

Albrektsson T, Wennerberg. Part 1--review focusing on topographic and chemical properties of different surfaces and in vivo responses to them. Int J Prosthodont. 2004 Sep-Oct; 17(5):536-43. 60 (Refs)

Purpose: To review the topographic and chemical properties of different oral implant surfaces and in vivo responses to them.

Materials and Methods: Literature review and authors' description.

Findings: Surface quality of an oral implant may be subdivided into mechanical, topographic, and physicochemical properties.

Mechanical Properties: These properties of oral implant systems have been insufficiently investigated.

Topographic properties: The surface topography relates to the degree of roughness of the surface and the orientation of the surface irregularities. Surface roughness has been the main focus on oral implants for more than a decade. Potential drawbacks of roughening the implant surface include greater problems with peri-implantitis and a greater risk of ionic leakage. The latter problem was based on the physical knowledge that greater surface roughness gives greater tissue-implant contact and hence ionic leakage. However, risk levels were not identified, and it seems probable that the increase in ionic leakages with slight roughening of an oral implant is negligible. With respect to surface roughness, it is unknown whether nanometer sized irregularities will affect the bone response. To the knowledge of the present authors, the proof is limited to in vitro data from various nanosurfaces.

Physical Characteristics: Theoretically, an oral implant with high surface energy may show stronger osseointegration than implants with a low surface energy. Glow discharge treatment results in high surface energy as well as implant sterilization. However, the hypothesis mentioned above has not been verified by in vivo studies. It is possible that an initially high surface energy will be immediately changed when the implant is moved from the glow discharge container through the air toward the patient. Chemical properties seem to be the main focus for the future in oral implantology. The surface layer may contain reactive bonds, and a continuous exchange of water and various ions influences the binding of proteins to the surface and the subsequent cell reactions.

Anchorage Mechanisms of Oral Implants:

Biomechanical bonding: A turned Ti implant is anchored to bone through in growth into small irregularities of the implant surface-biomechanical bonding. Blasted, acid-etched, and other moderately roughened implants are also dependent on biomechanical bonding. The potentially negative aspect with biomechanical bonding is that it is time consuming. There are weeks of delay before bone has started to grow into surface irregularities. Today, the irregularities at least down to 1µm may be invaded by bone, although complete Haversian systems need a larger space. The strongest biomechanical bonds are seen to surfaces of a roughness of about 1.5µm, whereas rougher, plasma-sprayed implants show weaker bone in growth.

Biochemical bonding: The best definition of the biochemical bonding mode of implant anchorage is "Bioactivity is the characteristic of an implant material which allows it to form a bond with living tissues." The bioactive implants may, in addition to chemical bonding, show biomechanical anchorage; hence, a given implant may be anchored through both mechanisms. The theoretic advantage with bioactive implants is that the biochemical attachment is rapid. To date, two types of implant surfaces are potentially

bioactive and presently marketed as oral implants: One such surface is represented by calcium phosphate-coated implants; the other is the fluoridated Osseospeed implant. Today it is generally believed that calcium phosphates may have bioactive capacity, although this may not apply to all types of calcium phosphates. The fluoridated implants sustained greater push-out forces than controls, and substantial bone adhesion was observed to fluoridated implants. The latter finding is an indication of bioactivity of the fluoridated implants.

Evidence for a Bioactive Implant surface: It has so far been impossible to prove the existence of bioactivity. Each investigation links to a plausible explanation for biochemical bonding. One problem is the fact that several techniques for surface modification of oral implants simultaneously lead to rougher surface.

Oral implant surfaces are suggested to be “Osteoattractive”: It is difficult to define particular osteoattractiveness and differentiate such surfaces from moderately roughened surfaces that are quite attractive for bone formation. All implant types described as “osteoatractive” may, in fact, share the characteristic of being moderately roughened and thereby more attractive for new bone formation than smoother turned or tougher plasma-sprayed implants.

Doped surfaces: they are still hypothetical solutions for the future.

