Straumann® SLActive® Surface

Scientific Update

Scientific Studies

	Topic	Study Type	Authors	Title	Outcomes	Date
1	Competitive Comparison	Preclinical	Buser, D et al	Enhanced Bone Apposition to a Chemically Modified SLA Titanium Surface	➢ About 60% more bone-to–implant contact with SLActive at 2 wks of healing ➢ Earlier formation of mature bone	2004
2		Preclinical	Schwarz F.et al.	Histological and immunohistochemical analysis of initial and early osseous integration at chemically modified and conventional SLA® titanium implants: preliminary results of a pilot study in dogs	>Increased activity of osteocalcin at the bone-to-implant interface with SLActive® ➢ Enhanced bone formation processes with SLActive®	2007
3		PreClinical	Schwarz ,F., et al	Influence of titanium implant surface characteristics on bone regeneration in dehiscence-type defects: an experimental study in dogs	> New bone height was significantly higher for SLActive®at both timepoints	2010
4	Biological Response	In Vitro	Rupp, F, et al.	Enhancing surface free energy and hydrophilicity through chemical modification of microstructured titanium implant surfaces.	> Enhanced surface free energy, increased hydrophilicity > Reduced atmospheric contamination by hydrocarbons	2006
5		In Vitro	Rausch-fan X, et al.	Differentiation and cytokine synthesis of human alveolar osteoblasts compared to osteoblast-like cells (MG63) in response to titanium surfaces.	> Vascularization factor most elevated on SLActive. > Highest expressions of differentiation markers and the highest growth factor productions on SLActive	2008
6		In Vitro	Maniura, K., et al.	Protein and blood adsorption on Ti and TiZr implants as a model for osseointegration.	> SLActive higher biological responses than SLA (blot clot formation, proliferation, differentiation and mineralization ..)	2013
7		In Vitro	Hotchkiss KM et al	Dental implant surface chemistry and energy alter macrophage activation in vitro	>Osteogenesis effect was greatest on Roxolid SLActive® >SLActive® activated anti-inflammatory macrophage	2016
8		PreClinical	Schwarz, F. et al.	Bone regeneration in dehiscence-type defects at non-submerged and submerged chemically modified (SLActive®) and conventional SLA® titanium implants: an immunohistochemical study in dogs.	> SLActive surface promoted bone regeneration in dehiscence-type defects	2008
9		Clinical	Raghavendra, S, et al.	Early wound healing around endosseous implants: A review for the literature.	> Description of healing pattern on implant and stability shift from primary to secondary with a dip in between	2005
10		Clinical	Oates, TW, et al.	Enhanced implant stability with a chemically modified SLA® surface: a randomized pilot study.	> A shift in implant stability, eliminating the dip > Reduced healing time from 6-8 weeks down to 3-4 weeks	2007
11		Clinical	Lang, N.P., et al	Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans.	> SLActive healing process has been confirmed to be similar to that of SLA. > Greater BIC after 2 weeks, significantly greater after 4 weeks	2011

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Scientific Studies

	Topic	Study Type	Authors	Title	Outcomes	Date
12		PreClinical	Schwarz, F., et al.	Bone regeneration in dehiscence-type defects at chemically modified (SLActive®) and conventional SLA® titanium implants: a pilot study in dogs.	> SLActive® surfaces may promote bone regeneration in acute-type buccal dehiscence defects and promotes the production of significantly greater and more mature bone	2007
13		PreClinical	Lai, HC, et al.	Bone apposition around two different sandblasted, large-grit and acid-etched implant surfaces at sites with coronal circumferential defects: An experimental study in dogs.	> SLActive® enhance bone apposition in coronal circumferential defects at non-submerged implants.	2009
14	Treatment Protocols	Clinical	Benic, GI, et al.	Titanium-zirconium narrow-diameter versus titanium regular-diameter implants for anterior and premolar single crowns: 1-year results of a randomized controlled clinical study.	> Roxolid SLActive® supports less invasive procedures with narrower implants in the anterior and premolar regions by enhancing the bone stability and the success rate	2013
15		Clinical	Buser, D, et al.	Long-term Stability of Early Implant Placement with Contour Augmentation.	> Long-term stability of peri-implant hard and soft tissues after 6 years with highly esthetic outcomes in early placement	2013
16		Clinical	Nicolau, P, et al.	Immediate and early loading of Straumann® SLActive® implants: A ten Year Follow-up	> Results of this long-term study show high implant survival and clinical outcomes at 10 years follow-up	2018
17	Compromised Health	PreClinical	Mardas, N, et al.	The effect of SLActive® surface in guided bone formation in osteoporotic-like conditions	> SLActive® surface may promote bone healing and osseointegration in osteoporotic rabbits	2011
18		PreClinical	Schlegel, KA, et al.	Osseointegration of SLActive® implants in diabetic pigs	> SLActive® elicited an accelerated osseointegration	2013
19		Clinical	Khandelwal N , et al	Conventional SLA® and chemically modified SLA implants in patients with poorly controlled type 2 Diabetes mellitus – a randomized controlled trial	> 100% implant survival rate with SLActive® compared to 96% with SLA	2013
20		Clinical	Nack C. et al Heberer et al Nelson K	Rehabilitation of irradiated patients with chemically modified and conventional SLA® implants: five-year follow-up	>SLActive® implants can be used in irradiated patients with a high predictability of success > 100% implant survival rate with SLActive®	2015 2011 2016
21		Clinical	Cabrera-Domínguez J et al	A Prospective Case-Control Clinical Study of Titanium-Zirconium Alloy Implants with a Hydrophilic Surface in Patients with Type 2 Diabetes Mellitus	>Patients with glycemic control exhibit similar outcomes to healthy individuals with regard to the investigated parameters. > 100% implant survival rate after 2 years >titanium-zirconium alloy small-diameter implants can be used in the anterior region of the mouth in type 2 diabetic patients.	2017

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1 D. Buser, et al.- Enhanced bone apposition to a chemically modified SLA titanium surface

Purpose
Evaluate bone apposition to a modified sandblasted/acid etched titanium surface (SLActive) as compared to standard SLA surface, during early stages of bone regeneration.

Methodology

- Split mouth design in 6 adult mini pigs; 3-4 implants placed on either side of maxilla
- Histological and histomorphometric analysis performed at 2,4,8 wks of healing
- Analysis done to identify effects of surface wettability on surface roughness and mean bone-to-implant contact (BIC)

Conclusion

- **About 60% more bone to implant contact after two weeks with SLActive**
- **Earlier formation of more mature bone**
- **SLA is hydrophobic; modSLA (SLActive) is hydrophilic**

Results

- **Significant difference in wettability of surface type observed: dynamic contact angle measurements showed that SLA is hydrophobic while modSLA (SLActive) is hydrophilic**
- **Both implant types showed direct bone-to-implant contact starting 2 wks at healing**
- **More bone to implant contact (BIC) at 2 and 4 wks with modSLA (SLActive)**

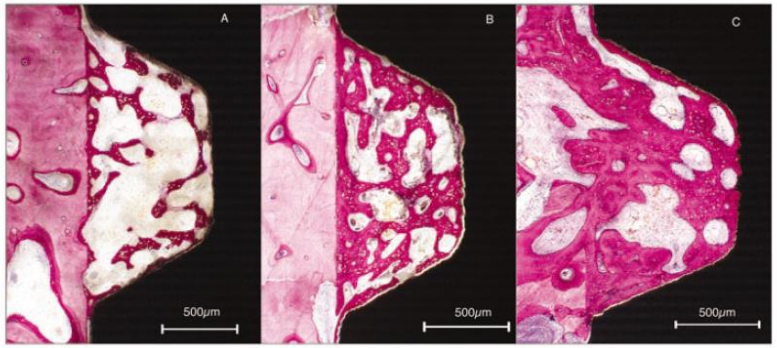

Figure 2. Histological appearance of bone apposition. (**A**) At 2 wks, bone is deposited on the bony wall of the tissue chamber and on the implant surface. Both layers are connected by a scaffold of tiny trabeculae. Woven bone is characterized by the intense staining of the mineralized matrix and the numerous osteocytes located in large lacunae (undecalcified ground section, surface-stained with toluidine blue and basic fuchsin; bar = 500 µm). (**B**) At 4 wks, the volume density of this scaffold has increased both by the formation of new trabeculae and by deposition of more mature, parallel-fibered bone onto the primary scaffold. Woven bone is mainly recognized by the numerous large osteocytic lacunae (bright). The gap between bone and implant surface is an artifact (bar = 500 µm). (**C**) At 8 wks, growth and reinforcement result in a further increase in bone density and an almost perfect coating of the implant surface with bone. Remodeling has started, replacing the primary bone by secondary osteons (arrows; bar = 500 µm).

