



# Literature review

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Ghinassi B, Di Baldassarre A, D'Addazio G, et al.

## Gingival Response to Dental Implant: Comparison Study on the Effects of New Nanopored Laser-Treated vs. Traditional Healing Abutments.

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*International Journal of Molecular Sciences*, 2020;21(17):e6056.

ABSTRACT: The health of peri-implant soft tissues is important for the long-term success rate of dental implants and the surface topography is pivotal in influencing it. Thus, the aim of this study was to evaluate, in human patients, the inflammatory mucosal microenvironment in the tissue surrounding a new, nanoscale, laser-treated healing abutment characterized by engineered nanopores versus a standard machined-surface. Analyses of anti- and pro-inflammatory markers, cytokeratins, desmosomal proteins and scanning electron microscopy were performed in 30 soft-tissue biopsies retrieved during second-stage surgery. The results demonstrate that the soft tissue surrounding the laser-treated surface was characterized by a lower grade of inflammation than the one facing the machined-surface, which, in turn, showed a disrupted epithelium and altered desmosomes. Moreover, higher adhesion of the epithelial cells on the laser-treated surface was detected compared to the machined one. In conclusion, the laser-treated surface topography seems to play an important role not only in cell adhesion, but also on the inflammatory makers' expression of the soft tissue microenvironment. Thus, from a clinical point of view, the use of this kind of topography may be of crucial importance not only on healing abutments but also on prosthetic ones.

Mongardini C, Zeza B, Pelagalli P, Blasone R, Scilla M, Berardini M.

## Radiographic bone level around particular laser-treated dental implants: 1 to 6 years multicenter retrospective study.

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*International Journal of Implant Dentistry, 2020;6(1):29*

**PURPOSE:** The aim of the present retrospective study was to evaluate clinical and radiological outcomes, in terms of implant survival rate, marginal bone loss, and peri-implantitis incidence, of a titanium implants with an innovative laser-treated surface.

**MATERIALS AND METHODS:** A total of 502 dental implants were inserted in four dental practices (Udine, Arezzo, Frascati, Roma) between 2008 and 2013. All inserted implants had laser-modified surface characterized by a series of 20- $\mu$ m diameter holes (7–10  $\mu$ m deep) every 10  $\mu$ m (Synthegra®, Geass srl, Italy). The minimum follow-up period was set at 1 year after the final restoration. Radiographs were taken after implant insertion (T0), at time of loading (T1), and during the follow-up period (last recall, T2). Marginal bone loss and peri-implant disease incidence were recorded.

**RESULTS:** A total of 502 implants with a maximum follow-up period of 6 years were monitored. The mean differential between T0 and T2 was  $0.05 \pm 1.08$ mm at the mesial aspect and  $0.08 \pm 1.11$ mm at the distal with a mean follow-up period of  $35.76 \pm 18.05$  months. After being in function for 1 to 6 years, implants reported varying behavior: 8.8% of sites did not show any radiographic changes and 38.5% of sites showed bone resorption. The bone appeared to have been growing coronally in 50.7% of the sites measured.

**CONCLUSION:** Implants showed a maintenance of marginal bone levels over time, and in many cases, it seems that laser-modified implant surface could promote a bone growth. The low peri-implant disease incidence recorded could be attributed to the laser titanium surface features that seem to prevent bacterial colonization. Future randomized and controlled studies are needed to confirm the results of the present multi-central retrospective analysis.

Ghinassi B, D'Addazio G, Di Baldassarre A, Femminella B, Di Vincenzo G, Piattelli M, Gaggi G, Sinjari B.

## Immunohistochemical Results of Soft Tissues Around a New Implant Healing-Abutment Surface: A Human Study.

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*Journal of Clinical Medicine, 2020 Apr 2; 9(4):e1009*

ABSTRACT: Although, the high success rate of implant rehabilitation treatment, the biological complications such as bone loss and peri-implantitis are still present. The creation of a coronal biological seal between the implant and the oral tissues seems to be a crucial point on preserving dental implants. The objective of this study was to immunohistochemically analyze the behavior of peri-implant soft tissues around a new implant healing-abutment surface on humans. A total of 30 soft tissue biopsies were collected after a healing period of 30 (±7) days, to analyze the expression of inflammatory (cluster of differentiation 63 (CD63), human neutrophil peptides 1–3 (HPN1–3)) and junctional (E-cadherin, occludin, and  $\beta$ -catenin) markers, on soft tissues around laser treated and machined alternated healing abutments. The evaluation demonstrated the whole area of the soft tissues adherent to the laser treated surface with a regular morphology. While several stress hallmarks in correspondence of machined surfaces were shown such as: (a) An irregular, disrupted, and discontinued basal membrane with an increased inflammation evident both the epithelial and connective tissues; (b) the absence or defective proper keratinization process of the external layer, and (c) damages in the cell to cell interaction. In conclusion, the laser treated surface is preferable to maintain the integrity and functionality of the gingiva epithelium.

Varvara G, Sinjari B, Caputi S, Scarano A, Piattelli M.

## The Relationship Between Time of Retightening and Preload Loss of Abutment Screws for Two Different Implant Designs: An In Vitro Study.

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*J Oral Implantol. 2020;46(1):13-17*

ABSTRACT: The loosening of an abutment screw is one of the most frequent complications in implant-prosthetic rehabilitation, especially for single-crown cemented prostheses. This complication is due to several mechanical factors including type of connection, abutment-screw geometry, settling effects, and cyclical load. The purpose of the present in vitro study was to compare and associate different times of retightening with reductions in preload losses. We evaluated 40 internal hexagon dental implants and 40 external hexagon dental implants, with their related abutment screws. The implants were embedded in acrylic resin in cylindrical polyvinyl chloride tubes (26 mm diameter, 20 mm height). The abutments were fixed to the implants with screws to an initial torque of 35 Ncm using a digital torque meter with decimal precision. Two different types of connection were randomly divided in 4 subgroups of 10 samples each. One subgroup was used as control. The test groups underwent retightening to the same initial torque at increasing times from initial torque application for tightening of the abutment screws, to their retightening at 2 minutes, 5 minutes, and 10 minutes. The retightening time of 2 minutes shows significantly reduced preload loss. Randomized clinical trials are strongly required to provide clinicians with a beneficial standardized protocol of retightening that can be applied in routine clinical practice.

