STRAUMANN® SLA
SCIENTIFIC EVIDENCE
FIRST EDITION (2011)
The ITI (International Team for Implantology) is academic partner of Institut Straumann AG in the areas of research and education.
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Introduction

Straumann® SLA – reliable and scientifically well documented

Roughened surfaces for dental implants have consistently demonstrated advantages over the older machined-type titanium surfaces. Significantly greater success rates, enhanced bone-to-implant contact (BIC) and greater biomechanical and functional stability have all been demonstrated by rough surface implants compared to those with smoother surfaces. Straumann’s proprietary Sandblasted, Large-grit, Acid-etched (SLA®) surface has become one of the best documented rough surfaces in implantology, having shown advantages over other roughened implant surfaces. In particular, preclinical analysis has shown the superiority of SLA® over the previously most common rough surface, titanium plasma-sprayed (TPS), with better maintenance of vertical bone height and significantly greater BIC. Shear strength of the bone-to-implant interface has also been shown to be greater with SLA® compared to TPS and machined surfaces, and compared to a machined and acid-etched surface in preclinical studies; a biomechanical comparison using implants of the same design showed that the better bone anchorage was a result of the surface topography rather than the implant design.

Sandblasted, Large-grit, Acid-etched (SLA®)

The extent of the bone-to-implant interface appears to increase with increasing surface roughness, but problems have been noted with surfaces that are very rough, suggesting that there may be an ‘optimum range’ of moderate surface roughness. The SLA® surface is sandblasted with large-grit (250–500 μm), which results in a peak-to-peak macro-roughness of approximately 20–40 μm, followed by micro-roughness of approximately 2–4 μm upon acid etching. Micro-rough surfaces increase the rate of cell spreading and the number of cells attached to the surface, and increase the rate that cells produce factors regulating the differentiation of bone-forming cells (osteoblasts) and reduce the activity of bone-destroying cells (osteoclasts).

The clinical benefit

The advent of the SLA® surface, with its proven osseointegration properties, therefore revolutionized the conventional timing of provisionalization, allowing it to be cut by half, from 12 weeks for the previous TPS surface to just 6 weeks, subsequently, even earlier loading (e.g. early and immediate) have been shown to be successful and predictable. The longevity of Straumann® Soft Tissue Level implants with the SLA® surface has also been demonstrated by success in numerous long-term investigations (e.g. 5 years and over). The substantial level of evidence for SLA® also acts as a proven foundation for the SLActive® surface, which is based on the SLA® technology.

Sandblasted, Large-grit, Acid-etched (SLA®)

The SLA® surface is available and has proven to be successful on various Straumann implant designs, Narrow Neck implants, Wide Neck implants, and short implants. The SLA® surface is also available on BL implant.

The 20 years of investigation and 10 years of clinical evidence for SLA® have provided a wealth of information, and implant survival rates of > 98 % have consistently been observed. The following information shows data from selected key preclinical and clinical studies with Straumann’s SLA®-surfaced implants, representing a range of indications, loading protocols and implant types. The excellent data demonstrate the advantages and versatility of the SLA® surface.

* With good bone quality and adequate bone quantity and implants of Ø 4.1 mm or Ø 4.8 mm, over 8.0 mm lengths.
† Please note that this Straumann Scientific Evidence document contains a selection of studies and makes no claim to be a complete study list. Articles were selected on merit from the results of a literature search using combinations of the following key words: sand-blasted and grit-blasted, sand-blasted and particle blasted, tapered effect, standard implant, standard plus, narrow neck implant, sand-blasted and large-grit and acid-etched, wide neck implant, ITI implant, sand-blasted and acid-etched, Straumann, rough surfaces, blasted SLA®, surface topography, dental implant, surface chemistry, surface modification, surface roughness, acid-etching, titanium, synOcta®, Locator®, IPS e.max®, preshaped abutment.
## Study overview

### PRECLINICAL STUDIES

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### CLINICAL STUDIES

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<td>10-year data on Soft Tissue Level SLA® implants in the edentulous maxilla</td>
<td>Fischer K</td>
<td>ITI World Symposium, Geneva, Switzerland, 15−17 Apr 2010.</td>
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The influence of various titanium surfaces on the interface shear strength between implants and bone

Wilke HJ, Claes L, Steinemann S.

Abstract: Mechanical effects of bone healing were evaluated for implants with various surface treatments. Maximum removal torque was shown by the SLA® surface.

Introduction
Bone healing around titanium implants can be influenced by the titanium surface. This investigation therefore examined the mechanical effect of the bone healing response to various surface morphologies of titanium implants in terms of implantation time.

Methods
Titanium screws with six different surface treatments (electropolished; sandblasted with fine grit/acid-pickled (HF/HNO₃)/anodized; titanium plasma-sprayed (TPS); sandblasted with medium grit/acid-pickled (HF/HNO₃); sandblasted with large grit/acid-pickled (HF/HNO₃); sandblasted with large grit/acid-etched (HCl/H₂SO₄) (SLA®) were placed in the tibiae of 10 sheep. Removal torque was evaluated after 2, 9, 12, 24 and 52 weeks, and histological analysis was performed after 9, 24 and 52 weeks.

Abstract:
Mechanical effects of bone healing were evaluated for implants with various surface treatments. Maximum removal torque was shown by the SLA® surface.

Results
SLA® implants showed the maximum removal torque, and the maximum removal torque increased over time for SLA® and TPS implants (Figure 1); in contrast, no significant changes in removal torque were observed for the remaining implants.

Figure 1: Removal torque (Nm) of titanium screws according to surface treatment and time in place.

1: electropolished
II: sandblasted with fine grit, acid pickled using HF/HNO₃ and anodized
III: titanium plasma-sprayed
IV: sandblasted with medium grit and acid pickled using HF/HNO₃
V: sandblasted with large grit and acid pickled using HF/HNO₃
SLA®: sandblasted with large grit and acid etched using HCl/H₂SO₄

Conclusions
• The interface shear strength of implants can be increased by altering the surface structure morphology.
• An optimal surface can potentially be developed for various biomechanical situations, e.g. strong anchorage for permanent implants, or weaker anchorage for temporary/removable implants.
Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study in miniature pigs

Buser D, Schenk RK, Steinermann S, Fiorellini JP, Fox CH, Stich H.

Abstract: Bone healing with various implant surface characteristics was evaluated. Rough surface promoted greater bone apposition, with an additional effect shown by SLA®.

Introduction
Several techniques have been employed to improve anchorage of titanium implants in bone by surface modification or coatings. The aim of this study was to investigate the influence of various surface characteristics on bone reactions in titanium implants.

Methods
Hollow cylinder implants with six different surface treatments (electropolished (E); sandblasted with medium grit/acid-pickled (HF/HNO₃) (SMP); sandblasted with large grit (SL); sandblasted with large grit/acid-etched (HCl/H₂SO₄) (SLA®); titanium plasma-sprayed (tPS); hydroxylapatite plasma-sprayed (HA)) (fig. 1) were placed in the metaphyses of the tibia and femur in six mini-pigs. Twelve implants of each type were placed. Histomorphometric analysis was performed after 3 and 6 weeks.

Results
Histological analysis showed direct bone-to-implant contact for all implants, but with significant differences in the percentages obtained. The lowest bone-to-implant contact was observed with the HF/HNO₃ implants (25.1 % ± 7.4 % and 21.6 % ± 9.3 %, respectively, at 6 weeks), while the highest bone-to-implant contact was found with the SLA® and HA implants (57.7 % ± 9.5 % and 69.5 % ± 6.5 %, respectively, at 6 weeks). The results showed increasing bone-to-implant contact with increasing surface roughness (fig. 2).