. D. Buser, N. Broggini, M. Wieland, R. K. Schenk, A. J. Denzer, D. Cochran, B. Hoffmann, A. Lussi, S. G. Steinemann - J. Dent. Res. 2004;83:529–533,2004

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2

Schwarz F, et al.- Analysis of initial and early osseous integration at chemically modified and conventional SLA® titanium implants : preliminary results of a pilot study in dogs

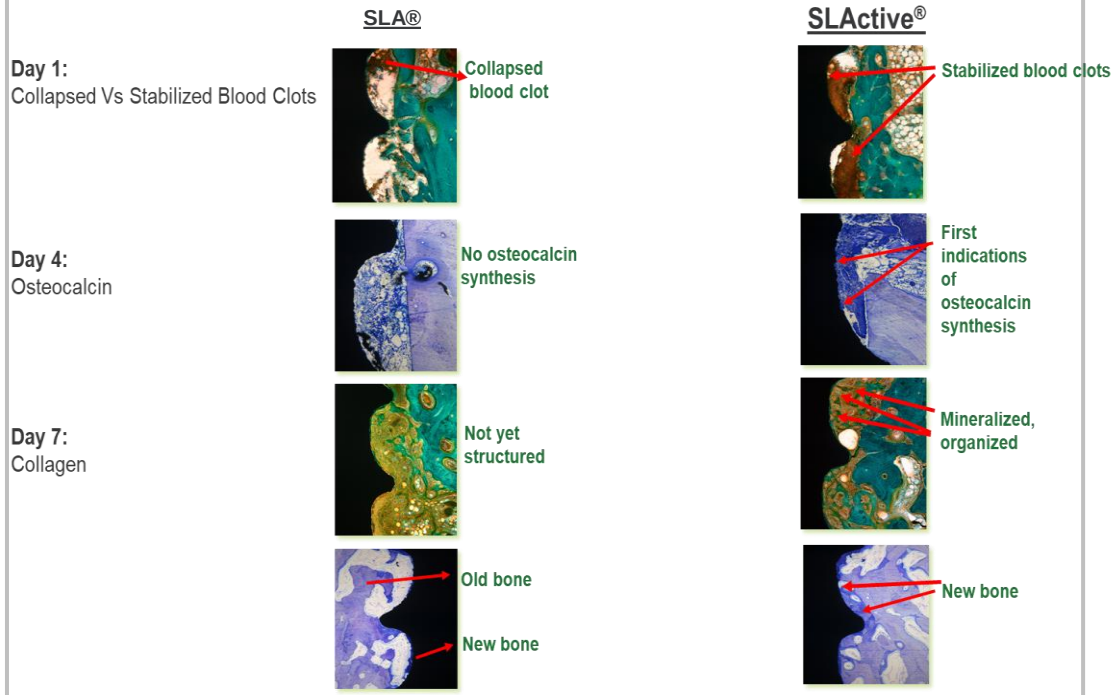
Purpose
Evaluate histologically, the initial and early osseous integration for SLActive and conventional SLA implants

Methodology
- Fox hounds
- SLA® (control); SLActive® (test)
- 6 implants in the maxilla (3 SLActive and 3 SLA)
- 10 implants in the mandible (5 SLActive and 5 SLA)
- Examination at Day 1, 4, 7, and 14
- Statistical analysis: Histological assessment of the quality and quantity of collagen and new bone formation

Conclusion
- **Analysis showed differences in bone formation vs. SLA®**
- **Increased activity of osteocalcin at the bone-to-implant interface with SLActive®**

Results

>Enhanced bone formation processes with SLActive®



F. Schwarz, M. Herten, M. Sager, M. Wieland, M. Dard, J. Becker Clin. Oral Impl. Res. 2007;18:481-488

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3 Schwarz F., et al.- Influence of titanium implant surface characteristics on bone regeneration in dehiscence-type defects: an experimental study in dogs.

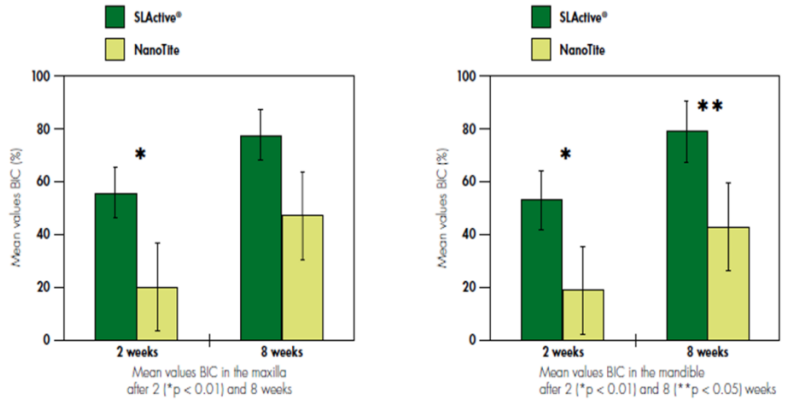
Purpose
Evaluate and compare bone regeneration in standardized dehiscence defects at implants with SLActive® and Nanotite surface

Methodology
- Split-mouth design in 12 dogs
- SLActive and NanoTite® implants randomly assigned and left to heal in a submerged position in sites with surgically created standard buccal dehiscence-type defects in both upper and lower jaws
- Analysis at 2 and 8 weeks for:
  - New bone height (NBH)
  - Percent bone-to-implant contact (BIC)
  - Area of new bone fill (BF)
  - Area of mineralized tissue within bone fill (MT)
- Differences in macro design of SLActive and NanoTite implants were not evaluated

Conclusion
- **New bone height was significantly higher for SLActive at both timepoints**
- **Bone-to-implant contact was significantly higher for SLActive compared to Nanotite at 2 weeks in the maxilla and at 2 and 8 weeks in the mandible**
- **SLActive implants may have a higher potential to support osseointegration in dehiscence-type defects than Nanotite implants**

Results

> New bone height was significantly higher for SLActive at both timepoints
> Bone-to-implant contact was significantly higher for SLActive compared to Nanotite at 2 weeks in the maxilla and at 2 and 8 weeks in the mandible
> Mean bone fill and mineralized tissue were comparable between groups



Mean BIC values after 2 and 8 weeks in the maxilla and mandible

Schwarz F, Sager M, Kadelka I, Ferrari D, Becker J. Influence of titanium implant surface characteristics on bone regeneration in dehiscence-type defects: an experimental study in dogs. J Clin Periodontol 2010; 37: 466–473. doi: 10.1111/ j.1600-051X.2010.01533.x.

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4 Rupp F., et al.- Enhancing surface free energy and hydrophilicity through chemical modification of microstructured titanium implant surfaces.

Purpose
To investigate the surface characteristics of SLActive® implants prepared under special conditions.