Conclusion: Moderately roughened surfaces may have some clinical advantages compared to smoother turned and rougher plasma-sprayed surfaces. Bioactive implants may present some promise for the future. A substantial number of claims made by manufacturers on alleged superiority due to design characteristics are not based on sound and long-term clinical scientific research. It seems probable that improvements in surgical technique will present good prospects for improving clinical results.

Albrektsson T, Wennerberg A. Oral Implant Surfaces: Part 2—Review Focusing on Clinical Knowledge of Different Surfaces. *Mt J Prosthodont* 2004; 17:544—564

Purpose: To investigate the published clinical evidence of implant surfaces

Materials and Methods: This is a review article; the attempt was to not merely to summarize various published papers, but the authors applied their own strict criteria to each paper while reviewing them.

Findings: TiUnite anodized surfaces are clinically documented in 1- to 2-year follow-up studies at best, with failures at about 3%. Sandblasted and acid-etched SLA surfaces are documented with good clinical results for up to 3 years. Osseotite dual acid-etched implants are documented with good clinical results for up to 5 years. Frialit-2 sandblasted and etched implants are positively documented for about 3 years in one study only. The Tioblast implant is the only design documented for survival over 10 years of follow-up and success over 7 years of follow-up.

Conclusions:

1. All new implant surfaces are moderately roughened, with the exception of Osseotite implant, which is minimally rough and in that respect similar to a turned, machined surface.
2. The standards of reporting the results of oral implants have improved over the status found during our previous reviews
3. Several oral implant systems have now been properly documented for 5 years or more
4. The best documented oral implants are no longer available from the major oral implant companies.
5. The only currently marketed long term documented implant from the major companies is the Osteotite and Tioblast implant. The later surface is also documented for seven years with respect to success and 10 years with respect to survival.
6. Commercial companies have generally preferred to develop new untested surfaces marketed with out any prelaunch clinical investigations.
7. Such untested clinical implants have become extremely successes full from a marketing point of view. Implant users don't see clinical documentation as necessary
8. The new osseo-speed implant represents the only recently introduced surface from the 5 big companies for which at least some clinical trials have been completed before marketing.

Bogaerde LV, Rangert Bo, Wendelhag I. Immediate/Early function of Branemark System Tiunite implants in fresh extraction sockets in maxillae and posterior mandibles: an 18 month prospective clinical study. Clinical Implant Dentistry and Related Research, Vol7 Sup1, 2005.

Purpose: The aim of this study was to develop a protocol for and to evaluate the possibility of immediate/early function of implants placed in fresh extraction sockets located in the maxilla and posterior mandible. It also aimed at evaluating and developing a protocol for regenerating defects around these implants.

Materials and Methods: Nineteen patients, fourteen females and five males with a mean age of 55 years were treated according to the immediate function protocol and were observed for 18 months. Exclusionary criteria included a compromised systemic health status, heavy bruxism and the presence of an anterior deep bite. Periodontal disease was not treated as a contraindication, but the affected patients received Sc/Rp and any necessary periodontal surgery. 55 implants were placed, 17 of which were in the maxilla and 5 in the mandible. Implant lengths ranged from 13 -15 mm in the maxilla and from 8.5 to 15 mm in the mandible. All implants were restored as splinted multiple units. Following reflection of mucoperiosteal flaps and debridement of the surgical sites, the implants were placed into the alveolar bone with the implant platform flush to the bone crest and implant torque was at least 30 Ncm. Final abutments 1 mm high were immediately placed on to these implants. Extraction sockets were divided as follows:

- (1) Extraction socket, no defect (ESND): No defect remained adjacent to the implant.
- (2) Extraction socket, closed defect (ESCD): When a defect remained adjacent to the implant but was enclosed by intact bone walls.
- (3) Extraction socket, open defect (ESOD): When a defect was present adjacent to the implant along with loss of one or more bone walls.