De Tullio I, Berardini M, Di Iorio D, Perfetti F, Perfetti G.

## Comparative evaluation among laser-treated, machined, and sandblasted/acid-etched implant surfaces: an in vivo histologic analysis on sheep.

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*International Journal of Implant Dentistry, 2020 Feb 19; 6(1):7.*

**PURPOSE:** The aim of the present in vivo analysis was to evaluate the osseointegration process of titanium implants with three different surfaces (machined, sandblasted and acid-etched, and laser-treated) after 15 and 30 days of healing period.

**MATERIALS AND METHODS:** Thirty-six implants with different surfaces were placed in the iliac crest of four Bergamasca sheep. The implant surfaces tested were sandblasted and acid-etched (group A), laser-treated (group B), and fully machined (group C). Two animals were sacrificed after 15 days while the other two after 30 days. Histological and histomorphometric analyses were performed.

**RESULTS:** After 30 days, the bone tissue layer onto implant groups A and B appeared almost continuous with small marrow spaces interruption, while on the machined surface (group C), larger spaces with marrow tissue alternated with the bony trabeculae onto the titanium surface. Implants in groups A and B showed significantly higher implant contact percentage (BIC%) value than group C ( $P < 0.05$ ). Moreover, it was observed a BIC% increase in both groups A and B between 15 and 30 days while in the machined group (group C), the BIC% decreased.

**CONCLUSION:** Results from the present in vivo analysis revealed that both sandblasted/acid-etched and laser-treated titanium implants, compared to the machined ones, have higher values of osseointegration in less healing time.

Sinjari B, Traini T, Caputi S, Mortellaro C, Scarano A.

## Evaluation of fibrin clot attachment on titanium laser-conditioned surface using scanning electron microscopy.

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*Journal of Craniofacial Surgery, 2018 Nov;29(8):2277-2281.*

**OBJECTIVES:** The study aimed to evaluate the effects of different titanium surface treatments on blood clot extension (bce).

**METHODS:** A total of 54 titanium disks with machined surface (M), laser-conditioned surface (L), and grit-blasted surface (S) were used in the present study. The surface characteristics such as contact angles and the microroughness were determined on each group (n=4). To evaluate the bce, 0.1 mL of human blood was dropped onto the surface of each specimen and left for 7 minutes at room temperature. After fixation, dehydration, and gold sputtering treatments, the specimens were observed under scanning electron microscope. The bce values were expressed as percentage of specimen surface covered by blood clot.

**RESULTS:** The surface roughness (Ra  $\pm$  standard deviation [SD]) was  $0.75 \pm 0.02\mu\text{m}$  for M,  $0.25 \pm 0.02\mu\text{m}$  for L, and  $1.30 \pm 0.03\mu\text{m}$  for S. The contact angles measured in static conditions (WCA  $\pm$  SD) were  $71 \pm 5.4^\circ$  for M,  $107 \pm 6.6^\circ$  for L, and  $91 \pm 7.2^\circ$  for S. Regarding the bce (bce  $\pm$  SD) of M samples ( $65.5 \pm 4.3\%$ ) was statistically lower compared with both L ( $83.4 \pm 5.1\%$ ) and S samples ( $72.4 \pm 4.7\%$ ) ( $P < 0.05$ ). Meanwhile, the L group showed the higher bce value.

**CONCLUSIONS:** The present results suggest that the laser-conditioned surface may increase the wettability and bce.

## Laser microtextured titanium implant surfaces reduce in vitro and in situ oral biofilm formation.

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*PLoS One*, 2018 Sep 7; 13(9):e0202262.

**INTRODUCTION:** Micro- or nano-topography can both provide antimicrobial properties and improve osseointegration of dental implant titanium surfaces. Laser treatment is one of the best surface microtexturing techniques. The aim of this study was to evaluate in vitro and in situ biofilm formation on a laser-treated titanium surface, comparing it with two conventional surfaces, machined and grit-blasted.

**METHODS:** For the in vitro experiment, an oral microcosm biofilm model was developed on the surface of titanium disks and reference human enamel using a bioreactor for 48 h. For the in situ experiment, titanium implants with laser-treated, machined and grit-blasted surfaces were mounted on intraoral trays and worn by ten volunteers for 48 h. Biofilm formation was quantitatively evaluated, and surfaces were analyzed using confocal laser scanning microscopy, scanning electron microscopy and energy-dispersive X-ray spectroscopy.

**RESULTS–IN VITRO STUDY:** Biofilm structures with a prevalence of viable cells covered most of the machined, grit-blasted and human enamel surfaces, whereas less dense biofilm structures with non-confluent microcolonies were observed on the laser-treated titanium. Laser-treated titanium showed the lowest biofilm formation, where microorganisms colonized the edges of the laser-created pits, with very few or no biofilm formation observed inside the pits.

**RESULTS–IN SITU STUDY:** The biofilm formation pattern observed was similar to that in the in vitro experiment. Confocal laser scanning microscopy showed complete coverage of the implant threads, with mostly viable cells in grit-blasted and machined specimens. Unexpectedly, laser-treated specimens showed few dead microbial cells colonizing the bottom of the threads, while an intense colonization was found on the threading sides.

**CONCLUSION:** This data suggests that laser-created microtopography can reduce biofilm formation, with a maximum effect when the surface is blasted orthogonally by the laser beam. In this sense the orientation of the laser beam seems to be relevant for the biological interaction with biofilms.

Falco A, Berardini M, Trisi P.

## Correlation between implant geometry, implant surface, insertion torque and primary stability: in vitro biomechanical analysis.