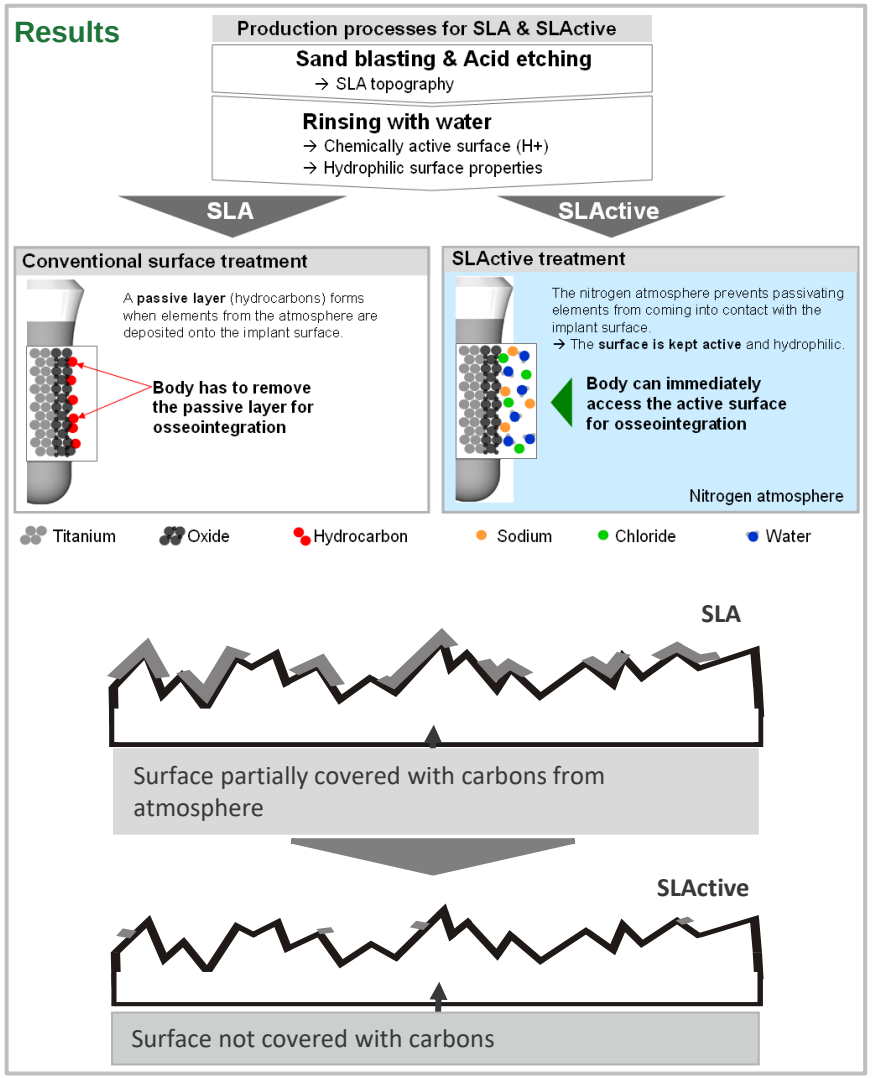
Methodology
Surface Free Energy (SFE) and hydrophilicity were measured after preparation of the SLActive® surface under special conditions:

Protective gas conditions
(Nitrogen atmosphere)

Liquid storage
instead of dry storage

Conclusion
- **Enhanced surface free energy ► chemical activity**
- **Increased hydrophilicity**
- **Reduced atmospheric contamination by hydrocarbons**

Results



Rupp F, Scheideler L, Olshanska N, de Wild M, Wieland M, Geis-Gerstorfer J. Enhancing surface free energy and hydrophilicity through chemical modification of microstructured titanium implant surfaces. Journal of Biomedical Materials Research A, 76(2):323-334, 2006

5

Rausch-fan X., et al. Differentiation and cytokine synthesis of human alveolar osteoblasts compared to osteoblast-like cells (MG63) in response to titanium surfaces.

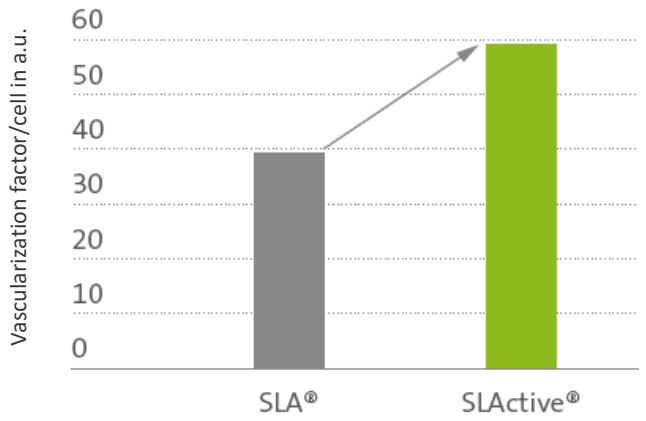
Purpose
The aim of this study was to investigate the influence of different implant surface topographies and chemistries on the expression of differentiation/proliferation markers on MG63 cells and primary human alveolar osteoblasts.

Methodology
- Four types of titanium discs were used: Acid-etched, SLA®, modified acid-etched and modified SLA (SLActive).
- Human primary cells (osteoblasts, gingival fibroblasts and gingival epithelial cells) were used in order to mimic the in vivo situation as closely as possible. In addition, appropriate cell lines were also used: MG-63 (human osteoblastic cell line), HGF-1 (gingival fibroblast cell line), HSC-2 (epithelial cell line) and an endothelial cell line.
- Growth on the titanium surfaces was monitored by fluorescence cell staining and time-lapse photography

Conclusion
- **Significantly enhanced early cell reaction in response to the chemically active SLActive surface**
- **Study showed for the first time that levels of VEGF (=vascularization factor), a well known molecule to stimulate angiogenesis playing an essential role in wound healing, most elevated on SLActive**
- **Highest expressions of differentiation markers and the highest growth factor productions on SLActive**

Results

> Vascularization factor at 1 week



Rausch-fan X, Qu Z, Wieland M, Matejka M, Schedle A. Differentiation and cytokine synthesis of human alveolar osteoblasts compared to osteoblast-like cells (MG63) in response to titanium surfaces. Dental Materials 2008 Jan;24(1):102-10. Epub 2007 Apr 27.

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6 Maniura, K., et al.–Protein and blood adsorption on Ti and TiZr implants as a model for osseointegration

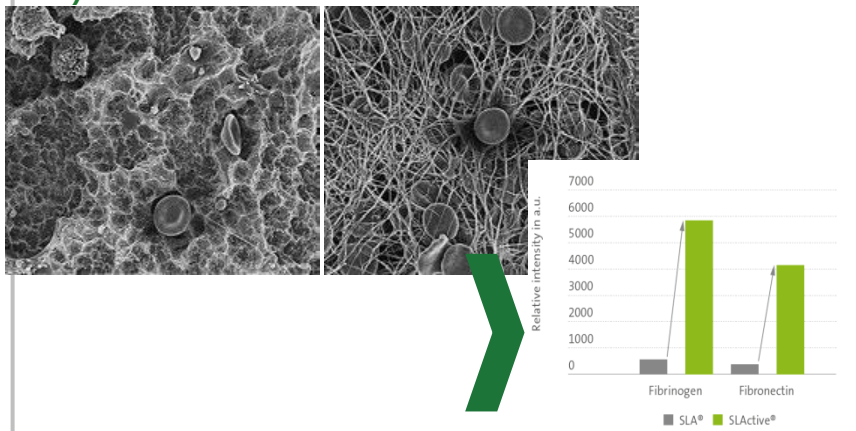
Purpose
A systematic investigation of the influence of different surface characteristics on the adsorption of blood proteins and the degree of early blood coagulation will help in understanding the mechanisms involved in osseointegration.

Methodology
- In vitro study on disc comparing the SLA® and SLActive® surface.
- The roughened surface topography on the SLA-type surfaces is due to the large-grit sandblasting process, which produces a macro roughness , with a lateral feature size of about 20-40 µm, and acid etching, which produces micro pits, with a lateral feature size about 2-4 µm.
- All discs were γ-sterilized (25-42 kGy) prior to all subsequent investigations.

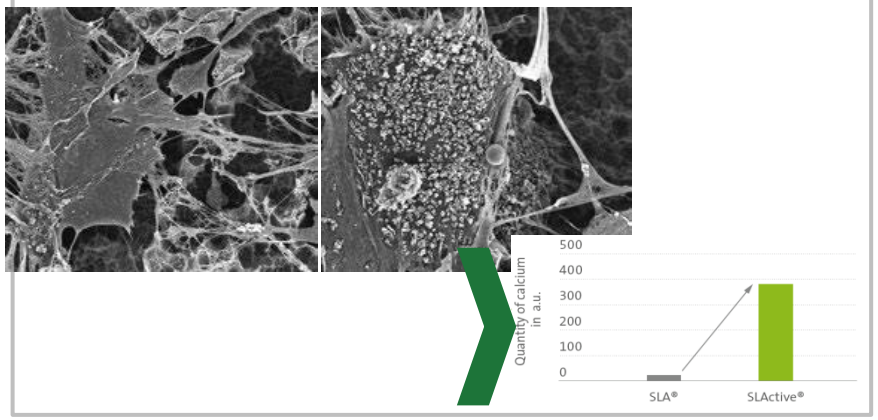
Conclusion
- **Ti SLActive and TiZr SLActive® surfaces enhance the following compared to Ti SLA:**
  - **Protein adsorption and blood coagulation**
  - **Osteogenic differentiation of primary human bone cells**
  - **Faster bone cell mineralization**
- **Interaction of blood components with implant surfaces can improve the predictiveness of cell studies for novel implant materials**
- **Explains <u>why</u> SLActive® shows earlier osseointegration**

Results

> Fibrin network formation (Protein adsorption and blood coagulation) is more prominent on SLActive® surface (at 10 min)



> Higher degree of mineralization of bone cells with the SLActive® surface (at 21 days)



Katharina Maniura. Laboratory for Materials – Biology Interactions Empa, St. Gallen, Switzerland Protein and blood adsorption on Ti and TiZr implants as a model for osseointegration. EAO 22nd Annual Scientific Meeting, October 17 – 19 2013, Dublin

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7 Hotchkiss et al.– Dental implant surface chemistry and energy alter macrophage activation in vitro

Purpose
To determine the effects of dental implant surface chemistry and energy on macrophage activation *in vitro*.