Abstract: Bone healing with various implant surface characteristics was evaluated. Rough surface promoted greater bone apposition, with an additional effect shown by SLA®.

Conclusions
• Greater bone apposition was observed with rough surfaces compared to polished or fine structured surfaces.
• The SLA® surface showed an additional effect on bone apposition compared to the sandblasted surface.
• The highest bone-to-implant contact was found with SLA® and HA surfaces.
• The HA coating consistently showed signs of resorption.

Figure 1: Scanning electron micrographs of different implant surfaces (bar is 20 µm; original magnification x1700). (A) SMP, (B) SL, (C) SLA, (D) TPS, (E) HA

Figure 2: Mean direct bone-to-implant contact (%) of different implant surfaces after 3 and 6 weeks; E = electropolished; SMP = sandblasted with medium grit (0.12–0.25 µm) and acid pickling with HF/HNO₃; SL = sandblasted with large grit (0.25–0.50 µm)

A narrow band of bone was often seen around SLA® and HA implants as an extension of perpendicularly oriented bone trabeculae; however, the HA coating consistently showed signs of resorption, predominantly in areas without bone covering.

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Evaluation of an endosseous titanium implant with a sandblasted and acid-etched surface in the canine mandible: radiographic results


Abstract: SLA® and tPS implants were compared under loaded and unloaded conditions in vivo. SLA® implants showed advantages in early healing and showed less crestal bone loss.

Introduction
Surface characteristics of titanium implants have a direct impact on integration with hard and soft tissues, and radiography is the only non-invasive method to assess the bone reaction. The aim of this study was to compare titanium implants with TPS and SLA® surfaces in a dog mandible model under loaded and unloaded conditions over 15 months.

Methods
Cylindrical implants with either a TPS or an SLA® surface (Fig. 1) were placed in the mandibles of six dogs after 3 months of healing following tooth extraction. A total of 69 implants were placed. In four dogs (groups B and C), impressions were taken 2 months after implant placement for the fabrication of screw-retained gold crowns, and the implants (4B implants) were loaded 3 months after implant placement. Radiographic analysis was performed for assessment of bone-to-implant contact, by measuring the distance from the implant shoulder to the most coronal bone-to-implant contact, and bone density, measured using computer-assisted densitometric image analysis (CADI A). Measurements were taken 3 months after implant placement for the unloaded implants (group A, 2 dogs), 3 and 6 months after implant placement in group B (2 dogs), and 3, 6, 9, 12 and 15 months after implant placement (12 months of loading) in group C (2 dogs).

Results
Excellent tissue integration with anklyotic stability and no signs of peri-implant infection were observed for all implants, and the radiography showed no signs of continuous peri-implant radiolucency around the implants. Stability was maintained after loading, and no complications were observed.

Mean crestal bone loss at the preload and 3-month evaluations were 0.52 mm and 0.73 mm, respectively, for SLA® implants and 0.69 mm and 1.06 mm, respectively, for TPS implants. All crestal bone loss occurred during the first 6 months after implant placement, 65 % before loading and 35 % in the first 3 months after loading, regardless of implant surface. Bone loss was significantly less with the SLA® implants at both preload and after 3 months of loading, and this was maintained during the 1-year follow-up period (Fig. 2).

Bone density values were also significantly greater for SLA® implants than TPS implants, comparing both preload and 3 months to baseline, but no detectable changes in bone density were observed in the apical areas between SLA® and TPS implants.

Conclusions
- SLA® implants showed a distinct advantage in early healing periods compared to TPS implants due to reduced crestal bone loss.
- SLA® implants were shown to be superior to TPS implants as measured via radiographic bone loss under both loaded and unloaded conditions.
Bone response to unloaded and loaded titanium implants with a sandblasted and acid-etched surface: a histometric study in the canine mandible

Cochran DL, Schenk RK, Lussi A, Higginbottom FL, Buser D.

Abstract: SLA® and TPS implants were evaluated under loaded and unloaded conditions in vivo. Greater bone-to-implant contact was observed with SLA® implants.

Introduction
Many investigations of titanium implants focus on the surface characteristics, and BIC has been shown to be greater with an SLA® surface compared to a TPS surface. This study was designed to evaluate the SLA® implant surface by histometric analysis in the canine mandible, compared to TPS surface implants.

Methods
Cylindrical implants with either a TPS or an SLA® surface were placed in the mandibles of six dogs after 3 months of healing following tooth extraction. A total of 69 implants were placed. Implants were left unloaded in two dogs (Group A), while the implants in the remaining four dogs were loaded with screw-retained gold crowns after 3 months (Groups B and C). Histometric analysis of the bone-to-implant contact was performed 3 months after implant placement in the unloaded group and 6 and 15 months after implant placement (3 and 12 months of loading, respectively) in the loaded groups (Fig. 1).

Figure 1: Study plan, showing implant placement and evaluation of the various groups

Figure 2: Bone-to-implant contact (%) for SLA® and TPS implants for unloaded implants and implants after 3 and 12 months of loading

Results
All implants were stable after 3 months, with healthy peri-implant tissues and no significant peri-implant inflammation. Bone-to-implant contact was significantly greater for the unloaded SLA® implants versus the unloaded TPS implants after 3 months and after 12 months of loading, but there was no significant difference after 3 months of loading (Fig. 2). No qualitative differences in bone tissue were observed between the SLA® and TPS implants.

Conclusions
• The SLA® surface promoted greater bone-to-implant contact at 3 months unloaded and 12 months loaded compared to the TPS surface.
• SLA® showed the potential for superior osseointegration results compared to the existing TPS surface.
Introduction
After the introduction of SLA®, another acid-etched implant surface, Osseotite®, was introduced onto the market, but there were no available data comparing this and other rough titanium surfaces. The aim of this investigation, therefore, was to compare an implant with this acid-etched surface (Osseotite®) with the sandblasted and acid-etched surface (SLA®) by measurement of removal torque values.

Methods
In the maxilla of each of nine adult miniature pigs, a total of 70 implants were placed (six to eight implants per animal) at least 6 months after tooth extraction. Biomechanical testing was performed on 54 of these implants by evaluation of removal torque after 4, 8 or 12 weeks. The implants had either a sandblasted and acid-etched (SLA®) surface or a machined and acid-etched (Osseotite®) surface (Fig. 1, Fig. 2). A commercially available standard hex device was used for removal of the Osseotite® implants, while a specially manufactured adapter was used for removal of the SLA® implants. Since the hex connection of the Osseotite® implants was rather short and unable to withstand the shear stresses during removal torque testing, the failure torque of these implants was also assessed. Torque rotation curves were recorded for each test and the removal torque was defined as the maximum torque on the curve.

Abstract: Removal torque was evaluated for SLA® and Osseotite® implants in vivo over 12 weeks, and was found to be significantly higher for SLA.

Results
Both surfaces showed similar features under scanning electron microscopy (i.e. small micropits of 1–2 μm in diameter), although the Osseotite® surface appeared to exhibit a flatter profile. Average roughness (Rₐ) was greater for the SLA® surface (Rₐ = 2.0 μm versus 1.3 μm). The mean removal torque was significantly higher for SLA® implants compared to Osseotite® implants at all time points (Fig. 3).

Conclusions
• Mean removal torque was 75–125 % higher for SLA® implants versus Osseotite® implants.
• In vitro and in vivo evaluation of new implant surfaces is therefore essential prior to clinical application in patients.
Interface shear strength of titanium implants with a sandblasted and acid-etched surface: a biomechanical study in the maxilla of miniature pigs

Buser D, Nydegger T, Hirt HP, Cochran DL, Nolte NP.

Abstract: Interface shear strength was evaluated for SLA®, TPS and machined implants in vivo. Removal torque was significantly higher for SLA® and TPS, and was higher for SLA® versus TPS at 4 weeks.

