A PILOT STUDY OF THE OSSEOINTEGRATION POTENTIAL OF A SURFACE-TREATED MINI-IMPLANT: BONE CONTACT OF IMPLANTS RETRIEVED FROM PATIENTS

Aims: To evaluate the osseointegration potential of surface-treated mini-implants retrieved from patients by examining bone-to-implant contact (BIC). Material and Methods: Five implants from four patients were inspected. The average patient age was 38.1 years, and the average treatment duration 11.4 months. The mini-implants were removed with a trephine bur under saline irrigation. After histologic preparation, the BIC was measured. Results: Under 300× magnification, an active adherence of bone cells to the treated surface was seen. The mean BIC was 52.6%. Conclusion: This pilot study confirms the osseointegration potential of a surface-treated mini-implant. World J Orthod 2009;10:202–210.

Key words: BIC, C-implant, mini-implant, osseointegration, SLA

A bsolute skeletal anchorage requires placement of mini-implants, mini-plates, or prosthetic implants.1,2 Mini-implants are widely used because they are relatively simple to insert and can almost immediately be loaded. Other advantages are the availability of numerous implant sites and their relatively low cost.

In orthodontics, mini-implants are mainly used to close spaces, correct open bites, and upright posterior teeth. If several mini-implants are placed around a tooth for its intrusion and the necessary force is applied with power chains or elastic threads, control of the tooth’s axial inclination is difficult. Depending on a mini-implant’s location, the intrusion may be accompanied by rotation and tipping.3,4

A partially osseointegrated implant can solve this problem because it can withstand even rotational forces and may be furnished with a lever arm to provide a force with an optimal vector.5–10

In contrast, a standard, smooth-surfaced mini-implant will become loose if rotational force is applied. The insertion of a lever arm is also advantageous because it allows the mini-implant to be placed in the attached gingiva at some distance from the tooth that needs to be moved. Osseointegration can be accomplished by large-grit sandblasting and acid-etching (SLA) the surface of a mini-implant.5,6

Because the implications of osseointegration are still unknown, five mini-implants used for anchorage were retrieved without any complications from four patients posttreatment. The interface of these mini-implants was inspected and histologically and histomorphometrically evaluated.

MATERIAL AND METHODS

The mini-implant used in this study was a two-part C-implant (Cimplant; 1.8 mm in diameter, 8.5 mm in length, and 1.0 mm in diameter in the neck area). Except for the top 2 mm, the entire surface was

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sandblasted with large-grit corundum and acid-etched to enhance the osseointegration (Fig 1). The sample consisted of four patients (one male, three females) with a total of five implants. Ages ranged from 23 to 51 years with a mean age of 30.75 ± 13 years; the mean treatment duration was 11.4 ± 2 months (Table 1).

Patient 1

A 23-year-old Asian woman’s bimaxillary protrusion was corrected by en masse retraction after extraction of all first premolars and the decayed mandibular left first molar (Fig 2). A C-implant was placed in front of the mandibular left second molar for protraction. The implant was removed after 12 months.

Table 1  Patient demographics and C-implant data

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (y)</th>
<th>Treatment duration</th>
<th>Unloaded period</th>
<th>No. of implants</th>
<th>BIC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>51</td>
<td>10 mo</td>
<td>8 wk</td>
<td>2</td>
<td>41.9</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>26</td>
<td>15 mo</td>
<td>4 wk</td>
<td>1</td>
<td>53.5</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>23</td>
<td>12 mo</td>
<td>4 wk</td>
<td>1</td>
<td>39.2</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>23</td>
<td>10 mo</td>
<td>0 wk</td>
<td>1</td>
<td>70.2</td>
</tr>
</tbody>
</table>

F = female, M = male, BIC= bone-to-implant contact.
Fig 2  Patient 1. A 23-year-old woman with crowding and protrusion (a and b) in whom all first premolars and the decayed mandibular left first molar were extracted and implant-supported protraction was initiated (c and d); situation after 12 months of protraction (e and f).
Patient 2

This 26-year-old Asian man had an open bite, which is why two C-implants were inserted in the area of the maxillary right first molar and in front of the left first molar (Fig 3). They were used for intrusion and en masse retraction. The C-implant on the right was removed after 15 months.

Patient 3

A 23-year-old Asian woman presented with protruded teeth; her maxillary right first, second, and third molars were missing (Fig 4). A C-implant was placed in the edentulous area and immediately loaded. Ten months later, the implant was removed, and the maxillary left first premolar was transplanted into the maxillary right edentulous area (Fig 5).

Patient 4

A 51-year-old Asian female presented with bimaxillary protrusion (Figs 6 and 7). Two C-implants were placed in the maxillary posterior edentulous area, and en masse retraction was carried out after an 8-week healing period due to the patient’s osteoporotic condition. Removal of the C-implants was performed after 10 months.
**Fig 4**  Patient 3. Sections of the panoramic radiograph of a 23-year-old woman with no molars in the maxillary right quadrant (a); situation after implant insertion (b); situation after en masse retraction, implant removal, and transplantation of the maxillary left first premolar (c and d).