*Int J Oral Maxillofac Implants. 2018, Jul/Aug;33(4):824-830.*

**PURPOSE:** Primary implant stability represents the first step for successful osseointegration. The knowledge of the correlation between host bone density, insertion torque, and implant macrogeometry seems to be fundamental to achieve sufficient primary implant bone fixation in each clinical situation. The purpose of this study was to measure, in vitro, the impact of dental implant macrogeometry and insertion torque values on primary stability in relation to different bone densities, representing both the human mandible and maxilla.

**MATERIALS AND METHODS:** One hundred twenty 3.8 × 11-mm commercial dental implants were used. Forty implants had small threads with a machined neck, 40 implants had small threads with a microthreaded neck, and the last 40 implants had large threads with a reverse neck design. Fresh bovine ribs, representing a medium-dense bone density (D2-D3), and fresh ovine iliac crest, representing a soft bone density (D4), were used. Insertion torque and micromobility under lateral force data were recorded for each implant.

**RESULTS:** In the medium-dense bone type, the reverse neck implant design showed less primary implant stability than the conventional straight implant neck. In soft bone, both implants with the large thread design and microthreaded neck implants showed better implant stability than the implant with a small thread design with a straight machined neck. Implants with large and self-cutting threads showed significantly ( $P < .05$ ) lower micromobility values than other implants in postextractive sites in low-density bone.

**CONCLUSION:** Implant geometries and bone density are the main factors involved in the degree of primary implant stability. Large-thread implant designs are highly desirable in cases of poor bone quality. Each implant geometry generates an insertion torque value, which is correlated to the stability of that specific implant in a specific bone quality, but the insertion torque is not an objective value to compare primary stability between different implant types.

Trisi P, Berardini M, Colagiovanni M, Berardi D, Perfetti G.

## Laser-treated titanium implants: an in vivo histomorphometric and biomechanical analysis.

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*Implant Dentistry, 2016 Oct;25(5):575-80.*

**PURPOSE:** the aim of the present histological and biomechanical analysis was to compare, in vivo, the strength and quality of osseointegration between a laser-treated implant surface and a standard machined surface.

**MATERIAL AND METHODS:** customized titanium implants, having 2 different surfaces, were used. Implants were longitudinally split in the 2 surfaces: one side was laser treated and the opposite one had a machined surface. Eight implants were inserted in the iliac crest of 2 sheep: 4 with a split laser and machined surfaces, 2 with a completely laser-treated surface, and 2 with fully machined surfaces. The animals were killed 8 weeks after the placement of implants. The histomorphometric and biomechanical parameters calculated for each surface were the bone-implant contact (%BIC) and the reverse torque value (RTV) **RESULTS:** The RTV of the laser-treated implants were about 3-fold higher than that of the machined implants. The histomorphometric results showed a significant difference of %BIC around 30% between the laser surfaces compared to the machined ones.

**CONCLUSIONS:** the present study showed that laser surface treatment induces better osteointegration than machined surface. The laser-treated surface seems to be able to increase the osseointegration amount in respect to the machined implants.

Drago L, Bortolin M, De Vecchi E, Agrappi S, Weinstein RL, Mattina R, Francetti L.

## Antibiofilm activity of sandblasted and laser-modified titanium against microorganisms isolated from peri-implantitis lesions.

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*Journal of Chemotherapy, 2016 Oct;28(5):383-9.*

Infections due to biofilm-producing microorganisms are one of the main causes for the failure of dental implants. Increasing efforts have been made in order to develop new strategies to prevent biofilm formation. In this study, the biofilm development on a newly designed laser-modified titanium implant surface was evaluated and compared to that on conventional sandblasted titanium used in implant dentistry. The amount of biofilm produced by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Porphyromonas gingivalis* isolated from peri-implantitis was assessed by a semi-quantitative spectrophotometric method and by confocal laser scanning microscopy. Results showed a lower biofilm production on laser-modified surface compared to the sandblasted one. In particular, a significantly lower total volume of the biomass was observed on laser-modified surface, while no significant changes in live/dead bacteria percentages were noticed between materials. Modifying the topography of the conventional implants surface with laser ablation could represent a promising approach for inhibiting biofilm formation.

Di Giulio M, Traini T, Sinjari B, Nostro A, Caputi S, Cellini L.

## Porphyromonas gingivalis biofilm formation in different titanium surfaces, an in vitro study.

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*Clin. Oral Impl. Res*, 2016 Jul;27(7):918-25.

**OBJECTIVE:** The aim of this work was to evaluate the biofilm formation of *Porphyromonas gingivalis* on disks of titanium (Ti) grade 4 (G4) and Ti-6Al-4V alloy grade 5 (G5) with different surface topographies.

**MATERIALS AND METHODS:** *Porphyromonas gingivalis* ATCC 33277 was used to develop an *in vitro* mature biofilm on a total of 96 disk-shaped specimens of laser-treated (L), sandblasted (S), and machined (M) surfaces of Ti G4 and Ti G5. Surface roughness (Ra) and the wettability contact angle (WCA) were measured to characterize the surface of the specimens. The bacterial biofilm was evaluated by biomass quantification, bacterial viability, visualization of the biofilm extracellular matrix, and bacterial cell count. Data were analyzed using one-way ANOVA and Holm-Sidak tests and expressed as mean standard deviation.

**RESULTS:** The Ra for the L group was 0.10 ( $\pm 0.07$ )  $\mu\text{m}$  inside the craters and 0.40 ( $\pm 0.08$ )  $\mu\text{m}$  in the area surrounding the craters resulting the smoothest ( $P < 0.05$ ) in respect to the S group ( $1.30 \pm 0.61 \mu\text{m}$ ) and the M group ( $0.75 \pm 0.23 \mu\text{m}$ ). The L group showed a higher WCA than S and M groups for both G4 ( $109.9^\circ \pm 6.6$ ) and G5 ( $104.2^\circ \pm 5.9$ ) materials ( $P < 0.05$ ). The L group displayed both the less *P. gingivalis* bacterial biomass ( $0.38 \pm 0.01$  for G4;  $0.62 \pm 0.02$  for G5) that was significant in respect to G4-S ( $P < 0.001$ ), G4-M ( $P < 0.001$ ), and G5-M ( $P = 0.001$ ) and the less total cell number ( $215 \pm 18$  for G4 and  $244 \pm 9$  for G5) than S and M groups for both G4 and G5 materials ( $P < 0.01$ ).