Introduction
The SLA® titanium surface has demonstrated enhanced bone apposition versus the TPS surface. This study was designed to evaluate the interface shear strength of the SLA® surface in the maxilla of miniature pigs versus TPS and machined surfaces.

Methods
A total of 54 implants with an SLA®, TPS or machined surface (Fig. 1) were placed in the maxillae (three implants on each side) of nine adult miniature pigs at least 6 months after tooth extraction. The anterior-posterior position of each implant type was varied so that no preference was given for any one implant type. Shear strength was evaluated by removal torque testing after 4, 8 and 12 weeks; torque rotation curves were recorded for each test and the removal torque was defined as the maximum torque on the curve. Histologic and histomorphometric analysis was also performed.

Results
Mean removal torque for the machined surface implants varied from 0.13 to 0.26 Nm, while mean values for the rough surfaced implants were between 1.14 and 1.56 Nm. Mean removal torque was higher for the SLA® surface after 4 weeks compared to the TPS surface, while mean values were similar for both surfaces at 8 and 12 weeks (Fig. 2). Implant position had a significant influence on removal torque – lower removal torque values were found for more posterior locations (Fig. 3), which correlated significantly with decreasing bone density from anterior to posterior sites. Histological analysis showed a separation between the bone and implant surface for machined surface implants. Bone trabeculae fractures were often observed for TPS and SLA® implants, but the bone-to-implant interface was maintained.

Conclusions
- Interface shear strength of titanium implants is significantly influenced by the surface characteristics.
- SLA® and TPS surfaces showed significantly higher removal torque values than machined surface implants.
- Mean removal torque was higher for SLA® compared to TPS implants after 4 weeks.

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Immediate and early loading of SLA® ITI single-tooth implants: an in vivo study.

Abstract: SLA® implants were loaded immediately or early in vivo; no significant differences were found between the loading protocols.

Introduction
A healing time of 6 weeks has been suggested for SLA® surfaced implants, indicating the potential for the implants to be loaded immediately or early. The aim of this study was to determine whether immediate or early loading of SLA® implants has any adverse effects compared to conventional loading, as assessed by clinical, radiographic and histological examination.

Methods
Mandibular premolars and first molars were removed from four dogs and a total of 48 SLA® surfaced implants (12 per dog) were placed 4 months later. The implants were loaded with single screw-retained gold crowns 2, 10 or 21 days or 3 months after implant placement and placed in functional occlusion. Block sections were obtained for histologic examination and the changes in crestal bone height mesially and distally at each implant, and the change in bone density of the coronal 3 mm of crestal bone, were recorded. Histological evaluation included primary, secondary and total BIC as well as bone marrow-to-implant contact and connective tissue-to-implant contact.

Results
All implants were well osseointegrated; implant survival was 100 %. Clinically normal peri-implant tissues were observed, with no signs of inflammation or suppuration. Changes in crestal bone height (combined mesial and distal aspects) for implants loaded after 2, 10 and 21 days and 3 months were 0.35 ± 0.18 mm, 0.15 ± 0.08 mm, 0.30 ± 0.08 mm and 0.02 ± 0.07 mm, respectively. The differences were not statistically significant, suggesting that loading time does not adversely affect the peri-implant crestal bone. There were also no significant differences in primary or secondary BIC, total BIC (Fig. 1) or total connective tissue-to-implant contact. For bone marrow-to-implant contact, the amount was marginally significantly greater for the implants placed 2 days before loading (19.16 ± 3.5 %) compared to those placed 3 months before loading (13.98 ± 2.02 %), but no other differences were observed.

Conclusions
• No significant differences were observed between the four loading protocols.
• Immediate and early loading of SLA® implants is therefore possible with no adverse peri-implant tissue effects.

Figure 1: Total BIC for implants placed 3 months (group A), 21 days (group B), 10 days (group C) and 2 days (group D) before loading.

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<thead>
<tr>
<th></th>
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Immediate implants at fresh extraction sockets: bone healing in four different implant systems.


Abstract: Bone healing in extraction sockets was evaluated for SLA®, OsseoSpeed™, Osseotite® and SPI® ELEMENT implants. Healing patterns were similar in all groups, but bone-to-implant contact was highest with SLA®.

Introduction

Implant placement immediately after tooth extraction has become a common procedure, but the outcomes may depend on implant design and/or surface. The aim of this study, therefore, was to investigate the differences in bone healing around four different implant systems placed in fresh extraction sockets in the dog, and to observe the influence on modelling of the buccal plate.

Methods

Third and fourth premolars were removed in each of eight dogs and four different implant types were randomly placed in the distal extraction sockets: Thommen SPI® ELEMENT Ø 3.5 mm; Straumann® Standard Plus Ø 3.3 mm; Astra Tech MicroThread OsseoSpeed™ Ø 3.5 mm; 3i Osseotite® Certain straight miniplant (fig. 1). Histologic, histometric and histomorphometric analysis was performed after 6 weeks of healing to assess Bic, bone area, new bone formation and ridge alterations.

Results

Bic proved to be highly variable, ranging from 39.84 % to 78.63 % for 3i implants (3i Osseotite® Certain straight miniplant), 35.78 % to 76.58 % for Astra Tech implants (Astra Tech MicroThread OsseoSpeed™ Ø 3.5 mm), 50.13 % to 86.88 % for Thommen implants (Thommen SPI® ELEMENT Ø 3.5 mm) and 58.14 % to 83.40 % for Straumann implants (Straumann® Standard Plus Ø 3.3 mm); Bic was therefore most consistent around Straumann implants. Mean Bic was also highest for Straumann implants (fig. 2), although the difference was not statistically significant. Marked bone remodelling of the buccal plate of approximately 2.5 mm was observed, regardless of the implant system. Similar bone area percentages and amounts of new bone formation were observed for all implant systems.

Conclusions

• Healing patterns for implants placed in fresh extraction sockets after 6 weeks were similar for all four implant systems.
• The highest Bic was observed with SLA® implants.
The use of reduced healing times on ITI implants with a sandblasted and acid-etched (SLA®) surface: early results from clinical trials with ITI SLA® implants


Abstract: SLA® implants were placed in 133 patients and restored after 6 weeks (12 weeks in class IV bone). The cumulative survival rate after 2 years was 99.3%.

Introduction
Since the SLA® surface has demonstrated advantages in earlier healing following implant placement, the aim of this investigation was to determine whether SLA® implants could be predictably and safely restored after 6 weeks after placement in class I to III bone and after 12 weeks in class IV bone.

Methods
This was a prospective multicenter trial to evaluate the success of abutment connection by descriptive analysis and implant success by life table analysis. A total of 133 patients were recruited into the trial, and 383 implants were placed. Abutments were placed and torqued to 35 Ncm 42–63 days after implant placement for implants in bone class I, II and III, and after 84–105 days in bone class IV. The patient groups were as follows: at least one tooth missing in the posterior mandible and a fixed implant-to-implant restoration on at least two implants (group A); at least one tooth missing in the posterior maxilla and a fixed implant-to-implant restoration on at least two implants (group B); at least 1 tooth missing in the posterior mandible and either a fixed restoration on at least four implants or a removable denture on at least four implants (group C). Implants were placed in a non-submerged technique and restorations were either cement- or screw-retained. Implant mobility, radiographic bone loss, gingival health and plaque accumulation were assessed.