**Fig 5**  Patient 3. Occlusal views before treatment (a), after implant supported retraction (b), after C-implant removal and transplantation of maxillary left first premolar (c), and finishing stage and temporary partial denture on the maxillary posterior dentition (d).
Fig 6  Patient 4. Lateral cephalograms of a 51-year-old woman with bimaxillary protrusion and missing posterior teeth (a), situation after 4 months of retraction (b), and after treatment (c). (Partly with permission from J Clin Orthod 2004;38:478–486.)

Fig 7  Patient 4. Intraoral photographs and panoramic radiographs before treatment (a and b), after 4 months of retraction (c and d), and after treatment (e and f). (Partly with permission from J Clin Orthod 2004;38:478–486.)
Clinical retrieval procedure

The treatment plan was presented to and accepted by all patients, who provided written informed consent. Before implant removal, a panoramic radiograph was taken to define the position of the microimplants relative to the adjacent roots. Then, the C-Implant head was removed with a sharp rotary force. After local anesthesia was administered, a flap was raised so it became obvious that all implants were clinically stable and had no sign of inflammation. The implant body was removed using a 3-mm internal diameter trephine bur (Komet) with saline irrigation (Fig 8). All specimens were rinsed in sterile saline and fixed in a 10% neutral buffered solution. The implant socket was filled with bovine bone mineral (Bio-Oss, Geistlich Pharma), and the wound was closed using 4-0 black silk. All surgical sites healed uneventfully.

Histological preparation and evaluation

The implants and surrounding bone were fixed in neutral buffered formalin; dehydrated in 70%, 90%, 95%, and 100% alcohol; and embedded in light-curing resin (Technovit 7200 VLC, Kulzer). Cutting and grinding were performed with an Exakt machine (Exakt Apparatebau). The approximately 10-μm sections were stained with toluidine blue. The histomorphometric analysis was performed with an Olympus BX microscope (Olympus) connected to a computer. The software used was Image Analysis (Bildanalysis). All measurements were calculated with a 10× magnification objective and 10× magnification ocular. During the morphometric analysis, the bone-to-implant contact (BIC) in all treated surfaces was measured and calculated as a percentage.

Fig 8  Intraoral situation before implant retrieval (a), after head removal (b), body retrieval with a 3-mm trephine bur with saline irrigation (c), removal of trephine block with forceps (d and e), retrieved bone block (f).
RESULTS

All five C-implants were loaded until removal. No patient complained of pain, the soft tissue around the implants appeared healthy, and no implant became loose. The bone surrounding all implants appeared to be firmly affixed. The histologic evaluation showed remodeling of the bone directly adjacent to the implant surface. The bone surrounding the implants had a uniform, matured structure.

The SLA-treated surface showed more bone apposition than the upper machined titanium surface (Fig 9). The mean BIC in the SLA area was 52.6% (see Table 1).

DISCUSSION

Ideal skeletal anchorage provides stationary anchorage during active treatment, even under heavy dynamic loading, and guarantees easy removal. These preconditions are fulfilled by osseointegrated mini-implants. Because such implants can withstand even rotational forces, they allow more applications. Yet the removal torque values (RTV) are similar to those of nonosseointegrated implants.

The histologic evaluation used in this investigation was similar to that of Jensen and Sennerby. Albrektsson and Johansson stated that a BIC of approximately 50% is required to provide successful implant restoration. If this statement is acceptable, C-implants with 52.6% BIC meet this criterion.

Buser et al showed a positive correlation between the percentage of BIC and roughness of five titanium surfaces tested. In some studies, SLA implants showed BIC already during an early stage and good stability when applying rotational moments.

The RTV was often used to measure the degree of osseointegration in animals and cadavers. Simon and Caputo reported that 16.1 ± 4.8 Ncm reverse

![Fig 9](image1) Histologic view of retrieved C-implant. Machined surface in the neck area for soft tissue contact (a) and SLA with intimate bone implant contact (b).

![Fig 10](image2) Clinically retrieved C-implant revealing microfractures (arrows) between adjacent bone and screw surface.
torque was required to remove smooth surfaced ITI implants (1.8 mm diameter, 10 to 14 mm length) in the maxilla. This is in accordance with a previous study of this group in which the mean RTV of C-implants in patients amounted to 16.4 ± 7.7Ncm. The accuracy of BIC is to some degree biased because the removal of the C-Implant head requires reverse torque, which might cause microfractures in the bone-implant contact surface (Fig 10).

CONCLUSION

SLA surface-treated C-implants showed partial osseointegration which can resist heavy and dynamic forces. Further studies are needed to evaluate resistance to rotation moment and clinical efficacy of surface-treated C-implants.

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REFERENCES