**CONCLUSION:** Within the limits of the present study, the results showed that G4-L appears to be significantly efficient in the reduction of the *P. gingivalis* biofilm formation.

Cei S, Karapetsa D, Aleo E, Graziani F.

## Protein adsorption on a laser-modified titanium implant surface.

*Implant Dentistry, 2015 Apr;24(2):134-41.*

**PURPOSE:** The aim of this study was to investigate the earlier phase of the osseointegration of a laser-treated implant surface in terms of human protein adsorption.

**MATERIALS AND METHODS:** Titanium surfaces were divided into machined (M), sandblasted (SB), and laser-treated (LT). The LT surfaces were created with an Nd diode-pumped laser in Q-switching, whereas the SB were treated with Al<sub>2</sub>O<sub>3</sub>. An x-ray photoelectron spectroscopy (XPS) analysis of titanium surface was performed. Titanium discs were used for albumin and fibronectin adsorption evaluation through fluorescence intensity. Fibronectin evaluation was also made with Western Blot analysis on experimental implants.

**RESULTS:** LT discs appeared to trigger a higher albumin and fibronectin adsorption with a regular pattern. The mean count of albumin adsorption was 0.29 and 3.8 for SB and LT, respectively (P = 0.016), whereas fibronectin values were 0.67 and 4.9 for (SB) and (LT) titanium (P = 0.02). XPS analysis showed that titanium, oxygen, carbon, and nitrogen were found on all 3 surfaces.

**CONCLUSIONS:** Laser-engineered porous titanium surface seems to promote, in vitro, the adsorption of albumin and fibronectin more than sandblasted (SB) or machined (M) implants.

Cecchi V, Felice P.

## The inlay technique with an allograft block used for the rehabilitation of an atrophic posterior mandible: a case report.

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*Clinical Advances in Periodontics, Vol. 5, No. 1, February 2015*

INTRODUCTION: To the best of the authors' knowledge, this case report is the first in the literature to describe the reconstruction of a severely atrophic poster mandible using an allograft block in the inlay technique.

CASE PRESENTATION: Differently orientated osteotomic cuts were performed in order to coronally elevate the osteotomized bony segment. An allograft block was then shaped and placed between the segment and the basal bone. Only 2 months after the grafting procedure, the allograft seemed to be well integrated and two dental implants were placed.

CONCLUSIONS: In this clinical case, after only 2 months, allograft block seemed to be an effective material for the reconstruction of the posterior mandible with the inlay technique.

## A comparison of two dental implant systems in partially edentulous patients: 1-year post-loading results from a pragmatic multicentre randomised controlled trial.

*EJOI 2014;7(4);397-409*

**PURPOSE:** To compare the clinical effectiveness of two implant systems: Way Milano and Kentron (Geass, Pozzuolo del Friuli, UD, Italy).

**MATERIALS AND METHODS:** A total of 64 patients requiring at least two single crowns or partial fixed dental prostheses supported by a maximum of three implants had their sites randomised according to a split-mouth design to receive both implant systems at six centres. Patients were followed up for 1 year after initial loading. Outcome measures were: prosthesis/implant failures; any complication; peri-implant marginal bone level changes; and clinician preference.

**RESULTS:** In total 71 Way Milano and 73 Kentron implants were placed. Six patients dropped-out before the 1-year follow-up, but all remaining patients were followed up to 1 year post-loading. No Way Milano implant failed, whereas three Kentron implants failed before loading. Two complications were reported, one for each implant type. There were no statistically significant differences for prosthesis/implant failures (difference in proportions = 0.05,  $P = 0.25$ ; 95% CI -0.02 to 0.13) and complications (difference in proportions = 0,  $P = 1.0$ , 95% CI -0.07 to 0.07) between the implant systems. Three operators preferred Way Milano implants whereas the other three had no preference. At implant placement (baseline) bone levels were higher for Way Milano implants (0.27 mm) than for Kentron implants (0.41 mm). Both groups gradually lost statistically significant amounts of periimplant marginal bone at 4 months after loading and at 1 year after loading. One year after loading, Way Milano implants lost an average of 0.73 mm peri-implant bone compared with 0.84 mm of Kentron implants. Marginal bone level changes were not statistically significant different for Way Milano compared to Kentron implants at 4 months (-0.16 mm, 95% CI -0.30, 0.01;  $P = 0.0606$ ) and 1 year (-0.09 mm, 95% CI -0.26, 0.09;  $P = 0.3407$ ) after loading.

**CONCLUSIONS:** No statistically significant differences were observed between the two implant types, although three Kentron implants failed versus none of the Way Milano type. Longer follow-up of wider patient populations are needed to better understand whether there is an effective advantage with one of the two implant designs.

## 1 stage versus 2 stage lateral sinus lift procedures: 1 year post-loading results of a multicentre randomised controlled trial.

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*Eur J Oral Implantol 2014;7(1):65-75*

**PURPOSE:** To compare the efficacy of 1-stage versus 2-stage lateral maxillary sinus lift procedures.

**MATERIALS AND METHODS:** Sixty partially edentulous patients requiring 1 to 3 implants and having 1 to 3 mm of residual bone height and at least 5 mm bone width below the maxillary sinus, as measured on CT scans were selected. They were randomised according to a parallel group study design into two equal arms to receive either a 1-stage lateral window sinus lift with simultaneous implant placement or a 2-stage procedure with implant placement delayed by 4 months, using a bone substitute in three different centres. Implants were submerged for 4 months, loaded with reinforced provisional prostheses, which were replaced, after 4 months, by definitive prostheses. Outcome measures, assessed by masked assessors, were: augmentation procedure failures; prosthesis failures and implant failures; complications; and marginal peri-implant bone level changes. Patients were followed up to 1 year after loading. Only data of implants placed in 1 to 3 mm of bone height were reported.