Results
There were 80 patients (198 implants), 21 patients (46 implants and 32 patients (139 implants) in groups A, B and C, respectively. At the time of publications, 110 patients with 326 implants had completed the 1-year follow-up evaluation, and 47 patients with 138 implants had completed the 2-year recall. Three implants were lost before abutment connection, giving a success rate of 99.3%, for a mean implant loading time of 49 days. No implant failures or implant-related adverse events were reported after abutment connection. The cumulative implant success rate, as determined by life table analysis, was 99.1% for both the 1-year and 2-year evaluations (Table 1).

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<th>No implants lost during interval</th>
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Table 1: Life table analyses.

Conclusions
• Implants with an SLA® surface can be restored after 6 weeks with high levels of predictability and success.
• Very high implant success rates were observed after 1 and 2 years.
• The results confirm the concept of enhanced bone formation around SLA® surfaced implants and confirm the possibility of reduced healing times prior to restoration.
Early loading on nonsubmerged titanium implants with a sandblasted and acid-etched (SLA®) surface: 3-year results of a prospective study in partially edentulous patients


Abstract: Non-submerged SLA® implants were evaluated in 51 partially edentulous patients after 3 years; the success rate was 99%.

Introduction
To evaluate the success rate of SLA® implants loaded after 6 weeks of healing in posterior sites in partially edentulous patients, and to determine whether the success rate is comparable to previous studies for implants with the TPS surface.

Methods
In 51 partially edentulous patients, 104 implants (89 mandibular, 15 maxillary) were placed in posterior sites in bone densities of class I, II or III. Solid abutments were connected and torqued to 35 N cm and the implants functionally loaded with cement-retained single crowns (39 implants), splinted single crowns (43 implants) or fixed partial dentures (21 implants) after 6 weeks. Clinical and radiographic examination was performed after 3, 12, 24 and 36 months – the parameters measured were modified plaque index (mPLI), modified sulcus bleeding index (mSBI), probing depth (PD), distance from implant shoulder to mucosal margin (DIM), clinical attachment level (CAL), mobility assessed by Periotest (PTV), and distance from implant shoulder to most coronal visible BIC (DIB).

Table 1: Mean values for clinical and radiographic parameters at 3, 12, 24 and 36 months

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<th>CAL (mm)</th>
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</table>

Results
One implant failed to osseointegrate and became unstable during healing, so was consequently removed; A second implant was placed 3 months later and osseointegrated with no complications. One patient was lost to follow-up and considered a drop-out from the study. The remaining 102 implants were successfully osseointegrated after 3 years, resulting in a success rate of 99.03%.

A local peri-implant infection as a result of excess cement was noted at two implants at the 3-month follow-up; the cement was removed and the infection successfully treated (Fig. 1). All other implants were firmly osseointegrated with no signs of peri-implant infection or radiolucency. Mean values for the clinical and radiographic examinations are shown in Table 1. Mean PLI significantly decreased at 1, 2 and 3 years compared to 3 months, and the mean decreases in mSBI from 3 months were also significant. PD, DIM, CAL and DIB remained stable throughout the study period, while there was a tendency for decreasing PTV score.

Conclusions
• Early loading of SLA® implants after 6 weeks leads to highly successful and predictable tissue integration in partially edentulous patients.
• Successful tissue integration is maintained for up to 3 years of follow-up.
• An excellent 3-year success rate of 99.03% was observed.

Figure 1: The two implants with previous peri-implantitis following successful treatment – at the 3-year examination both implants fulfilled the success criteria (Picture courtesy of M Bornstein).

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Early loading (2 or 6 weeks) of sandblasted and acid-etched (SLA®) ITI implants in the posterior mandible: A 1-year randomized controlled clinical trial

Salvi GE, Gallini G, Lang NP.

Abstract: SLA® implants were placed in 27 patients and loaded after 2 or 6 weeks. No implants were lost after 1 year, showing that 2-week loading does not jeopardize osseointegration.

Introduction
Implants placed in a two-stage surgical protocol are traditionally restored after a non-loaded healing period of 3–6 months, but evidence suggests that the SLA® surface can promote faster osseointegration. The aim of this investigation, therefore, was to assess clinical and radiographic outcomes of SLA® surfaced implants in the posterior mandible loaded after 2 or 6 weeks.

Methods
The study enrolled 27 patients with bilateral posterior mandibular edentulous areas requiring prosthetic reconstruction. A total of 67 implants were placed, 31 in one side of the mandible (test) and 36 in the contralateral side (control). In the control group, abutment placement was carried out after 35 days and single-tooth crowns were placed after 42 ± 2 days. Abutments were placed after 7 days in the test group and single-tooth crowns were placed after 14 ± 1 days. All abutments were torqued to 35 Ncm and all crowns were porcelain-fused-to-metal and were cemented. Clinical data (CAL, PD, bleeding on probing (BOP), implant stability by Periotest (PTV)) were assessed 2, 6, 12, 24 and 52 weeks after implant placement; width of keratinized mucosa (KM) was evaluated at implant placement and after 1 year. Distance from implant shoulder to most coronal BIC was evaluated radiographically at baseline and after 6 weeks and 1 year to assess bone loss (BL).

Results
The implant survival rate after 1 year was 100%. For three implants (two in the test group and one in the control group), abutment rotation occurred at abutment connection, so the final impression was not taken and the abutments were successfully re-tightened to 35 Ncm 12 weeks later. There were no significant differences between the test and control groups for any of the clinical or radiographic parameters measured (Table 1).

Conclusions
• Loading of SLA® surfaced implants as early as 2 weeks does not jeopardize the process of osseointegration.
• Proper handling of implant abutment rotation does not adversely affect tissue integration or implant stability.
• Clinical and radiographic outcomes are similar for implants in the posterior mandible loaded after 2 weeks as for those loaded after 6 weeks.

<table>
<thead>
<tr>
<th></th>
<th>Test sites (N=31)</th>
<th>Control sites (N=36)</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPD (mm±SD)</td>
<td>2.6±0.5</td>
<td>2.7±0.5</td>
<td>ns</td>
</tr>
<tr>
<td>CAL (mm±SD)</td>
<td>3.1±0.4</td>
<td>3.2±0.5</td>
<td>ns</td>
</tr>
<tr>
<td>BOP (%)</td>
<td>9.7</td>
<td>8.3</td>
<td>ns</td>
</tr>
<tr>
<td>Width of KM (mm±SD)</td>
<td>1.8±0.4</td>
<td>1.9±0.5</td>
<td>ns</td>
</tr>
<tr>
<td>PTV (±SD)</td>
<td>-1.4±0.9</td>
<td>-1.6±0.8</td>
<td>ns</td>
</tr>
<tr>
<td>BL (mm±SD)</td>
<td>0.37±0.49</td>
<td>0.72±0.5</td>
<td>ns</td>
</tr>
</tbody>
</table>

Table 1: Clinical and radiographic parameters at test and control sites at the 12-month follow-up evaluation.
A 3-arm study of early loading of rough-surface implants in the completely edentulous maxilla and in the edentulous posterior maxilla and mandible: results after 1 year of loading

Nordin T, Nilsson R, Frykholm A, Hallman M.

Abstract: A total of 234 SLA® implants were placed in patients with an edentulous maxilla or mandible. Cumulative survival after 1 year was 99.1 %, with favourable results for both immediate and early loading.

Introduction
Previous studies have indicated that early loading of SLA® implants may be feasible. The aim of this study was to investigate early loading of SLA® implants in the edentulous maxilla and posterior edentulous maxilla and mandible using a larger patient population than previously studied.