13 of 50 implants belonged to the ESND group, 33 belonged to the ESCD group and 4 to the ESOD group. ESCD group implants received autologous bone grafts. ESOD received a combination of bone graft and a resorbable membrane. Augmentin 1 gm bid x 1 week starting just before surgery combined with anti-inflammatory medication were prescribed. Standardized radiographs were taken at implant placement, 1 and 6 months after placement and 1 year after final prosthesis delivery. 38 implants were checked by resonance frequency analysis at baseline, 1, 2, 4 and 6 weeks to 3 and 6 months post placement. Implants were deemed to be successful when they were clinically stable and functioned without any discomfort to the patient.

Findings and Conclusions: None of the 50 implants had failed at the end of the 18 month observation period giving an implant survival rate of 100 %. 1 implant showed slight mobility and pain on pressure at 6 weeks. However, once the occlusal load was removed, the implant regained its stability and was used for prosthesis. The mean marginal bone resorption was 0.9 mm 18 months after implant placement. In the ESND group, the mean resorption was 1.1 mm and in the ESCD group it was 0.6 mm. In this group four implants gained an average of 0.7 mm of bone during the follow up. In the four implants in the ESOD group, the mean marginal bone resorption was 2.1mm. Of the 38 implants analyzed by RFA, 19 showed no variations in stability from baseline to the 6-month follow up where as 15 showed increasing stability over time. The remain-

ing 4 implants showed a decrease in stability at 6 months but were asymptomatic and able to support a prosthesis during the entire observation period.

Bogaerde LV. A Proposal for the Classification of Bony Defects Adjacent to Dental Implants. Int J Periodontics Restorative Dent 2004; 24:264-71. 20 (Refs)

Purpose: To propose a morphologic classification of bony defects adjacent to dental implants and discuss the clinical implications.

Materials and Methods: Author's description

Findings and Conclusions:

Bone defects adjacent to implants are divided into two main groups according to the remaining bone walls lining the defects as follows: 1) Closed defects: defects with fully preserved surrounding bone walls, and 2) Open defects: defects lacking one or more surrounding bone walls.

At the level of the implant neck, the open defect group is further divided into the following subgroups: a) ONs: no implant-bone contact at implant neck, suprabony defect, b) ON: no implant-bone contact at implant neck, intrabony defect, c) O1: one implant-bone contact at implant neck, d) O2: two implant-bone contacts at implant neck, e) O3i: three implant-bone contacts at implant neck, intrabony defect (dehiscence within the envelope), and f) O3e: three implant-bone contacts at implant neck, extrabony defect (dehiscence outside the envelope).

Closed defect fill is very predictable in all of the group's morphologic variants. Suprabony open defects (ONs) completely lack any bone wall and for this reason, its treatment is very demanding and challenging, and the outcome is fairly uncertain. At present, one of the best strategies to treat these defects is the use of nonresorbable, reinforced membranes. Intrabony defects (ON to O3i) are more predictable, and the greater the number of bone walls in contact with the implant neck, the better is the prognosis for defect healing; the rate of successful regeneration increases from the ON to O3i groups. The outcome of treatment in these defects depends on the space-making properties of the defect itself. When the defect lacks space-making features, the use of a particulated bone graft is always recommended for space maintenance, often in combination with a membrane.

O3e defect will have less space maintenance and less blood clot stability than O3i, and for this reason, O3e defects require a more complicated regenerative procedure, and the results are less predictable than those in O3i defects. In this situation, the combination of solid bone particles and a membrane to contain them is mandatory.

Botticelli D, Berglundh T, Lindhe J. Hard-tissue alterations following immediate implant placement in extraction sites. J Clin Periodontol 2004; 31: 820–828. 26 (Refs)

Purpose: To study dimensional alterations of hard tissues that occurs following tooth extraction and immediate placement of implants.