**RESULTS:** Two patients dropped out from the 1-stage group and none from the 2-stage group. No sinus lift procedure failed in the 1-stage group but one failed in the 2-stage group, the difference being not statistically significant ( $P = 1.00$ ). Two prostheses failed or could not be placed in the planned time in the 1-stage group and one in the 2-stage group, the difference being not statistically significant ( $P = 0.51$ ). Three implants failed in three patients of the 1-stage group, versus one implant in the 2-stage group, the difference being not statistically significant ( $P = 0.28$ ). Two complications occurred in the 1-stage group and one in the 2-stage group, the difference being not statistically significant ( $P = 0.61$ ). One year after loading, 1-stage treated patients lost an average of -1.01 mm (SD: 0.56) of peri-implant bone and 2-stage sites about -0.93 mm (SD: 0.40). There were no statistically significant differences in bone level change between groups 1 year after loading (-0.08 mm 95%CI: -0.33 to 0.18  $P = 0.56$ ).

CONCLUSIONS: No statistically significant differences were observed between implants placed according to 1- or 2-stage sinus lift procedures. However this study may suggest that in patients having residual bone height between 1 to 3 mm below the maxillary sinus, there might be a slightly higher risk for implant failures when performing a 1-stage lateral sinus lift procedure.

Esposito M, Blasone R, Favaretto G, Stacchi C, Calvo M, Marin C, Felice P.

## A comparison of two dental implant systems in partially edentulous patients: 4-month post-loading results from a pragmatic multicenter randomised controlled trial.

*Eur J Oral Implantol. 2013 Summer;6(2):169-79.*

**PURPOSE:** To compare the clinical effectiveness of 2 implant systems: "Way Milano" and "Kentron" (Geass, Pozzuolo del Friuli, UD, Italy).

**MATERIALS AND METHODS:** Sixty-four patients requiring at least 2 single crowns or partial fixed bridges supported by maximum 3 implants had their sites randomised according to a split-mouth design to receive both implant systems at 6 centres. Patients were followed for 4 months after initial loading. Outcome measures were: prosthesis/implant failures, any complication, and clinician preference.

**RESULTS:** Seventy-one Way Milano and 73 Kentron implants were placed. One patient died 45 days after placement of 2 implants, but all remaining patients were followed up to 4-month post-loading. No Way Milano implant failed whereas 3 Kentron implants failed before loading. Two complications were reported, one at each implant type. There were no statistically significant differences for prosthesis/implant success and complications between the implant systems. Three operators preferred Way Milano implants whereas the other 3 had no preference.

**CONCLUSIONS:** Preliminary short-term data (4-month post-loading) showed not statistically significant differences between the 2 implants systems, however trends are suggestive of a better clinical performance of Way Milano implants.

Felice P, Pistilli R, Piattelli M, Soardi E, Pellegrino G, Corvino V, Esposito M.

## 1-stage versus 2-stage lateral maxillary sinus lift procedures: 4-month post-loading results of a multicenter randomised controlled trial.

*Eur J Oral Implantol. 2013 Summer;6(2):153-65.*

**PURPOSE:** To compare the efficacy of 1-stage versus 2-stage lateral maxillary sinus lift procedures. **Materials and METHODS:** Sixty partially edentulous patients requiring 1 to 3 implants and having 1 to 3 mm of residual bone height and at least 5 mm bone width below the maxillary sinus, as measured on CT scans, were randomised into 2 equal groups to receive either a 1-stage lateral window sinus lift with simultaneous implant placement or a 2-stage procedure with implant placement delayed by 4-months using a bone substitute in 3 different centres. Implants were submerged for 4 months, loaded with reinforced provisional prostheses which were replaced, after 4 months, by definitive prostheses. Outcome measures were: augmentation procedure failures, prosthesis failures and implants failures, complications and marginal peri-implant bone loss assessed by a blinded outcome assessor. Patients were followed up to 4 months after loading. Only data of implants placed in 1 to 3 mm of bone height were reported.

**RESULTS:** Two patients dropped out from the 1-stage group and none from the 2-stage group. No sinus lift procedure failed in the 1-stage group but 1 failed in the 2-stage group, the difference being not statistically significant ( $P=1.00$ ). Two prostheses failed or could not be placed in the planned time in the 1-stage group and 1 in the 2-stage group, the difference being not statistically significant ( $P=0.51$ ). Three implants failed in 3 patients of the 1-stage group versus 1 implant in the 2-stage group, the difference being not statistically significant ( $P=0.28$ ). Two complications occurred in the 1-stage group and 1 in the 2-stage group, the difference being not statistically significant ( $P=0.61$ ). There were no statistically significant differences in bone loss between groups at loading (0.05 mm). 1-stage treated sites lost an average of 0.56 mm (SD: 0.36, 95% CI: -0.70 to -0.42,  $P<0.001$ ) of peri-implant bone and 2-stage sites about 0.61 mm (SD: 0.34 95% CI: -0.74 to -0.48,  $P<0.001$ ).

**CONCLUSIONS:** No statistically significant differences were observed between implants placed according 1- or 2-stage sinus lift procedures, however this study may suggest that in patients having residual bone height between 1 to 3 mm below the maxillary sinus there might be a slightly higher risk for implant failures when performing a 1-stage lateral sinus lift procedure.

Lepore S, Milillo L, Trotta T, Castellani S, Porro C, Panaro MA, Santarelli A, Bambini F, Lo Muzio L, Conese M, Maffione AB.

## Adhesion and growth of osteoblast-like cells on laser-engineered porous titanium surface-Expression and localization of N-cadherin and $\beta$ -catenin.

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*J Biol Regul Homeost Agents. 2013 Apr-Jun;27(2):531-41.*

**INTRODUCTION:** Response of different types of cells on biomaterials is crucial for the applications of tissue engineering and regenerative medicine. It is recognized that cell behaviour depend largely by material surface characteristics.