Methods
The study enrolled 54 patients in three groups: patients with a completely edentulous maxilla (20 patients, group A); patients with an edentulous posterior left and/or right maxilla (19 patients, group B); and, patients with an edentulous posterior left and/or right mandible (15 patients, group C). Patients each received from 2 to 7 implants – 234 implants were placed (122 implants in group A, 59 in group B and 53 in group C). 58 of the implants were placed immediately after tooth extraction. Straumann® synOcta abutments were mounted prior to flap suture and impressions were taken immediately after surgery. Placement torque was measured at all implant sites at the time the abutments were mounted. Sixty screw-retained prosthetic restorations were used to restore 2–12 teeth and were loaded after a mean period of 9 days (range 4 to 22 days). Intraoral radiographs were obtained at baseline and after 1 year of functional loading to evaluate change in marginal bone level, measured as the change in distance from the implant shoulder to the first bone apposition.

Results
Two of the 234 implants were lost, giving an overall cumulative survival rate of 99.1 %; survival rates for groups A, B and C were 99.2 %, 98.3 % and 100 %, respectively. Implant placement torque varied from 29 to 35 Ncm among the groups, and no significant differences were observed between placement torque for implants (Fig. 1). The mean reduction in marginal bone level from baseline to implant placement was -0.75 ± 0.13 mm (range 0 to 3.5 mm); the mean changes in marginal bone level were -0.63 mm, -1.03 mm and -0.96 mm for groups A, B and C, respectively. No significant differences were found between the groups or between implants placed in extraction sockets and those placed in healed bone.

Conclusions
• Favorable results were obtained for immediate and early loading of SLA® implants in this patient population.
• Early loading with SLA® implants can have predictable outcomes for the rehabilitation of the edentulous maxilla and edentulous posterior maxilla and mandible.

Figure 1: Implant placement torque for implants placed in extraction sockets and in healed bone for the three groups (A – edentulous maxilla, B – edentulous posterior left and/or right maxilla, C – edentulous posterior left and/or right mandible)
Immediate loading of implants with 3-unit fixed partial dentures: a 12-month clinical study

Cornelini R, Cangini F, Covani U, Barone A, Buser D.

Abstract: SLA® implants were immediately loaded with 3-unit fixed partial dentures in 20 patients. The survival rate after 1 year was 97.5 %.

Introduction
Studies have shown that shortened treatment times (e.g. loading after 6 weeks) with SLA® implants can be predictable and have advantages for both patients and clinician. The aim of this investigation was to evaluate implant success after 12 months for immediately loaded SLA® implants in the posterior mandible supporting 3-unit fixed partial dentures (FPDs).

Methods
Twenty patients with missing mandibular molars or premolars were enrolled, and a total of 40 implants were placed. Copings were connected to the implants, wound closure was achieved and impressions were taken. Healing caps were then placed and temporary screw-retained acrylic resin 3-unit FPDs in functional occlusion were connected to the implants within 24 hours, i.e. immediate loading. Definitive abutments and metal-ceramic restorations were placed after 6 months. Implant stability (iSQ), width of keratinized mucosa (KM) and distance from implant shoulder to point of first BIC (DiB) were measured at implant placement and after 12 months. Implants were included in the study only when the primary stability exceeded an iSQ measurement of 62.

Results
One implant was removed 2 months after placement due to acute infection at the implant site – a new implant was placed, which was subsequently successful. The remaining 39 implants were successful, giving a 1-year success rate of 97.5 %. No significant differences were observed between implant placement and 12 months for DiB, KM or iSQ (Table 1). No technical complications (e.g. screw loosening, resin fracture, pain during chewing) were observed.

Conclusions
• Immediate functional loading of SLA® implants resulted in an excellent survival rate.
• The placement of SLA® implants in the mandible and immediate loading with 3-unit FPDs has been shown to be a successful procedure in this study.

Table 1: Changes in clinical and radiographic parameters between baseline (implant placement) and 12-month follow-up

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>12 months</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>DIB</td>
<td>2.4</td>
<td>0.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Mesial</td>
<td>2.6</td>
<td>0.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Distal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midbuccal</td>
<td>2.0</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Middiaphragm</td>
<td>2.4</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Width of keratinized mucosa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISQ</td>
<td>72.0</td>
<td>5.7</td>
<td>74.5</td>
</tr>
</tbody>
</table>
A five-year life table analysis on wide neck ITI implants with prosthetic evaluation and radiographic analysis: results from a private practice

Bischof M, Nedir R, Abi Najm S, Szmkler-Moncler S, Samson J.

Abstract: A 5-year life table analysis was performed for 263 wide neck SLA® implants in 212 patients. The cumulative survival rate after 5 years was 97.9 % and the mean bone loss after 2 years was comparable to standard SLA® implants.

Introduction
Implants with diameters in the range of 3.75 to 4.1 mm have been extensively used and investigated, but conflicting clinical data have been reported for implants with wider diameters (e.g. 5–6 mm). The aim of this investigation was to report on the follow-up of SLA® Wide Neck implants (4.8 mm) in a 5-year life table analysis, including prosthetic outcomes.

Methods
Over a 5-year period, 263 SLA® Wide Neck implants were placed in 212 patients. 61.2 % were placed in the maxilla and 38.8 % in the mandible. The majority (97 %) were placed in the molar region, with only 3 % in the premolar region. The mean implant lengths used were 8.9 mm and 9.7 mm in the maxilla and mandible, respectively. Single crowns were used to replace single missing molars, and bridges (two splinted crowns, FPDs with pontics and/or unit extensions) were used in larger edentulous spaces. The width of the vestibular and buccal lamellae was ≥ 1 mm in 89 % of cases (234 implant sites), while 9.1 % (24 implant sites) had one lamellae < 1 mm and 1.9 % (five implant sites) had both lamellae < 1 mm. Sinus perforation of 1–2 mm was tolerated and occurred with 52 % of the maxillary implants placed. Simultaneous bone augmentation was performed at 37 sites, 28 of which were vertical and 9 of which were lateral. Slightly detectable mobility was observed for 20 implants (7.6 %); the remaining 92.4 % were stable.

Results
The 1- and 2-year implant survival rates, based on 259 implants and 174 implants, respectively, were 98.8 % and 97.7 %; the 5-year cumulative survival rate was 97.89 %. Two early failures occurred before loading, and three late failures occurred after loading. A total of 157 single crowns and 80 FPDs were placed; the majority of prosthetic restorations were cement-retained. Over 5 years, 93 % of the single crowns and 95 % of FPDs were free from complications. Porcelain fracture was noted for 11 prostheses supported by 11 implants in 11 patients; all of these were cement-retained. Of these, five were major fractures, all of which occurred on single crowns, and six were minor fractures, four with single crowns and two with FPDs. After 2 years, mean crestal bone loss mesially and distally was 0.71 ± 0.62 mm and 0.60 ± 0.64 mm, respectively. Crestal bone loss > 1 mm was observed at 21.3 % of mesial and distal sides, and only 2.5 % showed crestal bone loss > 2 mm (Table 1).

Conclusions
- Wide Neck SLA® implants supporting single crowns and FPDs in molar regions are highly predictable.
- Mean bone loss after 2 years was comparable to standard SLA® implants.
- The safe and predictable use of Wide Neck implants simplified implant treatment.
- Very few prosthetic complications were noted.