Materials and Methods: Eighteen healthy subjects (nine female and nine male; mean age, 49.1 years; range, 21–81) providing 21 extraction sockets were included in the study. Full thickness flaps were elevated and the tooth extracted and an implant placed within the socket. Only incisor, canine and premolar teeth were extracted. Reasons for extraction were limited to endodontic and carious lesions combined with root or crown fractures. No teeth were removed for severe periodontal reasons. Solid screw ITI® implants with an SLA surface were used with the following dimensions: 2.8 mm coronal smooth collar; 4.1 mm diameter with a length varying between 8-12 mm. B-L thickness of the socket walls were measured at a point 1mm below the crest of bone for unexplained reasons. After implant installation, the defect that occurred between the bone walls of the extraction socket and the implant surface was characterized and the following landmarks were identified: S=rim of the implant shoulder, C=top of the bone crest, OC=outer border the bone crest, D=base of the defect.

Following implant installation (i) the vertical distance between the implant shoulder (S) and the bone crest (C), (ii) the width of the gap between the implant surface and the inner side of the bone wall (G) and (iii) the horizontal distance between the implant surface and the outer side of the bone crest (OC) were assessed.

The flaps were subsequently replaced and secured with sutures in such a way that only the healing cap of the implant was exposed to the oral environment. After 4 months of healing a re-entry procedure was performed and the clinical measurements were repeated.

Findings and Conclusions:

Baseline: M-D mean width of the marginal socket dimension was 5.3 ± 1.2 (SD) mm (range 4.0-8.0); B-L mean width was 7.3 ± 1.1 mm (range 5.5-9.0)

Fifty-two marginal defects exceeding 3mm in the S-D dimension were present at baseline: 21 at buccal, 17 at lingual/palatal, and 14 at approximal surfaces.

Buccal Gap: Mean 2.0 ± 0.7 mm, range 1-3 mm. Lingual/palatal Gap: Mean width 1.5 ± 0.9 mm, range 0-3mm. Approximal Gap: Mean width 0.7 ± 0.8 mm at the mesial, and 0.6 ± 0.7 mm at the distal; range 0-3.0 mm. At the re-entry, 4 months later, eight defects exceeding 3.0mm remained.

Buccal Gap: Mean width 0.4 ± 0.5 mm; range 0-1.5mm

Lingual/palatal: Mean 0.4 ± 0.4 mm; range 0-1.0

Approximal: Mesial and distal had the same mean width at 0.5 ± 0.5 mm; range 0-2.0mm

During the 4 months of healing, the bone walls of the extraction underwent marked change. The horizontal resorption of the buccal bone dimension amounted to about 56%. The corresponding resorption of the lingual/ palatal bone was 30%. The vertical bone crest resorption amounted to 0.3 ± 0.6 mm (buccal), 0.6 ± 1.0 mm (lingual/palatal), 0.2 ± 0.7 mm (mesial), and 0.5 ± 0.9 mm (distal). This study reveals that under the conditions presented here implants placed into extraction sockets without additional filler materials healed with acceptable hard tissue fill, which could be summarized by the combination of new bone formation from inside the socket defect (implant to defect

wall) and substantial bone resorption from the outside of the ridge (socket defect wall to outer ridge surface).

Bronstein MM, Schmid B, Belser US, et al. Early loading of non-submerged titanium implants with a sandblasted and acid-etched surface: 5 year results of a prospective study in partially edentulous patients. Clin Oral Imp Res 2005;16(6):631-8. (45 Refs)

Purpose: The purpose of this study was to evaluate the radiographic and clinical 5 year results for implants with a SLA surface restored in posterior sites of partially edentulous patients with an early loading protocol.