Methodology
- Ti and TiZr disks with two different surface treatments SLA® and Modified SLA (SLActive®) were produced
- Primary murine macrophages were isolated from mice and cultured on test surfaces (Ti SLA, TiZr SLA, Ti modSLA, TiZr modSLA) or control tissue culture polystyrene
- mRNA was quantified by quantitative polymerase chain reaction after 24 h of culture.
- Pro- (IL-1b, IL-6, and TNF-a) and anti-inflammatory (IL-4, IL-10) protein levels were measured by ELISA after 1 or 3 days of culture

.

Conclusion
- The ability of the SLActive® surface to modulate the immune response may prevent the development of a chronic immune response once the cells have been in contact with the implant surface,
- Aiding the wound healing process and promoting osseointegration

Results

>Two surfaces stored in saline post-modification are hydrophilic, with high surface energy while the ones stored dry were hydrophobic with low surface energy

>The macrophage response shows a higher expression and release of anti-inflammatory markers on both high energy surfaces

1. Hotchkiss KM, Ayad NB, Hyzy SL, Boyan BD, Olivares-Navarrete R. Dental implant surface chemistry and energy alter macrophage activation in vitro. Clin. Oral Impl. Res. 00, 2016, 1–10. doi: 10.1111/clr.12814.

8

Schwarz, F., et al.- Bone regeneration in dehiscence-type defects at non-submerged and submerged chemically modified (SLActive®) and conventional SLA® titanium implants

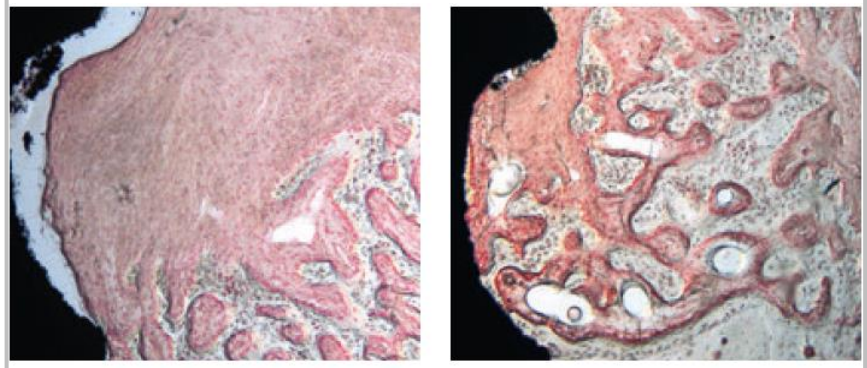
Purpose
To evaluate bone regeneration in dehiscence-type defects at non-submerged and submerged titanium implants with chemically modified (mod) and conventional sandblasted/acid-etched (SLA) surfaces.

Methodology
- After implant site preparation, standardized buccal dehiscence defects were surgically created in both the upper and lower jaws of 12 beagle dogs.
- Both types of implants were randomly assigned to either a non-submerged or a submerged healing procedure
- Dissected blocks were processed for histomorphometrical [e.g. new bone height (NBH), per cent linear fill (PLF), percentage of bone to implant contact (BIC-D), area of new bone fill (BF)] and immunohistochemical analysis. after 1, 2, 4, and 8 weeks,

Conclusion
- **SLActive surfaces promoted bone regeneration in acute-type buccal dehiscence defects**
- **Additionally, a submerged healing procedure improved the outcome of the healing process**

Results

> Bone regeneration in close contact to a modSLA surface. Newly formed trabeculae of woven bone, originating from both the lateral walls as well as the bottom of the defects, have started to invade the dehiscence areas.(2 weeks, non-submerged, lower jaw, central aspect, TG antigen reactivity, original magnification x200).



SLA®

SLActive®

Schwarz F, Sager M, Ferrari D, Herten M, Wieland M, Becker J. Bone regeneration in dehiscence-type defects at non-submerged and submerged chemically modified (SLActive) and conventional SLA titanium implants: an immunohistochemical study in dogs. J Clin Periodontol. 2008 Jan;35(1):64-75. Epub 2007 Nov 21

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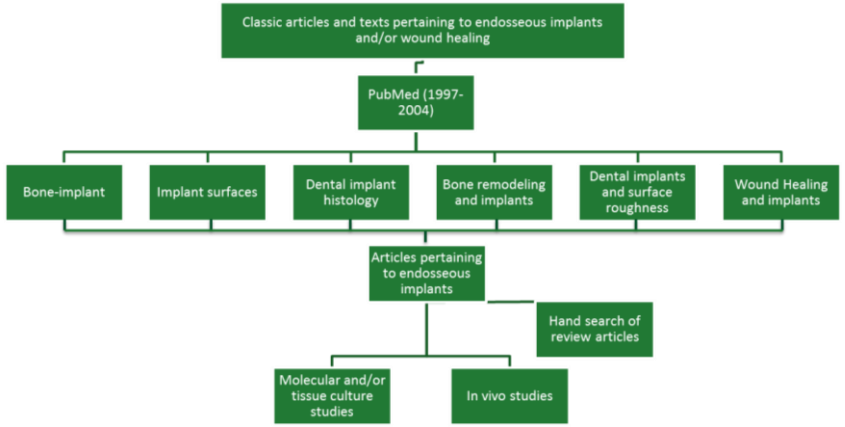
Raghavendra S., et al. - Early wound healing around endosseous implants: a review of literature

Purpose
This article is intended to provide the clinician with a state-of-the-art review of the current literature related to early wound healing and the creation of an Osseo integrated interface between living and nonliving structures.

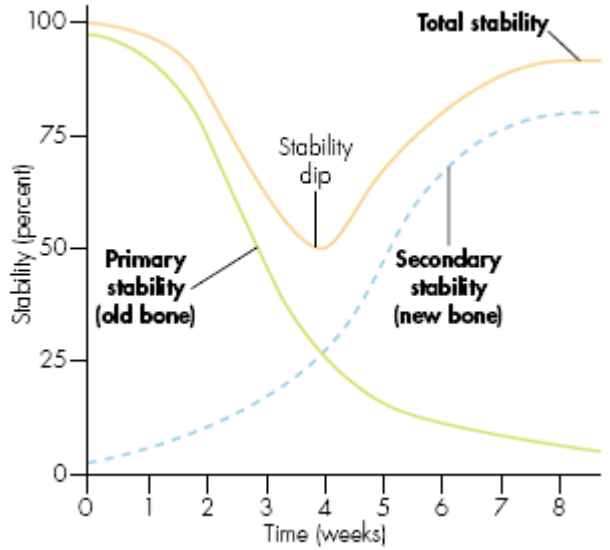
Methodology
Flow chart demonstrating method of literature search



Conclusion
- **Description of healing pattern on implant and stability shift from primary to secondary with a dip in between**

Results

> Changeover from primary stability created at the time of implant placement to secondary stability created by deposition of new bone (osseointegration) in humans.