<table>
<thead>
<tr>
<th>CBL</th>
<th>Mesial side</th>
<th>Distal side</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain [mm]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–1</td>
<td>6 (6 %)</td>
<td>11 (10.8 %)</td>
<td>17 (8.4 %)</td>
</tr>
<tr>
<td>Loss [mm]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–0.5</td>
<td>33 (33 %)</td>
<td>41 (40.2 %)</td>
<td>74 (36.6 %)</td>
</tr>
<tr>
<td>0.5–1</td>
<td>30 (30 %)</td>
<td>21 (40.6 %)</td>
<td>51 (25.2 %)</td>
</tr>
<tr>
<td>1–1.5</td>
<td>22 (22 %)</td>
<td>21 (40.6 %)</td>
<td>43 (21.3 %)</td>
</tr>
<tr>
<td>1.5–2</td>
<td>6 (6 %)</td>
<td>6 (5.9 %)</td>
<td>12 (5.9 %)</td>
</tr>
<tr>
<td>&gt; 2</td>
<td>3 (3 %)</td>
<td>2 (2.0 %)</td>
<td>5 (2.5 %)</td>
</tr>
<tr>
<td>Sum</td>
<td>100 (100 %)</td>
<td>102 (100 %)</td>
<td>202 (100 %)</td>
</tr>
</tbody>
</table>

Table 1: Crestal bone loss distribution after 2 years
Clinical field trial examining an implant with a sand-blasted, acid-etched surface
Cochran D, Oates T, Morton D, Jones A, Buser D, Peters F.

Abstract: A clinical field trial was performed with 990 implants in 509 patients. Survival and success after 5 years were 99.3 % and 97.4 %, respectively, comparable to those achieved in formal clinical trials.

Introduction
Traditionally, dental implants required 3 to 6 months of undisturbed healing before the prosthetic restoration could take place. Formal clinical trials have demonstrated that implants with the SLA® surface can be successfully restored after 6 weeks. The aim of this study, therefore, was to evaluate the use of SLA® surfaced implants and a reduced healing time (6–8 weeks) in a large number of patients treated in predominantly private practice settings.

Methods
The study was designed to include over 500 patients and over 800 implants. The patients were to be treated no differently to any other implant patients in the private practice setting. Requirements for treatment included good general health and sufficient bone at the implant site (crest width > 6 mm and height > 10 mm). The implants were placed in a non-submerged technique and had abutments placed and restored in full occlusion by 63 days following placement. Follow-up examinations were performed after 3 months and annually thereafter. A total of 86 investigators worldwide placed 1,406 implants in 706 patients; 27 patients (79 implants) were excluded because six investigators did not return documentation, and 170 patients (337 implants) were excluded due to implant restoration after > 63 days (Fig. 1).

Abstract: A clinical field trial was performed with 990 implants in 509 patients. Survival and success after 5 years were 99.3 % and 97.4 %, respectively, comparable to those achieved in formal clinical trials.

Results
A total of 509 patients with 990 implants (270 in the maxilla and 720 in the mandible) were treated according to the protocol. There were four early implant failures (i.e. prior to or at abutment connection), and another implant failed 3 months after abutment placement; of these five, one was still in function after 3 years and was rated as successful by the investigator. One late implant failure occurred after 49 months of function. The cumulative survival rates after 3 and 5 years were 99.56 % and 99.26 %, respectively, while the corresponding success rates were 99.12 % and 97.38 % (Table 1). Complications noted included gingivitis in two patients (four and two implants), recurrent peri-implant infection in two patients (one implant each) and pain/discomfort in one patient (one implant). Successfully treated complications included implant rotation on abutment placement (12 patients/15 implants), pain/discomfort on abutment placement (22 patients/34 implants), gingival recession (one patient), parasthesia of the lower lip (two patients) and gingival hyperplasia (one patient).

Table 1: Cumulative implant survival and success rates – life table analysis

<table>
<thead>
<tr>
<th>Interval (months)</th>
<th>Implants at baseline</th>
<th>Failures</th>
<th>Cumulative survival rate (%)</th>
<th>Failures</th>
<th>Cumulative success rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–12</td>
<td>990</td>
<td>4</td>
<td>99.56</td>
<td>4</td>
<td>99.56</td>
</tr>
<tr>
<td>12–24</td>
<td>809</td>
<td>0</td>
<td>99.56</td>
<td>1</td>
<td>99.42</td>
</tr>
<tr>
<td>24–36</td>
<td>686</td>
<td>0</td>
<td>99.56</td>
<td>2</td>
<td>99.12</td>
</tr>
<tr>
<td>36–48</td>
<td>603</td>
<td>0</td>
<td>99.56</td>
<td>3</td>
<td>98.56</td>
</tr>
<tr>
<td>48–60</td>
<td>462</td>
<td>1</td>
<td>99.26</td>
<td>4</td>
<td>97.38</td>
</tr>
<tr>
<td>60–72</td>
<td>202</td>
<td>0</td>
<td>99.26</td>
<td>0</td>
<td>97.38</td>
</tr>
<tr>
<td>&gt; 72</td>
<td>11</td>
<td>0</td>
<td>99.26</td>
<td>0</td>
<td>97.38</td>
</tr>
</tbody>
</table>

Compliance with study protocol?
- Yes
- No

Implants restored within 63 days?
- Yes
- No

Conclusions
- SLA® implants can be successfully restored after 6–8 weeks in a private practice setting.
- Very high survival and success rates were documented (99.26 % and 97.38 % after 5 years).
- Cumulative survival rates were comparable to those from formal clinical trials with stricter inclusion criteria.
- The high numbers of investigators and patients suggested that the characteristics of the SLA® surface are such that critical aspects of the healing process are accounted for.
Clinical performance of wide-body implants with a sandblasted and acid-etched (SLA®) surface: results of a 3-year follow-up study in a referral clinic


Abstract: A total of 116 patients received SLA® wide body implants in a specialist clinic. Survival and success rates of 99.3 % were achieved after 3 years.

Introduction

The aim of this investigation was to evaluate the clinical performance of SLA® wide-body implants with a regular or wide neck in a referral clinic to assess whether the success rates were similar to those achieved under strict, well-defined conditions.

Methods

This was a prospective investigation of patients referred by their private dentist to a specialist clinic for implant therapy. The study enrolled 116 partially edentulous patients, including smokers and those with defects requiring bone augmentation. A total of 151 wide-body implants with either a regular neck or wide neck configuration were placed (75 in distal extension situations, 56 in single-tooth gaps and 20 in extended edentulous spaces). Prosthetic rehabilitation took place after 6–8 weeks for implants placed without bone augmentation and after 10–14 weeks for implants with local bone augmentation. Single crowns were used for 95 implants, 29 were restored with splinted single crowns and 20 were used as abutments for implant-supported FPDs. After 36 months, clinical and radiographic follow-up was performed, and the following parameters were evaluated: modified plaque index (mPl), modified sulcus bleeding index (mSBi), probing depth (PD), distance from implant shoulder to mucosal margin (DiW), clinical attachment level (CAL), mobility, as measured by Periotest (PTV), and, distance from implant shoulder to first visible BIC.

Results

One implant in the left maxilla became unstable during the healing period due to a peri-implant infection and was removed; no signs of peri-implant infection or mobility were observed for the remaining 150 implants. Six patients with 11 implants did not attend the 36-month examination and were therefore lost to follow-up. Clinical and radiographic analysis therefore included 109 patients with 139 implants, all of which were successfully integrated. The 3-year survival and success rate was 99.3 %. All 139 implants showed favorable clinical and radiographic findings: mean mPl and mSBi were 0.26 and 0.6, respectively. Mean PD and CAL were 3.87 mm and 2.79 mm, respectively. Mean DiW at 3 years was -1.13 mm, and the mean DiB increased from 2.52 mm at implant insertion to 2.85 mm after 3 years; the difference was significant, but progressive bone loss was not detected at any implant over the 3-year evaluation period (Fig. 1). Frequency analysis showed that most implants had a DiB between -0.5 and +0.5 mm (Fig. 2), corresponding to < 0.2 mm bone gain or loss per year.

Conclusions

- Wide body SLA® implants with regular or wide neck configurations achieved successful integration and high predictability in patients referred for implant therapy.
- Favorable clinical and radiographic results were observed.
- The 3-year survival and success rates was 99.3 %.
- The implant survival compares well with that from clinical studies with standard diameter SLA® implants in selected patient populations.