Materials and Methods: Between the time interval May 1997 and June 1999, 51 partially edentulous patients were utilized for the study. Exclusion criteria for the study included patients that had severe systemic health problems, heavy smokers and patients requiring bone augmentation surgery due to localized bony defects. A total of 104 implants were placed in these 51 patients. All implant sites exhibited bone density of class I-III. All implants were placed using a standardized surgical technique with the border of the SLA approximating the crest of the alveolar bone. After a 6-week healing period solid abutments were placed with an insertion torque of 35 N cm. The implants were either restored with a single crown restoration or acted as abutments for a fixed prosthesis depending on the restorative treatment plan of each patient. All restorations were cemented. The time at which the abutment connection was placed was termed as day 0. The patients were then seen for recall examinations at 3, 12, 24, 36, 48, and 60 months. The following parameters were assessed at each of the recall appointments: 1) Modified plaque index (mPLI); 2) Modified sulcus bleeding index (mSBI); 3) Probing depth measurements taken at four aspects around the fixture; 4) The distance between the implant shoulder and the mucosal margin (DIM, in mm) at four aspects around the fixtures; 5) Clinical attachment levels (AL, in mm) at four aspects around the implants; 6) Mobility was tested both manually and with a periotest; and 7) The distance between the implant shoulder and the first visible bone-implant contact (DIB) was measured in mm at the mesial and distal aspects of each implant utilizing periapical radiographs taken with the long-cone technique. The 60 month DIB values were compared with the 3 month values in order to evaluate the crestal bone changes around the fixtures. Analysis of the data was then performed in order to find statistical differences between the variables used during the examination periods.

Findings: During the healing period, one implant developed instability due to the presence of a peri-implant infection and was subsequently removed. The remaining 103 fixtures demonstrated no clinical signs of peri-implant infection or detectable mobility throughout the healing period. At the 3 month examination, 2 implants had developed peri-implant infections. These peri-implant infections were attributed to the presence of excess cement present at the abutment-implant interface after placement of the definitive restorations. The cement was removed and the area was treated with local irrigation of the peri-implant sulcus using chlorhexidine (0.1%). The peri-implant infections were subsequently resolved after treatment. Two patients with a total of 3 implants placed did not return for the follow-up evaluations and were considered as drop-outs from the study thus removing them from the statistical analysis. In general, the patients performed good oral hygiene. The mean mPLI for the 3 month evaluation was 0.48. There was a statistically significant decrease of the mean mPLI score at the 5-year examination in comparison with the mean mPLI at the 3 month examination. The peri-implant soft tissues demonstrated little tendency to bleed following probing. There was a statistically significant decrease in the mSBI from the 3 month evaluation to the 5

year evaluation. For probing depth (PD), at the 3 month examination the mean PD was 4.3 mm. During the 12, 24, 36, 48, and 60 month evaluations, the mean PD decreased to a value of 4.02 mm at the 60 month evaluation. The mean DIM score at the 3 month evaluation was -1.13 mm, indicating the presence of a subgingival implant shoulder. The mean values of DIM increased from -1.25 mm to -0.91 mm at the 5 year examination. The addition of PD and DIM resulted in the AL. The mean AL at the 3 month evaluation was 3.16 mm. The AL values remained stable from the 1 to 5 year examination with no statistical significant change between the values. All inserted implants revealed ankylotic stability in the jaw bone throughout the observation period with mobility never being detected when evaluated with either manual testing or the periotest. None of the radiographs exhibited signs of continuous peri-implant radiolucency which also confirmed the stability of the fixtures. The results of the change in DIB between the 3 month exam and the 60 month exam demonstrated that no implant had bone gain of more than 1 mm, while only one implant showed a bone loss of more than 1 mm.

Conclusions: From the results of this prospective cohort study, the SLA surface fixtures surgically placed with a 6 week early loading protocol demonstrated a success rate of 99% after both the 6 week healing period and the 5 year examination period. Thus, SLA surface titanium implants achieved successful tissue integration with a high predictability after placed into function 6 weeks after surgical placement.

Chacon GE, Bower DL, Larsen PE, McGlumphy EA, Beck FM. Heat production by 3 implant drill systems after repeated drilling and sterilization. J Oral Maxillofac Surg. 2006 Feb; 64: 265-9.

Purpose: To investigate the heat generated in bone by 3 individual implant drill systems after repeated drilling and sterilization cycles.

