing implant stability is suggestive of a change in overall bone metabolism associated with the implant surface from predominantly resorptive to predominantly formative in nature. These findings suggest that the bone metabolism associated with the implant surface is predominantly resorptive during the early period after flap implant surgery. A possible reason for this activity may be the fact that the cortical bone blood supply is affected dramatically when the periosteum is reflected off of the crestal bone, resulting in osteoblast death on the surface from both trauma and lack of nutrition.13

An interesting finding in the present study was that implant stability increased without an initial decrease after flapless implant surgery. These findings suggested that there was no resorptive bone metabolism during the early period after flapless implant surgery and that the implant stability increased after 2 weeks. This might have been due to the processes of bone formation during the healing process. A possible reason for this may be better vessel preservation at the implant site after flapless implant surgery, as compared to that in flap implant surgery.10

Schwarz et al. reported that chemical modification to a sandblasted, large-grit, acid-etched (SLA) implant surface increased the number of blood vessels, cellular activity, and bone apposition around implants earlier than standard SLA surface. Oates et al. reported that a shift in implant stability from decreasing stability to increasing stability occurred after 2 weeks for the SLAActive implants and after 4 weeks for the standard SLA surface implants. It was hypothesized in the present study that the combined use of the flapless procedure and SLAActive implants would increase implant stability much earlier than the values reported by Oates et al., who used SLAActive implants in a flap procedure. The results of the present study showed that the combined use of the flapless procedure and SLAActive implants managed to boost implant stability, demonstrating that the stability of the implants began to increase after the 2-week time-point without a period of decreasing stability.

One may argue that the implants placed with the aid of flaps reach the same stability level as the flapless implants after a certain period of time. From a clinical perspective, there is an increasing need for immediate loading in implant therapy, because it increases patient satisfaction and avoids the difficulty of wearing a conventional denture during the healing process. Brånemark et al. stated that the remodeling period after implant placement would continue for at least 18 months. A faster increase in implant stability owing to the flapless procedure is desirable for shorter rehabilitation times, which would indicate earlier osseointegration.

In recent years, flapless implant surgery has been reported to have a predictable outcome with a high success rate, as long as patients were properly selected for the procedure and have an appropriate width of bone available for implant placement. Although flapless implant surgery has numerous advantages, the approach also has some drawbacks. Some of these include the inability of the surgeon to visualize ana-
tomic landmarks and vital structures, the potential for thermal damage secondary to reduced access for external irrigation during osteotomy preparation, the increased risk of a malposed angle or depth of implant placement, a decreased ability to contour osseous topography when needed to facilitate restorative procedures, and the inability to save the keratinized mucosa owing to the removal of keratinized mucosa from tissue punches.\textsuperscript{9,13}

To our knowledge, this is the first report to provide controlled experimental data on the influence of flapless implant surgery on implant stability. Our findings suggest that, in the canine model, flapless surgical placement of implants may increase the initial stability of implants compared with implants placed after the reflection of the mucoperiosteal flap.

REFERENCES

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