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Figure 1: 36-month peri-apical radiograph showing normal bone structures around implants, with no signs of peri-implant radiolucencies

Figure 2: Frequency analysis of bone gain or loss around 134 implants using $\Delta$DiB values
Five-year results from a randomized, controlled trial on early and delayed loading of implant supporting full-arch prosthesis in the edentulous maxilla

Fischer K, Stenberg T, Hedin M, Sennerby L.

**Abstract:** SLA® implants were placed in the edentulous maxillae of 24 patients and loaded with full-arch prostheses either early or conventionally. The 5-year cumulative survival rate was 95.1 %, indicating that early loading in the maxilla is a viable treatment option.

---

**Introduction**

Studies with SLA® implants have shown stable radiographic bone levels, but few studies have presented long-term radiographic data. The aim of this investigation, therefore, was to compare the clinical outcome and stability of early and delayed loaded one-stage implants with the SLA® surface in the edentulous maxilla.

**Methods**

The study included 24 patients with totally edentulous maxillae requiring implant treatment. Each patient received five or six implants (diameter 4.1 mm, length 8–12 mm). The patients were assigned to either early implant loading (16 patients with 95 implants loaded after 9–18 days) or delayed loading (eight patients with 47 implants loaded after 2.5–5.1 months). Prostheses were fabricated from cast titanium alloy with acrylic resin crowns. Clinical and radiographic evaluations (sulcus bleeding index, plaque index, probing depth, distance from implant shoulder to crestal bone level) were performed after 1, 3 and 5 years of loading; the prostheses were removed on each occasion. Implant stability was also recorded in mesial-distal and buccal-palatal directions for each implant using resonance frequency analysis (RFA).

---

**Results**

During the 5-year study period, seven implants were lost (five in the test group and two in the control group); three were early failures (before loading) and four were late failures. In addition, one patient with six implants did not attend the 5-year follow-up evaluation. The 5-year cumulative survival rate was 95.1 % (94.7 % and 95.7 % in the test and control groups, respectively). There were no significant differences between the groups for RFA values. Plaque and bleeding on probing were greater in the control patients, and more control implants showed probing depths > 3 mm. Mean marginal bone level after 5 years was 2.9 ± 1.1 mm in the test group and 3.7 ± 1.2 mm in the control group (Fig. 1); mean bone loss was 0.8 ± 1.2 mm and 0.3 ± 1.0 mm for test and control implants, respectively — the difference was significant. It was noted, however, that the early loaded implants were generally placed deeper into the bone. The numbers of patients with > 2 mm bone loss was similar in both groups, but more patients in the test group showed > 3 mm bone loss. Resin-related technical complications were also more prevalent in the test group (18 versus 12 in the control group), but implant, abutment, abutment screw or assembly screw fractures did not occur in either group.

---

**Conclusions**

- Survival rates for early and delayed loaded SLA® implants in the edentulous maxilla were not significantly different after 5 years.
- Minimal bone resorption indicated favorable long-term marginal bone response to the SLA® surface.
- Early loading of SLA® implants to support full-arch prostheses in the edentulous maxilla is therefore a viable treatment option.
- Technical complications were mainly resin-related, which may be improved by the use of a lingual gold onlay.
Performance of dental implants after staged sinus floor elevation procedures: 5-year results of a prospective study in partially edentulous patients

Bornstein MM, Chappuis V, von Arx T, Buser D.

Abstract: SLA® and TPS implants were placed in 56 patients following sinus floor elevation. After 5 years, survival was 100% for SLA® and 89% for TPS implants.

Introduction
Sinus floor elevation using graft material is the most common solution for insufficient bone volume in the posterior maxilla. The aim of this study was to evaluate the clinical and radiographic 5-year results for implants with either a TPS or an SLA® surface placed in a two-stage sinus floor elevation procedure in the posterior maxilla.

Methods
A total of 59 sinus floor elevation procedures were performed in 56 partially edentulous patients. A composite graft was used, consisting of autogenous bone chips combined with deproteinized bovine bone mineral or synthetic β-tricalcium calcium phosphate. After a healing period of 4–12 months, a total of 111 implants (90 SLA® and 21 TPS) were placed (93 in distal extension situations, four in single-tooth gaps and 14 in extended edentulous spaces). Abutments were placed after a healing period of 8–14 weeks and prostheses were placed (41 single crowns and 71 splinted single crowns). Patients were recalled 12 and 60 months after abutment connection for clinical and radiographic examination, consisting of modified plaque index (mPI), modified sulcus bleeding index (mSBI), probing depth (PD), clinical attachment level (CAL), mobility (assessed by Periotest; PTV), distance between implant shoulder and mucosal margin (DIM) and distance from implant shoulder to first visible BIC (DIB).

Results
At the 5-year evaluation, 100 implants could be analyzed; six patients with 11 implants dropped out of the study at the 12- and 60-month examinations. There were two implant failures, both of which were TPS implants, resulting in a 5-year survival and success rate of 98% (100% for SLA® implants and 88.98% for TPS implants). A local peri-implant infection occurred at two of the implants after 12 months – both cases were successfully treated. No peri-implant radiolucency or mobility was detected for any of the implants at any time point. There were no significant differences in gingival parameters between 12 and 60 months except for PD, which showed a significant decrease (Table 1).

<table>
<thead>
<tr>
<th>Exam</th>
<th>mPI</th>
<th>mSBI</th>
<th>PD (mm)</th>
<th>DIM (mm)</th>
<th>CAL (mm)</th>
<th>PTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>0.34 ± 0.03</td>
<td>0.35 ± 0.04</td>
<td>4.43 ± 0.11</td>
<td>-1.35 ± 0.11</td>
<td>3.04 ± 0.06</td>
<td>-2.71 ± 0.31</td>
</tr>
<tr>
<td>5 year</td>
<td>0.27 ± 0.03</td>
<td>0.29 ± 0.03</td>
<td>4.14 ± 0.11</td>
<td>-1.22 ± 0.11</td>
<td>2.89 ± 0.08</td>
<td>-3.00 ± 0.28</td>
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</table>

Table 1: Gingival parameters and mobility at 1 and 5 years (mean ± SE)

Conclusions
• Implants with an SLA® surface placed after sinus floor elevation with a composite graft achieve successful tissue integration with high predictability over 5 years of follow-up.
• The survival and success rate for SLA® implants was 100%.
• Implant placement after sinus floor elevation for single crowns or FPDs can be considered the standard of care, provided that the patient has no active periodontal disease, is not a smoker and is not medically compromised.
Clinical and radiographic study of implant treatment outcome in periodontally susceptible and non-susceptible patients: a prospective long-term study  
De Boever AL, Quirynen M, Coucke W, Theuniers G, De Boever JA.  

Abstract: SLA® and TPS implants were placed in periodontally susceptible or non-susceptible patients. Implant surface and periodontal status significantly influenced implant survival, which was significantly greater for SLA® implants.

Introduction  
Placement of dental implants has become a routine procedure for tooth replacement, but clinical outcome in periodontally compromised or susceptible patients is still controversial. The aim of this investigation was to compare implant survival and periodontal and radiographic parameters of non-submerged implants with either a TPS or SLA® surface in periodontitis-susceptible and healthy non-periodontally susceptible patients.

Methods  
A total of 221 patients requiring non-submerged implants and FPDs were enrolled – of these, 194 were available and were divided into three groups: non-periodontally susceptible patients (NSP; 110 patients, 261 implants), in whom teeth required replacement due to cavities or trauma; periodontally susceptible patients (CAP; 68 patients, 193 implants), in whom teeth were lost due to generalized chronic adult periodontitis; or, patients with generalized aggressive periodontitis (GAP; 16 patients, 59 implants). TPS implants (259) were used in the first phase of the study and SLA® implants (254) were used after this surface was introduced. At the follow-up times (at least every 6 months), probing depth (PD), bleeding on probing (BOP), plaque score, bone score, bone loss and implant failures were evaluated.