Raghavendra S, Wood MC, Taylor TD. 'Early wound healing around endosseous implants: a review of the literature.' Int J Oral Maxillofac Implants. 2005 May-Jun;20(3):425-31

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10

Oates T.W., et al.- Enhanced implant stability with a chemically modified SLA® surface: a randomized pilot study

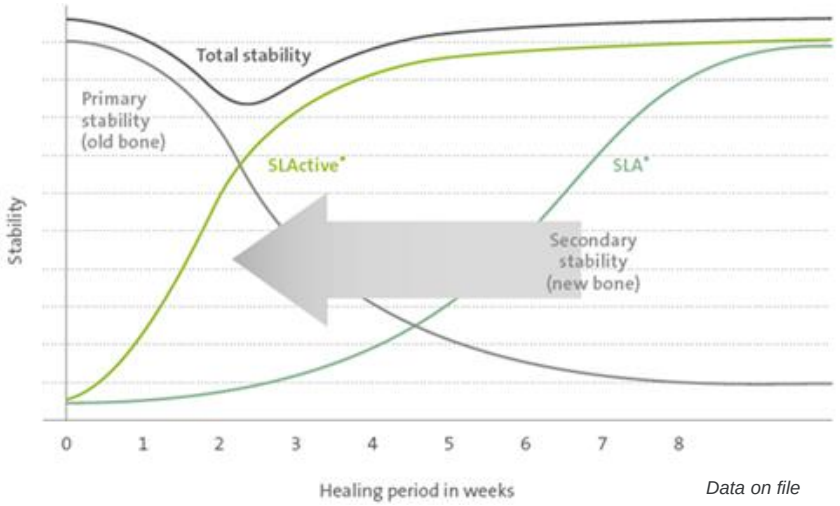
Purpose :
The goal of the present study was to examine changes in stability for implants with a chemically modified SLA surface and to compare their outcomes to those of control implants.

Methodology
- Randomized controlled trial was conducted with 31 patients
- Each received 2 implants with the same physical properties but with surfaces that were chemically different.
- The test implants had a chemically modified surface while the control implants had a standard SLA surface.
- Over the first 6 weeks, following implant placement, resonance frequency analysis was assessed weekly.

Conclusion
- **This study shows there is potential for the chemical modification of the SLA surface to alter biologic events during the osseointegration**
- **Also demonstrates that the short-term clinical success is similar to those observed for implants with an SLA surface**

Results

> All implants proved clinically successful, allowing for restoration. Most implants were placed in the mandible (50 of 62). A shift in implant stability from decreasing stability to increasing stability (P < .001), occurred after 2 weeks for the test implants and after 4 weeks for the control implants.



Data on file

Oates TW, Valderrama P, Bischof M, Nedir R, Jones A, Simpson J, Toutenburg H, Cochran DL. Enhanced implant stability with a chemically modified SLA surface: a randomized pilot study. Int J Oral Maxillofac Implants. 2007 Sep-Oct;22(5):755-60

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11

Lang, N.P., *et al*- Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans.

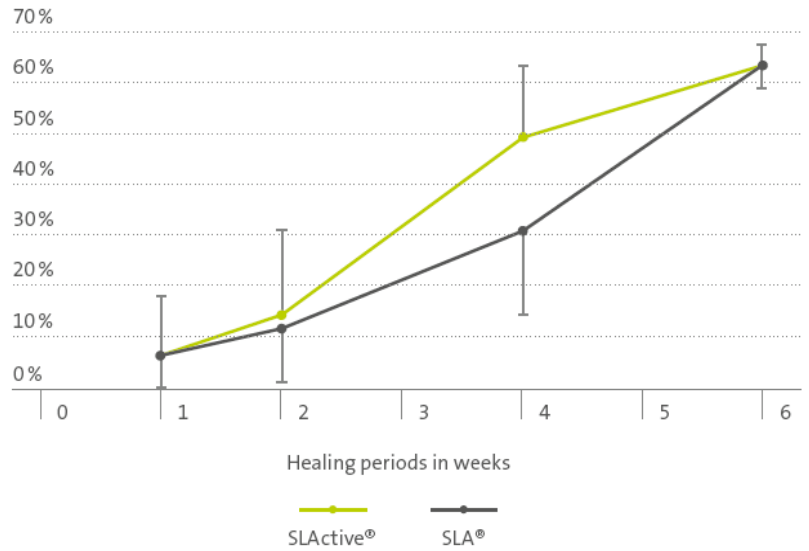
Purpose
To evaluate the rate and degree of osseointegration at chemically modified moderately rough, hydrophilic (SLActive) and moderately rough, hydrophobic (SLA) implant surfaces during early phases of healing in a human model.

Methodology
- 49 specially designed titanium implants (length 4 mm, outer diameter 2.8 mm) with either a SLA® or SLActive® surface were placed in the retromolar region of 28 healthy volunteers.
- A healing cap with an internal screw assembly was attached to the coronal part of the implant.
- After submerged healing periods of 7, 14, 28 and 42 days, the implants were removed using a specially designed trephine, which removed the implant and circumferential tissue of 1 mm thickness.
- Histological sections were prepared and histometric analyses performed for amounts of new bone, old bone, bone debris, soft tissue and BIC .

Conclusion
- **SLActive healing process has been confirmed to be similar to that of SLA**
- **Greater BIC after 2 weeks, significantly greater after 4 weeks**

Results

> Human histology study : New bone on the implant surface (SLA Vs SLActive)



Lang NP, Salvi GE, Huynh-Ba G, Ivanovski S, Donos N, Bosshardt DD. Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans. Clin Oral Implants Res. 2011 Apr;22(4):349-56.

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12

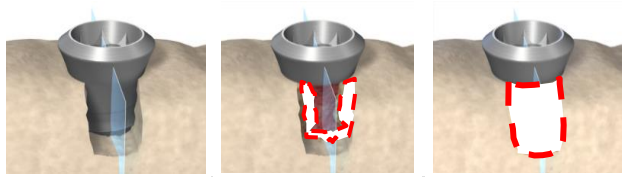
Schwarz, F., et al.- Bone regeneration in dehiscence-type defects at non-submerged and submerged chemically modified (SLActive®) and conventional SLA® Ti implants: immunohistochemical study in dogs

Purpose

The aim of the present study was to evaluate bone regeneration in dehiscence-type defects at titanium implants with chemically modified (mod) and conventional sand-blasted/acid-etched (SLA) surfaces.

Methodology

- Following implant site preparation, standardized buccal dehiscence defects (height: 3 mm, width: 3 mm) were surgically created in both the upper and lower jaws of four beagle dogs.
- According to a split-mouth design, modSLA and SLA implants were inserted bilaterally . The animals were sacrificed after 2 and 12 weeks (n=2 animals each). Dissected blocks were processed for the following histomorphometrical analysis: defect length, new bone height (NBH), percent linear fill (PLF), percent of bone-to-implant contact (BIC-D) and area of new bone fill (BF).



Conclusion

- **SLActive surfaces may promote bone regeneration in acute-type buccal dehiscence defects at submerged implants**
- **Promotes the production of significantly greater and more mature bone than hydrophobic surfaces, and it increases new bone height, bone fill and BIC**

Results

> SLActive implants exhibited a complete defect fill in 12 weeks following implant placement
> SLActive implants revealed significantly higher mean BIC-ND values at 2 weeks in comparison with SLA implants

Schwarz F, Herten M, Sager M, Wieland M, Dard M, Becker J. Bone regeneration in dehiscence-type defects at chemically modified (SLActive) and conventional SLA titanium implants: a pilot study in dogs. J Clin Periodontol. 2007 Jan;34(1):78-86. Epub 2006 Nov 24

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13

Lai HC., et al.- Bone apposition around two different sandblasted, large-grit and acid-etched implant surfaces at sites with coronal circumferential defects: An experimental study in dogs

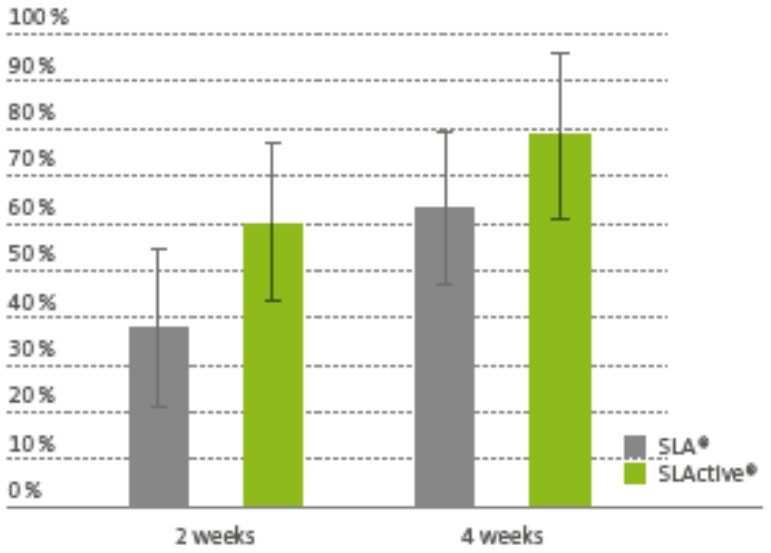
Purpose
The study was designed to evaluate bone apposition around SLA (sandblasted, large-grit and acid-etched) implants compared with modified SLA (modSLA) ones at sites with different sizes of circumferential gaps.