Materials and Methods: Three implant drill systems were evaluated in vitro using bovine femoral cortical bone. System A: triple twist drills with a relief angle. System B: triple twist drills without a relief angle. System C: double twist drills with a relief angle. Three identical sets of drills were evaluated for each specific implant drill system. The relief, clearance, and edge angles of the 3 studied systems were measured by use of a goniometer. The drills were powered by the same milling machine, which was modified to accept the hand piece for the drills, and under a constant load of (2.4 Kg) and a constant speed of 2500 rpm. Teflon-insulated thermocouples were used to measure temperature changes during the drilling sequence of each system. Sequential drilling was accomplished following each manufacturer's recommendations. Temperature measurements were made during site preparation with the final drill of each system. Final drill diameters were 4.0 mm for system B and 4.2 mm for both systems A and C. Thermocouples were placed 0.5mm away from the osteotomy site to the full depth of 15mm. A standard dental radiograph was taken to verify the depth of the thermocouple and to ensure its contact with the wall facing the planned osteotomy site. Temperature measurements were recorded on the 1st, 5th, 10th, 15th, 20th, and 25th uses. Irrigation temperature, initial bone temperature, maximum bone temperature at the final drill diameter, time that the temperature was greater than 47°C, and actual measured distance to the thermocouple were all recorded. After 2 uses, each drill system was hand scrubbed with a soft brush and placed in an ultrasonic cleaner for 10 minutes.

Findings and Conclusions: After 25 uses, systems A and C maintained drilling temperatures below 47°C. There was no statistical difference in heat production between these 2 systems. These results indicate that these 2 systems can be sterilized and reused at least 25 times, without the danger of thermonecrosis, in very dense bone. System B however generated temperatures that were constantly higher than 47degrees. After its 25th use, temperatures generated were around 60°C. However, very little drill wear was observed after 25 osteotomies in any of the systems tested when examined under light microscopy.

Covani U, Bortolaia C, Barone A, Sbordone L .Bucco-Lingual Crestal Bone Changes After Immediate and Delayed Implant Placement. J Periodontol 2004; 75:1605-1612.

Purpose: To analyze bone healing and coronal bone remodeling around implants placed immediately after tooth removal and others done as a delayed placement.

Materials and Methods: This study has 33 subjects, 19 females and 14 males, the average age being 49.7 years. A total of 35 implants were placed in these subjects, 20 were done as an immediate placement and 15 were placed 6 to 8 weeks after extraction. All implants were placed within the alveoli and were clinically stable. During the implant placement (both immediate and delayed) and during extraction (delayed placement) measurements were done to measure the distance between the buccal bone to the lingual bone. After implant placement the mean distance from buccal bone to lingual bone was 10 mm (SD 1.522) for immediate implants and 8.86 mm (SD 2.356) for delayed implants. No membrane or filling materials were used. Primary flap closure was accomplished in all cases. These measurements were done again during the second stage surgery, 4 months for mandibular placements and 6 months for maxillary placements.

Findings and Conclusions: 28 implants were placed in the maxilla and 7 were placed in the mandible. Two implants became exposed 1 month after implant placement, although no therapy was deemed necessary. At second-stage surgery all peri-implant defects were filled, and the mean distance from buccal bone to lingual bone was 8.1 mm (SD 1.334) for immediate implants and 5.8 mm (SD 1.265) for delayed implants. This pattern of coronal bone remodeling, showing a narrowing of the bucco-lingual width, was clinically similar for the two groups, although it should be noted that the delayed implants exhibited smaller bucco-lingual bone width already at the first measurement. This study also suggests that circumferential defects could heal clinically without any guided bone regeneration (GBR) in both experimental groups, and that the procedure was virtually free from complications in the postoperative period, probably because of the absence of barrier membranes and/or grafting materials. Although the cases dealt in this study were not numerous enough to draw any conclusions, the data suggests that in cases with strong esthetic concerns, immediate implantation would be the procedure of choice.

Covani U, Crespi R, Cornelini R, Barone A. Immediate Implants Supporting Single Crown Restoration: A 4-Year prospective Study. J Periodontol 2004; 75:982-988.