Results  
There were 24 implant failures in 22 patients, 20 of which occurred before loading and four of which occurred after loading. There were eight, seven and three failures in the NSP, CAP and GAP groups, respectively, giving implant failure rates of 3.06 %, 3.62 % and 15.25 %, respectively. Cumulative implant survival rates were 97 % in the NSP group (over 140 months) and 96 % in the CAP group (over 140 months), but was significantly lower at 80 % in the GAP group (over 100 months). General impaired health did not adversely affect survival for all patients combined, but led to a further decrease in survival rate (to 71 %) in the GAP group. The survival rate for TPS implants was lower than that for SLA® implants (93 % versus 97 %, respectively; Fig. 1). There was no difference in implant survival between current and former smokers for all patients combined, but smoking significantly decreased implant survival in the GAP group (to 63 %). Mean marginal bone loss compared to baseline was 0.28 ± 0.7 mm and 0.24 ± 0.6 mm at the mesial and distal sides, respectively. Mean mesial and distal bone loss/year was 0.08 mm and 0.07 mm in the NSP group, 0.12 mm and 0.09 mm in the CAP group and 0.17 mm and 0.17 mm in the GAP group, where bone loss was significantly related to bleeding on probing, age, inflammation, plaque and probing depth.

Conclusions  
• Periodontally susceptible and non-susceptible patients demonstrated similar peri-implant variables and implant survival, but those with generalized aggressive periodontitis showed lower implant survival, higher marginal bone loss and more peri-implant pathology.
• Implant surface and periodontal classification had a significant influence on implant survival.
• Implant survival was significantly greater for SLA® versus TPS implants.

Figure 1: Kaplan-Meier survival curve for TPS and SLA® implants
Marginal bone level changes and prosthetic maintenance of mandibular overdentures supported by 2 implants: a 5-year randomized clinical trial


**Abstract:** SLA® or TiUnite® implants were placed in 28 patients to support mandibular overdentures. Implant survival was 100% in both groups, but marginal bone loss was significantly less for Straumann® Soft Tissue Level SLA® implants.

**Introduction**
Success with early loading of implant-supported restorations has been demonstrated, but documentation on early loading of mandibular overdentures is scarce. The aim of this investigation, therefore, was to compare biologic and prosthetic outcomes of mandibular overdentures supported by early loaded one- and two-stage implants after 5 years.

**Methods**
This was a randomized, controlled, single-blind trial in 28 patients, randomized into two groups to receive either two unsplinted Straumann® Soft Tissue Level SLA® implants (14 patients) to support mandibular overdentures (retained by retentive anchor abutment with PVC ring covered gold matrix) or two unsplinted Brånemark (Mk III TiUnite®) implants (14 patients) to support mandibular overdentures (retained by ball attachments with gold caps). Straumann® implants were placed so that the SLA®/machined border was at the level of the cortical bone, and Brånemark implants were placed so that the upper outer edge of the implant neck was at the level of the cortical bone. During a healing period of 4–6 weeks after implant placement, the patients' existing dentures were re-lined, and the prostheses were placed in both groups after 6–8 weeks. Plaque index, calculus index, peri-implant inflammation and bleeding were recorded, and radiographic marginal bone levels were examined 1 week and 5 years post-surgery.

**Results**
Six patients (two with Straumann® implants and four with Brånemark implants) were excluded from the study after 5 years; data were therefore available from 22 patients (12 patients with 24 Straumann® implants and 10 patients with 22 Brånemark implants). There were no implant failures in either group. Peri-implant parameters were comparable for both implant systems, but mean marginal bone loss was significantly higher for Brånemark implants (Fig. 1), and the maximal bone level change was also higher (1.8 mm compared to 1.3 mm for Straumann® implants; Fig. 1). Survival probabilities for overdentures were similar, but wear of the ball abutment was observed more for the Brånemark implants, while occlusal adjustment, broken/loose/lost retainers and retainer retightening were more prevalent in the Straumann group.

**Conclusions**
- Similar peri-implant soft tissue and prosthetic outcomes were found for mandibular overdentures supported by Straumann® Soft Tissue Level SLA® or Brånemark TiUnite® implants.
- All implants survived after 5 years.
- Marginal bone loss was significantly less for Straumann® SLA implants versus Brånemark TiUnite® implants after 5 years.

![Figure 1: Marginal bone loss (mm) around Straumann® and Brånemark implants after 5 years](image_url)
10-year outcome of SLA® implants in the edentulous maxilla

Fischer K.
ITI World Symposium; Geneva, Switzerland, 15–17 Apr 2010.

Abstract: SLA® implants were placed in the edentulous maxillae of 24 patients and loaded with full-arch prostheses either early or conventionally. The implant survival rate after 10 years was 95.1 %, with no significant bone loss between 5 and 10 years.

Introduction
Studies with SLA® implants have shown stable radiographic bone levels and, although some trials show data over long periods (e.g. 5 years), no 10-year follow-up data have been published. The aim of this study, therefore, was to evaluate and compare the long-term outcomes of two different loading protocols for SLA® implants in the edentulous maxilla.

Methods
This was a randomized, controlled study in 24 patients with completely edentulous maxillae. A total of 142 SLA® surfaced implants* were placed and loaded with full-arch prostheses either after 9–18 days (early loading – test group; 16 patients with 95 implants) or after 2.5–5.1 months (delayed loading – control group; eight patients with 47 implants). Radiographic examination was performed at prosthesis placement and after 6 months and 1, 2, 3, 5 and 10 years; prosthesis placement was the baseline measurement. Plaque index (PI), sulcus bleeding index (SBi) and probing depth (PD) were also measured.

Results
One-year31, 3-year32 and five-year17 results of the study were previously published. Seven implants were lost between baseline and 5 years, and no further implants were lost between 5 and 10 years. One patient with severe/aggressive periodontitis only had three implants still in place at the 5-year evaluation and dropped out of the study before the 10-year evaluation. No other patients showed signs of peri-implantitis. In terms of implant losses, the implant survival rate was 95.1 %, but if implants of unknown status were also considered (i.e. the drop-out patient with three implants), then the implant survival rate was 93 %. The prosthesis survival rate was 96 %, and high patient satisfaction was reported. The change in mean marginal bone level between 5 and 10 years was not significant; mean marginal bone loss after 5 and 10 years in the test group was -0.8 ± 1.2 mm and -1.1 ± 0.9 mm, respectively, and in the control group was -0.3 ± 1.0 and -0.7 ± 1.3 mm, respectively (Fig. 1). The majority of implants (67.9 %) had a sulcus bleeding index of 1 and most had a plaque index of 1 (28.6 %) or 2 (39.3 %). A total of 70 prosthesis-related complications occurred, 68 of which were resin-related and two of which were metal-related. There were no abutment fractures.

Conclusions
- There were no implant losses between 5 and 10 years.
- There was no significant bone loss between 5 and 10 years.
- Prosthesis survival was high (96 %) and complications were predominantly resin-related.
- No signs of peri-implantitis were noted (except in one patient with severe aggressive periodontitis).
- Patient satisfaction was high.

* SLA® surface implants refers to Straumann® Soft Tissue Level SLA® implants.
ADDITIONAL STUDIES

The following publications indicate the scientific evidence about Straumann’s SLA® surface, including over 110 clinical studies (see list below), over 140 in vitro (e.g. laboratory, cell culture) investigations and over 80 preclinical in vivo investigations:

Clinical studies:


REFERENCES