**OBJECTIVES:** The purpose of this study was to define the biologic response of MG63 cells to an innovative patented surface Synthebra®.

**MATERIALS AND METHODS:** The MG63 morphology and distribution on the three different titanium disks surface were evaluated by microscopy analysis after staining with hematoxylin and eosin. Cell adhesion was determined by crystal violet assay at 48 hours while proliferation and cytotoxicity were performed by MTT assay at 24, 48, 72 and 240 hours. The expression and localization of N-cadherin and  $\beta$ -catenin were studied by immunofluorescence and confocal microscopy.

**RESULTS:** At 48 h the adhesion was similar in all titanium surfaces, no cytotoxic difference in cell viability were observed in all titanium disks when compared with controls, while the cell growth on p30 disks was significantly higher at 240 h than at 72 and 24 h. Morphological analysis show that cells are aligned along the grooves and inside the cavities.  $\beta$ -catenin appeared more diffuse and localized underneath the cell membrane, while N-cadherin signal was fainter in cells grown onto Synthebra® surface.

**CONCLUSIONS:** This work put in evidence the performance of newly designed laser-micromachined surface for adhesion, growth and distribution of human osteoblast-like cells. Synthebra® surface inducing modification of N-cadherin and  $\beta$ -catenin expression and localization, which are suggestive of cells undergoing differentiation towards osteocytes, could be particularly suited for immediate load implant procedures.

## Immediate loading with LASER-treated surface implant: two-year resonance frequency analysis follow-up.

*J Craniofac Surg. 2013 May;24(3):849-55.*

**BACKGROUND:** The chemical, physical, and morphologic characteristics of the implant surface play a fundamental role during the osteointegration process. Implant design is of paramount importance in determining implant primary stability and implant ability to sustain loading during and after osteointegration. LASER treatment of the surface allows defining the precise parameters of roughness to obtain a regular and repeatable surface in total absence of contamination.

**PURPOSE:** The aim of this study was to analyze the behavior of implant stability of LASER-treated surface implants by repeated resonance frequency analysis (RFA) measurements during 2 years in patients with complete upper maxilla edentulism subject to an immediate-loading protocol.

**METHODS:** Ten patients were included, and each treated with the insertion of 6 or 8 LASER surface implants according to the individual surgical-prosthetic planning. During the bone drilling and implant insertion, torque values were monitored with a specific handpiece and software. All implants were loaded within 24 hours from the insertion with the application of a temporary full-arch prosthesis. Subsequent follow-up has been done at 24 months from the loading with radiographic controls (OPT) and RFA measurement on all implants at time of implant insertion and at 1, 3, 6, 12, and 24 months from loading.

**RESULTS:** Resonance frequency analyses at 3 and 6 months from the implant loading have shown a rapid increment of implant stability quotient (ISQ) values in the first phases of bone remodeling, subsequent to the peri-implant bone remodeling. The paired comparisons between mean ISQ values by patient showed a statistically significant decrease in primary stability from baseline up to 1 month ( $P = 0.0039$ ). Subsequent measurements revealed a statistically significant increase in implant stability from 1 up to 3 months ( $P = 0.0156$ ), from 3 up to 6 months ( $P = 0.0020$ ), from 6 up to 12 months ( $P = 0.020$ ), and 12 up to 24 months ( $P = 0.0391$ ).

**CONCLUSIONS:** Resonance frequency analysis of the LASER-treated surface implants showed good ISQ values at all time point measurements. These results are consistent with data from literature on the analysis of RFA in protocols of immediate loading at the upper maxilla.

Moraes EJ, Rao Genovese F.

## Comparison between immediate and delayed laser surface implants with switching platform: a clinical retrospective study.

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*J Oral Implantol. 2013 Jun;39(3):333-8.*

**PURPOSE:** The aim of the present study was to compare immediate (Im) versus delayed (De) placement of titanium dental implants with laser surfaces and platform switch (Syntegra) to confirm the predictability and performance of this type of implant.

**MATERIALS AND METHODS:** A retrospective study was made of subjects treated with immediate or delayed dental implants in for tooth extractions and healed sites at the incisor, canine, premolar and molar regions of the maxilla or the mandible. A protocol was prepared in which patient age, sex, implant length, diameter, and use of bone graft were recorded.

**RESULTS:** The study included 44 GEASS Srl (Udine- Italy) implants with laser surface and morse taper connection, placed in 27 patients with mean age of 56 years (range, 25 to 80 years).The survival rates were 100 % in the Im group and in the De group. The patients were followed up to minimum period of 12 months.

**DISCUSSION AND CONCLUSIONS:** Implants with laser surface and morse connection presented when placed in fresh sockets has been shown similar results to implants placed in mature bone after 12 months of follow-up.

Sinjari B, Guarnieri S, Diomede F, Merciaro I, Mariggio MA, Caputi S, Trubiani O.

## Influence of titanium laser surface geometry on proliferation and on morphological features of human mandibular primary osteoblasts.

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*J Biol Regul Homeost Agents. 2012 Jul-Sep; 26(3):505-13.*

The aim of this study is to assess in vitro the proliferation and the morphological changes of primary osteoblast-like cells (HOst) seeded on titanium dish grade 4 and 5 with different roughness and different titanium grade: machined (M), sandblasted (SBT), laser-treated with pitches of 20-microm diameter and 30-microm interpore distance. The titanium disks were divided into two groups: group A (titanium grade 4) and Group B (titanium Grade 5), respectively. Proliferation rate of attached cells was evaluated at different time (24, 48, 72 h and 1 week) by the quantitative colorimetric MTT assay. Our results showed a cell growth decrease evident in M titanium surfaces in both Groups A and B, while the cells seeded on the STB and laser disks displayed an increase of cells growth, more evident in laser titanium surfaces in groups A and B. Morphological changes of the biocomplex cells/titanium was assessed by light, scanning and confocal microscopy. In fact, the microscopic analysis helped to clarify the behavior of the cells in contact with the titanium surfaces, in particular the M surface induced significant morphological changes, which were less evident in the SBT surfaces. Laser-engineered porous titanium surfaces promoted viability and proliferation of the osteoblasts. In particular, hemispherical porosity of 20  $\mu\text{m}$  could be responsible for the higher HOst activation, in terms of cells proliferation, adhesion and morphological features.