Purpose: To investigate the cumulative success rate of dental implants placed in fresh extraction sockets with and without GBR restored with single crown restorations.

Materials and Methods: The sample size of this study was 95 patients. The inclusion criteria of the study included the following: 1) patients with no medical history of disorders that would inhibit wound healing, 2) presence of at least 4 mm of bone beyond the root apex, and 3) absence of acute infection at the level of the implant site. A total of 163 teeth were treatment planned for extraction with immediate placement of fixtures at the extraction site. All surgeries were performed by one clinician and 95 implants were placed in the maxilla and 68 implants were placed in the mandible. The surface of the fixtures were characterized by a sandblasted/acid etch surface, in order to obtain maximum bone-to-implant contact. Small autogenous bone chips with a bioresorbable membrane were placed over 105 fixtures presenting with bone fenestrations or dehiscences and/or peri-implant bone defects exceeding 2 mm. Grafting materials and barrier membranes were not placed over the remaining 58 fixtures due to the fact that they did not present with a bony wall fenestration or dehiscence where the gap between the implant surface and surrounding bony walls exceed 2 mm. Primary closure was obtained for all the fixtures placed. Each year the fixtures were evaluated according to the following criteria: 1) presence or absence of mobility, 2) presence or absence of pain, 3) presence or absence of suppuration, 4) clinical attachment level (CAL), and 5) radiographic examination with an occlusal stent to determine both the presence of periapical radiolucencies and the first crestal bone contact (CBC) with the implant. Uncovering of the fixture was performed at 6 months, followed by restoration with porcelain fused to metal crown. All fixtures were evaluated at the end of each year following placement. The cumulative success rate (CSR) was determined for each fixture placed at the end of the study.

Findings: Immediately after tooth extraction and implant placement, 10 of 15 fixtures which had GBR had an implant exposure. This was treated with chlorhexidine rinses, and no additional surgeries were required to correct the exposures. These complications occurred in 10 patients, 7 of which were smokers. All of the 15 implants were integrated at the 4 year follow-up visit. Five implants failed over the 4 year follow-up period. Two fixtures (1 from each group) failed during the initial healing period from peri-implantitis. Three fixtures (2 which had received GBR) failed after prosthetic rehabilitation from progressive bone loss around the implants. The remaining 158 fixtures placed were successful and demonstrated no mobility, pain, or suppuration. The 158 fixtures also showed no signs of peri-implant radiolucencies and had stable CAL levels throughout the study. According to the Student t-tests performed, there were no significant differences between the groups of implants receiving GBR and those not receiving GBR. The 4 year cumulative success rate for all the fixtures placed was 97%. The single tooth restorations were all in good function during the 4 year period and the only prosthetic complication was the loosening of the abutment screw, which occurred in 16 implant restorations.

Conclusions: The findings from this study demonstrate that implants placed into fresh extraction sockets with or without GBR and restored with a single crown restoration have a cumulative success rate of 97% during a 4 year period.

Covani U, Cornelini R, Barone A. Bucco-lingual bone remodeling around implants placed into immediate extraction sockets: A case series. J Periodontol 2003; 74:268-73. 23 (Refs)

Purpose: To analyze bone healing and coronal bone remodeling around 15 implants placed immediately after extraction without the use of GBR techniques.

Materials and Methods: 10 patients (7 females and 3 males; 18 to 58 yrs) were included in this study. Exclusions criteria from the study were presence of the defects of the residual bony walls and presence of a gap between the implant surface and surrounding bony walls exceeding 2mm. A total of 15 immediate implants (6 in Mx PM, 3 in Mx I, 2 in Mx C; 3 in Md PM, 1 in Md C) were placed. 9 of these implants had a 4mm diameter and 6 had a 5mm diameter. After implant placement, the distance from the coronal border of the buccal bone to the cortical border of the lingual bone was measured using a standardized periodontal probe. No grafting materials and/or barrier membranes were used to treat the small peri-implant defects. Primary flap closure was obtained and patients were put on antibiotics, anti-inflammatory agents and CHX. A second-stage surgery was performed 6 months later and clinical measurements were repeated to measure bone changes at the coronal bone level. Radiographic examination was also carried out.