Methodology
- Mandibular premolars and first molars were extracted from six dogs and implants with SLA and SLActive surfaces (three of each; length 10 mm) were placed after 3 months;
- SLA and SLActive implants were randomly assigned to either side. Implants were placed with a 0.5 mm gap, 1.0 mm gap or no gap (control) around the coronal 5.0 mm of the implant .
- Histological and histomorphometric analyses were performed after 2, 4 and 8 weeks.

Conclusion
- **Significantly more bone apposition was found for the modSLA surface than for the SLA surface at early stage of healing, indicating that modSLA surface may enhance bone apposition in coronal circumferential defects at non-submerged implants**
- **Gap size within 1 mm may not need any kind of regenerative procedures**

Results

> BIC % results within the non defect area (expressed as mean)



Lai HC, Zhuang LF, Zhang ZY, Wieland M, Liu X. Bone apposition around two different sandblasted, large-grit and acid-etched implant surfaces at sites with coronal circumferential defects: An experimental study in dogs. Clin. Oral Impl. Res. 2009;20(3):247–53

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Benic G., et al.- Titanium-zirconium narrow-diameter versus titanium regular-diameter implants for anterior and premolar single crowns: 1-year results of a randomized controlled clinical study

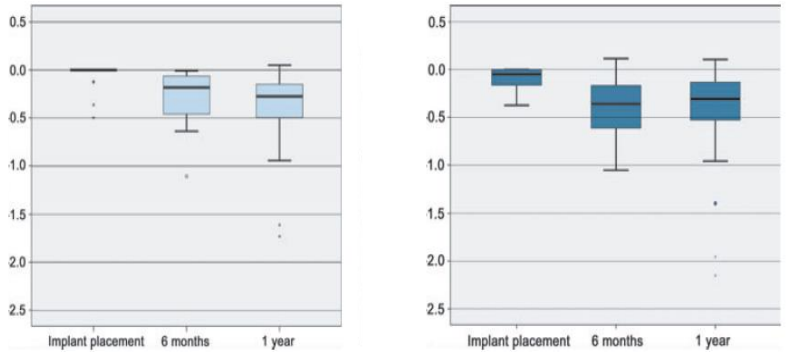
Purpose
To test whether titanium-zirconium (TiZr) 3.3 mm diameter implants perform differently from titanium (Ti) 4.1 mm diameter implants with respect to marginal bone level (MBL) and clinical parameters.

Methodology
- Two centers, 40 subjects, who were in need of a single implant-supported crown in the anterior or premolar regions.
- After random allocation, either a Ti or a TiZr implant was placed.
- Definitive crowns were inserted 6 months after implant placement
- Implant survival, change in MBL, clinical parameters and occurrence of adverse events were assessed over a 1-year period.

Conclusion
- **The use of TiZr implants with narrow diameter for the support of single crowns in the anterior and premolar regions leads to successful tissue integration and clinical performance over a 1-year period**
- **TiZr implants with 3.3 mm diameter perform the same as titanium implants with 4.1 mm diameter regarding the change in marginal bone level over a 1-year period**

Results

> Mean marginal bone levels (in mm) relative to the implant shoulder at the implant placement, at 6 months and at 1 year (a) in the titanium 4.1 mm diameter (Ti 4.1) and (b) in the titanium zirconium 3.3 mm diameter (TiZr 3.3) group.



(a) (b)

> Implant survival rate after 1 year

Benic GI, Gallucci GO, Mokti M, Hämmerle CH, Weber HP, Jung RE. Titanium-zirconium narrow-diameter versus titanium regular-diameter implants for anterior and premolar single crowns: 1-year results of a randomized controlled clinical study. Journal of Clinical Periodontology 2013 Nov;40(11):1052-61

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Buser D, and al. - Long-term Stability of Early Implant Placement with Contour Augmentation.

Purpose

Prospective case series study was to analyze the stability of esthetic treatment outcomes in 20 patients following single-tooth replacement in the anterior maxilla using the concept of early implant placement with simultaneous contour augmentation.

Methodology

- 20 partially edentulous patients were enrolled between November 2005 and July 2006
- *Surgical procedure:* flapless tooth extraction, soft tissue healing period of 4 to 8 weeks, insertion of a bone-level implant in a correct 3-dimensional position with a Ø 4.1 mm, 10 or 12 mm length
- Contour augmentation was performed with locally harvested autogenous bone chips to cover the exposed implant surface and followed by a layer of deproteinized bovine bone mineral (DBBM)
- Reopening procedure: after 8 to 12 weeks of healing followed by prosthetic procedures for a screw-retained full ceramic crown bonded with composite resin to the titanium milling abutment

Conclusion

- **Long-term stability of peri-implant hard and soft tissues after 6 years with highly esthetic outcomes in early implant placement**
- **Non of the implants developed mucosal recession of 1 mm or more**
- **The study also showed that the risk for mucosal recession is low with early implant placement**

Results

> Clinical and Cast Parameters of the 20 Implants over Time (mean ± standard deviation)

Parameters	Modified Plaque Index (modPII)	Modified Sulcus Bleeding Index (modSBI)	Probing Depth (PD; mm)	Keratinized Mucosa (KM; mm)	Distance Implant Shoulder to Mucosal margin* (DIM; mm)	Height of Implant Crown (IC; mm)	Height of Contralateral Tooth Crown (TC; mm)
1 year	0.36 (± 0.33)	0.21 (± 0.17)	4.43 (± 0.57)	4.50 (± 1.54)	-3.53 (± 1.16)	10.03 (± 1.05)	9.85 (± 1.23)
3 years	0.40 (± 0.27)	0.20 (± 0.20)	4.00 (± 0.56)	4.10 (± 1.17)	-3.68 (± 0.97)	9.94 (± 1.04)	9.84 (± 1.21)
6 years	0.40 (± 0.41)	0.16 (± 0.17)	4.24 (± 0.49)	4.20 (± 1.28)	-3.95 (± 1.14)	9.99 (± 1.04)	9.94 (± 1.23)

Buser D, Chappuis V, Kuchler U, Bornstein MM, Wittneben JG, Buser R, Cavusoglu Y, Belser UC. Long-term Stability of Early Implant Placement with Contour Augmentation. J Dent Res. 2013 Dec;92(12 Suppl):176S-82S.

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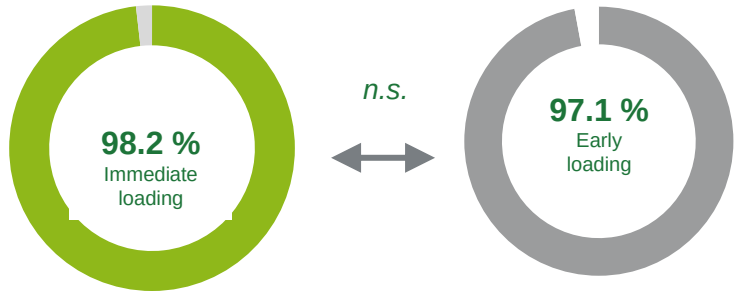
Nicolau P. et al. - 10-year outcomes with immediate and early loaded implants with a chemically modified SLA surface

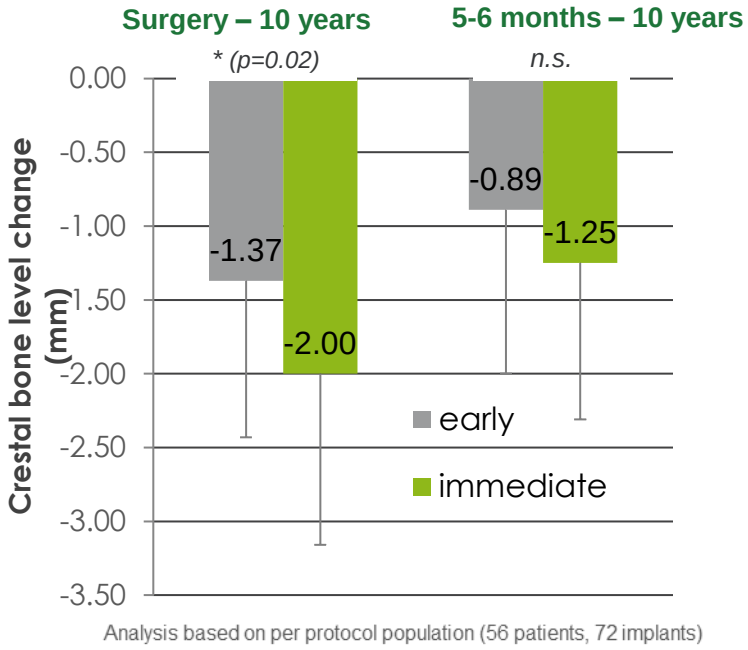
Purpose
The aim of this study was to evaluate long-term outcomes in a 10-year follow-up study of patients who previously completed a 3-year multicenter randomized controlled trial of immediate and early loading of dental implants with a hydrophilic and chemically active surface (SLActive) in the posterior maxilla or mandible.