Aleo E, Varvara G, Scarano A, Sinjari B, Murmura G.

## Comparison of the primary stabilities of conical and cylindrical endosseous dental implants: an in-vitro study.

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*J Biol Regul Homeost Agents. 2012 Jan-Mar; 26(1):89-96.*

The aim of this study is to determine the differences in primary stability between conical and cylindrical dental implants. The insertion and removal torques were the parameters used to measure the primary stability of the implants. Ten conical and cylindrical dental implants were positioned in polyurethane foam blocks to simulate bone density classes D1, D2, D3 and D4. The insertion and removal torques were quantified using a digital torque gauge. The maximum insertion torque and the maximum removal torque measured for the D1 and D4 synthetic bone were significantly higher for the conical implants than the cylindrical implants. In this in-vitro model, conical implants show significantly higher primary stability than cylindrical implants for the D1 and D4 synthetic bone classes.

Leonida A, Vescovi P, Baldoni M, Rossi G, Lauritano D.

## Immediate loading in mandible full-arch: pilot study in patients with osteoporosis in bisphosphonate therapy.

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*J Oral Implantol. 2012 Feb; 38(1):85-94. Epub 2010 Jun 16.*

AIM: The aim of this paper was to show how it was possible a full-arch immediate loading rehabilitation in the mandible in patients taking biphosphonates.

MATERIALS AND METHODS: Nine adult patients (8 women and 1 man) aged 45 to 68 years presented for a rehabilitation of the fixed mandible. All patients were non-smokers with non-contributory medical histories. None of the patients had undergone chemotherapy or radiation at any time. All patients had been shown osteoporosis disease (t-scan < 2,5) and they were being treated with bisphosphonates per os (Residronate and Alendronate) for less than 3 years. Furthermore, all patients had residual teeth with several periodontal compromise. That was tied to compromised continuous time reference of the surgical step. All patients were rehabilitated in mandible with full-arch prosthesis supported by six Way Syntegra implants.

RESULT: No subjective complaints were reported throughout the follow up period. After 2 years of loading, all implants were checked and all were found to be clinically stable without signs of infection. In the same period, no soft tissue swellings and no osteonecrosis lesions. The clinical survival rate is 100% in this interval.

CONCLUSIONS: Rehabilitation of the edentulous mandible in patients with osteoporosis in therapy with biphosphonates per os by an immediate occlusally loaded full-arch prosthesis supported by six Way Syntegra implants is a viable alternative treatment to the classical delayed protocols.

Berardi D, De Benedittis S, Scoccia A, Perfetti G, Conti P.

## New laser-treated implant surfaces: A histologic and histomorphometric pilot study in rabbits.

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*Clin Invest Med.* 2011 Aug 1; 34(4):E202.

**PURPOSE:** The purpose of this study was to confirm the validity of laser treated implant surfaces, with regard to high superficial purity preservation and to extremely regular and uniform roughness surfaces.

**METHODS:** In this in vivo study, seven different laser treated implant surfaces were analyzed. A diode-pumped solid state source laser, in a Q-Switch output mode, was used at various wavelengths, which were chosen to generate surface irregularities of varying diameter, depth and pitch. Twenty one implants were placed in 11 New Zealand rabbits. Eight weeks after surgery, implants were harvested for histometric analysis: total, threads and body bone-to-implant, and bone-to-implant contacts were measured. The morphologic analysis of the surface was carried out using a Scanning Electron Microscope.

**RESULTS:** Average bone-implant contact values were approximately 50% for all tested surfaces. Both total and threads values, within the same processing pattern group, had a high variance. Bone-implant contact thread and body variances were different, so that is possible that laser beam angle is able to modify the superficial roughness and thus the histological response.

**CONCLUSIONS:** Implants provided with pores of 20 and 25  $\mu\text{m}$  achieved more than satisfactory bone-implant contact partial peaks. Further statistically significant experiments are needed in order to study, in depth, these surfaces.

Cei S, Legitimo A, Barachini S, Consolini R, Sammartino G, Mattii L, Gabriele M, Graziani F.

## Effect of Laser Micromachining of Titanium on Viability and Responsiveness of Osteoblast-Like Cells.

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*Implant Dent. 2011 Aug;20(4):285-91.*

**OBJECTIVES:** Laser engineering may create hemispherical porosities on titanium surfaces obtaining regular and predetermined rough titanium surfaces. The aim of this study was to assess the viability and the proliferation of primary osteoblast-like cells (OB) to growth factors on titanium surfaces with a different roughness in vitro. **MATERIALS AND METHODS:** OB were obtained from volunteers undergoing wisdom tooth removal following a standardized protocol. OB were allowed to attach on 4 different titanium surfaces: sandblasted titanium (SBT) disks, 5-, 10-, and 20- $\mu\text{m}$  regular laser-engineered micropore titanium disks. A well with no disk was used as control. Cell morphology was evaluated with scanning electron microscopy. Viability was measured with MTT (3[4,5 dimethylthiazol 2yl]2,5 diphenyltetrazolium bromide) assay. Proliferation rate of attached cells was evaluated with Cell Counting Kit-8 48 hours after platelet-released supernatant (PRS) application. Statistical analysis was performed with analysis of variance test.

**RESULTS:** All surfaces showed OB attachment on scanning electron microscopy. OB appeared more numerous on 20T surfaces. Laser-engineered surfaces showed higher OB viability than SBT ( $P < 0.01$ ). In terms of proliferation, viability increase was noted for all groups after platelet-released supernatant application. 20T and SBT disks seemed to trigger the higher cellular proliferation (20T vs 10T,  $P < 0.05$ ).