Methodology
- Patients received implants to replace at least one missing tooth, with provisional restoration on the day of surgery (immediate loading) or 28 to 34 days later (early loading).
- Implant survival, change in crestal bone level, and patient satisfaction were evaluated.

Conclusion
- **Implants with the SLActive surface show successful long-term outcomes following immediate or early loading in posterior maxillae and mandibles**.

Results





Analysis based on per protocol population (56 patients, 72 implants)

Nicolau P et al. Quintessence Int. 2018 Dec 18:2-12,

17

Mardas N., *et al*. The effect of SLActive® surface in guided bone formation in osteoporotic-like conditions

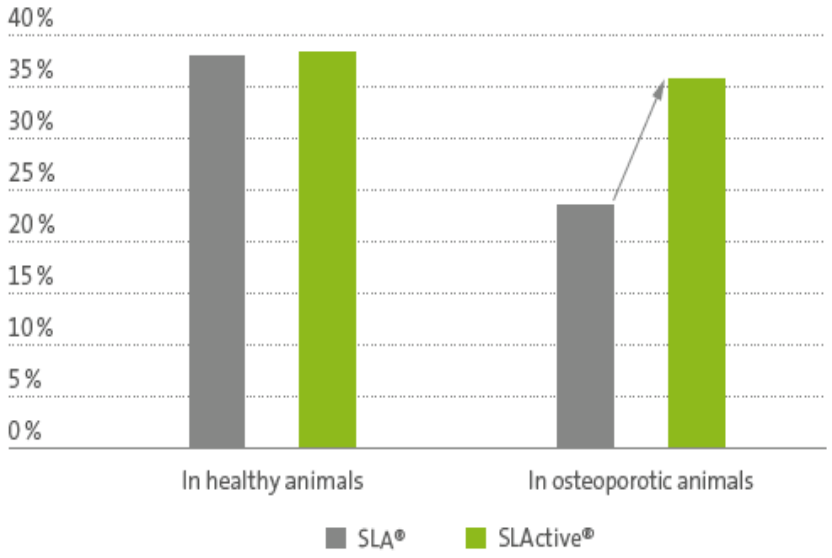
Purpose
The aim of the study was to evaluate new bone formation under etched titanium (SLA®) and modified-etched hydrophilic titanium (modSLA) domes placed on the calvarium of healthy, osteoporotic and osteoporotic treated with bisphosphonates rabbits.

Methodology
- 24 female rabbits, experimental osteoporosis was induced by ovariectomy (OV) and a calcium-deficient diet.
- 12 OV rabbits were treated with weekly dozes of alendronate (Fosamax(®)) (B) while 12 OV rabbits received no treatment (O). Another 12 rabbits were sham operated and used as healthy controls (C).
- Following OV, at 6 weeks, one modSLA and one SLA titanium dome were placed in the parietal bones of each rabbit.
- The animals were sacrificed at 30 and 120 days following the dome placement and various histomorphometric measurements were performed in the most central of the undecalcified sections produced.

Conclusion
- **The use of modSLA surface may promote bone healing and osseointegration in osteoporotic rabbits**

Results

> Newly formed bone at 30days



Mardas N, Schwarz F, Petrie A, Hakimi AR, Donos N. The effect of SLActive® surface in guided bone formation in osteoporotic-like conditions Clin Oral Implants Res. 2011 Apr;22(4):406-15.

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Schlegel KA., *et al*. Osseointegration of SLActive® implants in diabetic pigs

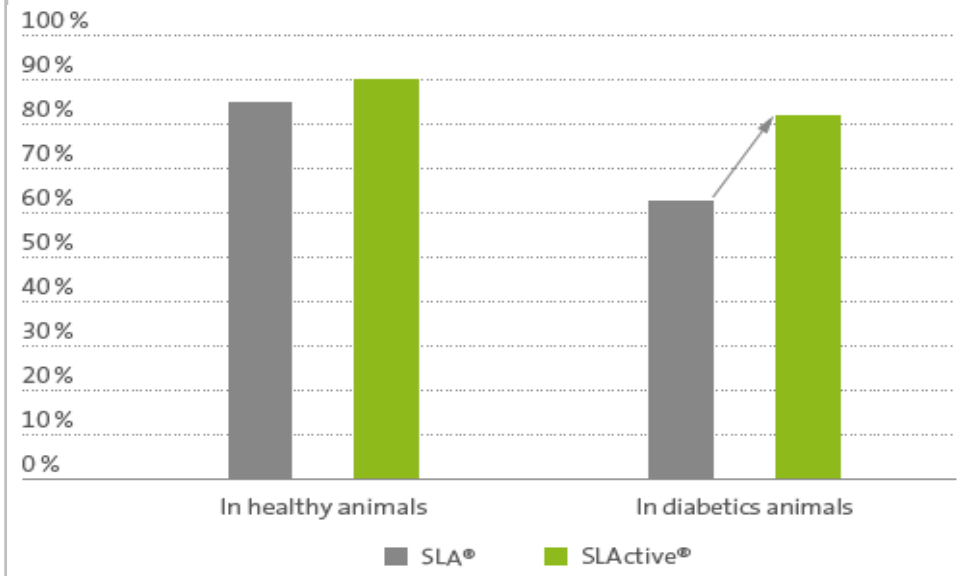
Purpose
The study aim was to investigate peri-implant bone formation in a diabetic animal model in comparison to healthy animals and to evaluate the differences between conventional (SLA®) and modified (SLActive®) titanium implant surfaces on osseointegration.

Methodology
- Six implants each were placed in the calvaria of 11 diabetic and 4 healthy domestic pigs.
- At 30 and 90 days after implant placement, the bone-to-implant contact (BIC) and bone density (BD) were calculated.
- Additionally, using immunohistochemical staining methods, the expression of the bone-matrix proteins collagen type I and osteocalcin was evaluated at 30 and 90 days.

Conclusion
- **The results indicate the negative effect of untreated diabetes mellitus on early osseointegration of dental implants**
- **The modified SLA® surface (SLActive) elicited an accelerated osseointegration of dental implants in diabetic pigs**

Results

> Bone to implant contact at 90 days (in %)



Schlegel KA, Prechtl C, Möst T, Seidl C, Lutz R, von Wilmowsky C. Osseointegration of SLActive® implants in diabetic pigs Clin Oral Implants Res. 2013 Feb;24 (2):128-34

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Khandelwal N et al. Conventional SLA and chemically modified SLA implants in patients with poorly controlled type 2 Diabetes mellitus – a randomized controlled trial

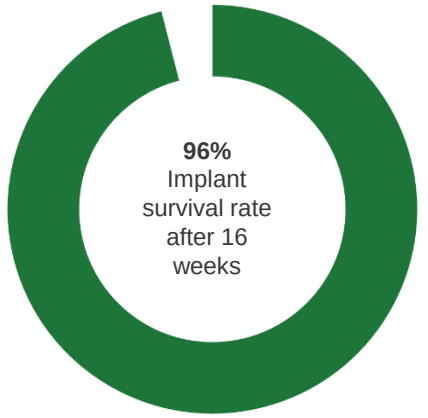
Purpose
The objective of this study was to evaluate the potential for a chemically modified SLA surface, compared with a conventional SLA surface, to enhance implant healing and integration in poorly controlled diabetic patients, a group previously demonstrated to have compromises and delays in implant stabilization during the metabolically active healing period following implant placement.

Methodology
- 24 patients with type 2 diabetes, baseline HbA1c levels between 7.5–11.4%, and a minimum of two posterior mandibular tooth sites at least 4 months following extraction.
- Each patient, at a randomly selected site, received an implant with the conventional SLA surface; at the second site, the patient received an implant with the chemically modified SLA (modSLA) surface.
- 48 study implants were placed. Implant stability was assessed using Resonance Frequency Analysis (RFA).
- Readings were taken from the buccal and proximal directions for each implant. Implant stability (ISQ) was assessed at the time of surgical placement (baseline) and 2, 3, 4, 6, 8, 10, 12, and 16 weeks following implant placement.

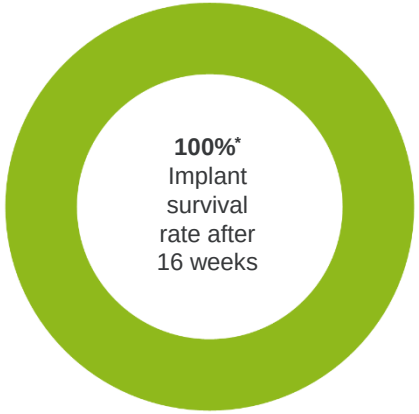
Conclusion
- **Implant stabilization was similar for the conventional SLA and chemically modified SLA implants in type 2 diabetic patients with relatively poor glycemic control.**
- **Furthermore, this study demonstrated clinically successful implant placement even in poorly controlled diabetic patients.**

Results

Implant survival rates after 16 weeks



SLA®



SLActive®

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. Khandelwal N et al., Clin Oral Implants Res. 2013 Jan;24(1):13-9. *personal communication Dr. T. Oates, Given the small number of implants, survival can not serve as a significant statistical difference between implant categories.

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Nack C et al- Rehabilitation of irradiated patients with chemically modified and conventional SLA implants: five-year follow-up

Purpose
Evaluate the clinical and radiological parameters of SLA®/SLActive® surface implants in irradiated patients after the initial 12-month loading period up to 5 years.

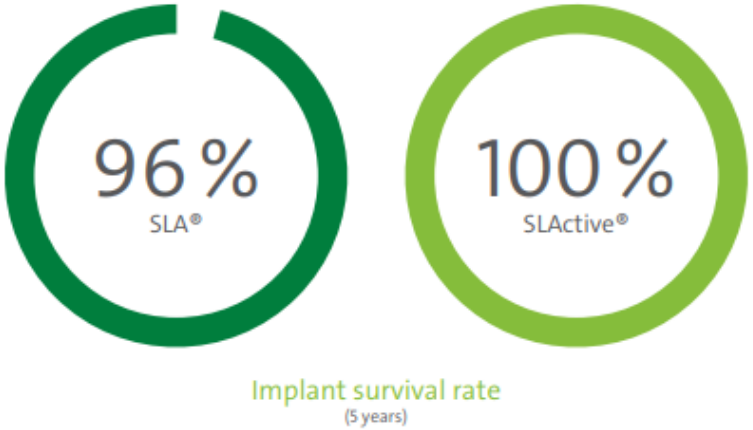
Methodology[1]
- Randomized split mouth study; 20 patients, 102 implants
- Minimum 6 months between radiation therapy and implant placement
- Study duration 5 years
- SLA: Maxilla -27 implants; Mandible- 23 implants
- SLActive: Maxilla 28 implants; Mandible 24 implants

Conclusion
- **SLActive® implants can be used in irradiated patients with a high predictability of success**
- **Crestal bone level was stable within 5 years after placement**
- **Lower implant survival rates in patients with oral cancer may be associated with a higher mortality rate rather than a lack of osseointegration**

Results [2,3]

* 1 patient had tumor recurrence>>resection to remove bone and 5 implants: 2 patients lost 1 implant before loading. Prosthetic rehabilitation could still take place successfully in these patients despite the loss of these implants; 4 patients died due to cancer (-18) implants

Taking into account that the clinical performance and longevity of their implants would not be any different to the other implants in the study, had the patients survived, the implant survival rate would be:
96% for SLA® | 100% SLActive®



1.Heberer S, Kilic S, Hossamo J, Raguse JD, Nelson K. Rehabilitation of irradiated patients with modified and conventional sandblasted acid-etched implants: preliminary results of a split- mouth study. Clin Oral Implants Res. 2011 May;22(5):546-51. doi: 10.1111/j.1600-0501.2010.02050.x.
2. Nack C, Raguse JD, Stricker A, Nelson K, Nahles S. Rehabilitation of irradiated patients with chemically modified and conventional SLA® implants: five-year follow-up. J Oral Rehabil. 2015 Jan;42(1):57-64. doi: 10.1111/joor.12231.
3.Nelson K. Rehabilitation of irradiated patients with chemically modified and conventional SLA® implants: a clinical clarification. Letter to the editor. J Oral Rehabil. 2016 Submitted.

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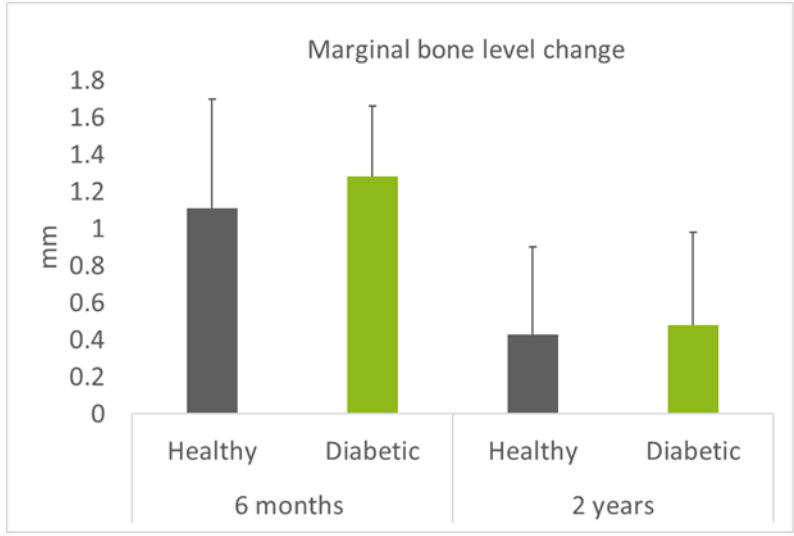
Cabrera-Domínguez J et al. - A Prospective Case-Control Clinical Study of Titanium-Zirconium Alloy Implants with a Hydrophilic Surface in Patients with Type 2 Diabetes Mellitus

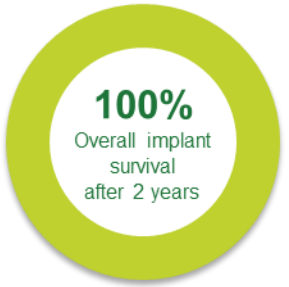
Purpose
To evaluate prospectively the behavior of narrow-diameter (3.3-mm) titanium-zirconium alloy implants with a hydrophilic surface (Straumann Roxolid SLActive) in patients with type 2 diabetes mellitus in single-unit restorations, compared with a healthy control group (assessed using the glycosylated hemoglobin HbA1c test).

Methodology
- Single-unit implant treatments
- 15 patients had type 2 diabetes mellitus, and 14 patients were healthy (control group [CG]).
- Marginal bone level (MBL) change around the implants was evaluated using conventional, sequential periapical digital radiographs.
- Patient HbA1c was assessed in each check-up.
- Normality test (Kolmogorov-Smirnov), univariate and multivariate logistic regression, analysis of variance (ANOVA), and Mann-Whitney U test were used for statistical analysis

Conclusion
- **Patients with glycemic control exhibit similar outcomes to healthy individuals with regard to the investigated parameters.**
- **In light of these findings, the titanium-zirconium alloy small-diameter implants can be used in the anterior region of the mouth in type 2 diabetic patients.**

Results





Cabrera-Domínguez J et al Int J Oral Maxillofac Implants. 2017 Sep/Oct;32(5):1135-1144.; Cabrera-Domínguez J et al data presented during the 26th EAO annual meeting in Madrid 2018

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Thank You