**CONCLUSIONS:** Laser-engineered porous titanium surfaces promote viability and proliferation of OB. In particular, hemispherical porosity of 20  $\mu\text{m}$  seems to trigger the higher OB response. Further research is needed to confirm these data.

Esposito M, Piattelli M, Pistilli R, Pellegrino G, Felice P.

## Sinus lift with guided bone regeneration or anorganic bovine bone: 1-year post-loading results of a pilot randomised clinical trial.

*Eur J Oral Implantol. 2010 Winter;3(4):297-305.*

**PURPOSE:** To compare the efficacy of two different techniques for maintaining the space beneath a maxillary lining lifted using a lateral window approach: rigid synthetic resorbable barriers versus granular anorganic bovine bone.

**MATERIALS AND METHODS:** Ten partially edentulous patients having bilaterally 1 to 5mm of residual bone height and at least 5mm bone width below the maxillary sinuses, were randomised in a split-mouth study design, to receive a rigid Inion GTR Biodegradable Membrane System barrier without any graft on one side and 100% loosely packed granular Bio-Oss on the contralateral side following a lateral window, two-stage, sinus lift procedure. After 6 months, two or three implants were inserted at each side and submerged for 4 months. Implants were loaded with provisional acrylic prostheses and replaced, after 4 months, by definitive metal-ceramic prostheses cemented with provisional cement. Outcome measures were implant and prosthetic failures, any complication and peri-implant marginal bone level changes assessed by a blinded outcome assessor. All patients were followed up to 1 year after loading.

**RESULTS:** One patient dropped out after implant placement. One distal implant failed at the Inion side just before delivery of the definitive prosthesis, which was cut and maintained as a single crown. Four complications occurred in three patients at Inion sites (two sinus lining perforations, one fracture of the ceramic cusp of the definitive prosthesis, one iatrogenic peri-implantitis) versus two complications at Bio-Oss sites (one sinus lining perforation and one iatrogenic peri-implantitis). There were no differences for failures or complications between groups; however, in one of the patients where a perforation occurred at the Inion site, at implant placement, the sinus was filled two-thirds with soft tissue and the site was retreated with Bio-Oss. There were no statistically significant differences in bone loss between groups. One year after loading, Inion sides lost an average of 1.5mm of peri-implant bone and Bio-Oss sides about 1.7mm.

**CONCLUSIONS:** A bone graft may not be needed to augment atrophic maxillary sinuses since it is sufficient to keep space with a rigid barrier; however, it may be simpler to fill sinuses with a bone substitute than positioning a rigid barrier to maintain space.

Berardi D, De Benedittis S, Polimeni A, Malagola C, Cassinelli C, Perfetti G.

## In vitro evaluation of the efficacy of a new laser surface implant: cellular adhesion and alkaline phosphatase production tests.

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*Int. J. Immunop. Pharm. 2009; 1;125-131.*

Bone tissue reacts in different ways to implant surfaces with different patterns. The aim of this study is to understand which laser generated surface pattern produces the best cell adhesion in vitro, evaluating both the activity of the alkaline phosphatase and the cells adhering to titanium samples. Tests were carried out on titanium samples with sandblasted surfaces with laser-produced holes with diameters of 5, 10, and 20 micron, and on sandblasted titanium cylinders without holes as controls. The samples were inserted into culture medium containing SaOS-2 cells for 3, 7 and 10 days. The results showed that at days 3 and 7 the laser surfaces stimulated a higher production of alkaline phosphatase (ALP) compared to the data from the control group. At day 10 there were no significant differences between the test group and the control group.

Felice P, Scarano A, Pistilli R, Checchi L, Piattelli M, Pellegrino G, Esposito M.

## A comparison of two techniques to augment maxillary sinuses using the lateral window approach: rigid synthetic resorbable barriers versus anorganic bovine bone. Five-month post-loading clinical and histological results of a pilot randomised controlled clinical trial.

*Eur J Oral Implantol. 2009 Winter;2(4):293-306.*

**PURPOSE:** To compare the efficacy of two different techniques to augment maxillary sinuses using a lateral window approach: rigid synthetic resorbable barriers (Inion) versus granular anorganic bovine bone (Bio-Oss).

**MATERIALS AND METHODS:** Ten partially edentulous patients having bilaterally 1 to 5 mm of residual bone height and at least 5 mm bone width below the maxillary sinuses, as measured on computed tomography (CT) scans, were randomised to receive two different 2-stage sinus lift procedures using the lateral window approach. In one side, the sinus lining was raised by placing a resorbable rigid Inion barrier without any bone substitute whereas the contralateral side was loosely packed with 100% granular Bio-Oss. After 6 months, 2 to 3 implants were inserted at each side and submerged for 4 months. Implants were loaded with provisional acrylic prostheses and replaced after 4 months, by definitive screwretained metal-ceramic prostheses. Outcome measures were: time necessary to complete the augmentation procedure, bone gain on CT scans, histomorphometry, any complication, implant and prosthetic failures, and clinician and patient preference assessed by a blinded outcome assessor. All patients were followed up to 5 months after loading.

**RESULTS:** No patient dropped out. There was no significant difference in time to complete the augmentation procedure (19.8 minutes for Inion versus 20.5 for Bio-Oss). After 6 months, both interventions gained bone in a highly statistically significant way (14.4 mm for Inion versus 14.1 mm for Bio-Oss) with no significant differences between the procedures. Histologically, more new bone formed at Bio-Oss treated sites (36.1% versus 24.2%), the difference being highly statistically significant ( $P = 0.002$ ). There were no differences in complications between groups (2 perforations of the maxillary lining at Inion treated sites versus 1 at a Bio-Oss site), however, in one of the patients where a perforation occurred at the Inion site, at implant placement, the sinus was two-thirds filled with soft tissue and the site was successfully retreated with Bio-Oss. No implant failed. The clinician preferred Bio-Oss because it was simpler to handle. There were no statistically significant differences in patient preference 1 month after surgery and 1 month after delivery of definitive prostheses: 8 patients had no preference while 2 preferred the Bio-Oss treated side.

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