Findings: At second-stage surgery, all of the implants were clinically stable and asymptomatic without any signs of radiographic peri-implant bone loss. The mean changes in distance from the coronal border of the buccal bone to the coronal border of the lingual bone was 10.5mm +/- 1.52 (baseline) to 6.8mm +/- 1.33 (second-surgery). No residual bone defects were observed or probed around implant.

Conclusions: The present study suggests that implants placed in fresh extraction sockets, delimiting small circumferential defects not exceeding 2mm, could heal with good predictability without using a regenerative procedure. Bone healing at the coronal level showed a narrowing of alveolar crestal width.

Ellingsen JE, Johansson CB, Wennerberg A, et al. Improved retention and bone-to-implant contact with fluoride-modified titanium implants. Int J Oral Max Implants; 2004 (19): 659-66. (51 References)

Purpose: To compare TiO₂-blasted titanium implants with and without fluoride-modified surfaces with respect to bone-to-implant contact, bone area in threads, and removal torque resistance in rabbit tibia 1 and 3 months after placement.

Materials and Methods: 80 screw type implants (3.5x 8mm); 40 (test) surface=turned and TiO₂ blasted and dipped in hydrofluoric acid; and 40 (control) turned and blasted only. 3 test and 3 control underwent surface analysis using optical profilometry. Twenty rabbits (mean age 9 months) had two implants placed in each tibia, two test and two control implants respectively per tibia shaft under surgical settings. Animals were then divided into two groups of 10, group A and group B. Group A was given a healing period of 1 month following implant placement, where as animals in group B were given a 3-month healing period. Removal torque values were achieved by testing one implant per tibia prior to en-bloc removal of both implants. Interfacial shear strength was calculated by mathematical formula. Bloc sections were ground into 10µm thick sections and viewed under a light microscope to evaluate bone-to-implant contact and bone area in threads.

Findings and Conclusions:

: Table 1 Surface Characterization of the Implants

Implant	S ^a (µm)	Scx(µm)	Sda
Fluoride-modified	0.91 ± 0.14	11.71 ± 0.83	1.21± 0.04
Control	1.12± 0.24	11.33± 1.00	1.34± 0.08

S^a= average height deviation from the mean plane; Scx= average distance between surface irregularities; Sda=surface developed area ratio

Table 2 Removal Torque and Shear Strength, Mean ± SD

Group	Removal Torque		Shear Strength	
	Ncm	P	N/mm	P
1-month healing period				
Fluoride-modified	31 ± 11 (14-55)	NS	-----	----
Control	27 ± 8.5 (14-42)		-----	----
3-month healing period				
Fluoride -modified	85 ± 16 (60-114)	.005	23 ± 9 (11-49)	
Control	54 ± 12 (41-79)		15 ± 5 (8-23)	

Table 3 Percentage of Bone-to-Metal Contact, Mean \pm SD		
Group P	Flouride-Modified Implants	Control Implants
1-month healing period		
All threads	35 \pm 14 (15-52)	26 \pm 8 (9-36)
.04		3
Best	55 \pm 15 (34-80)	47 \pm 10 (24-59)
NS		
3-month healing period		
All Threads	39 \pm 11 (16-65)	31 \pm 6 (22-41)
.05		
3 Best	54 \pm 12 (41-79)	53 \pm 10 (34-67)
.005		

3 Best = the 3 consecutive threads with the most bone-to-metal contact

Table 4 Percentage of Bone Area, Mean \pm SD (Range)		
Group P	Flouride-Modified Implants	Control Implants
1-month healing period		
All threads	29 \pm 4 (24-36)	29 \pm 5 (21-38)
NS		3
Best	55 \pm 9 (40-67)	56 \pm 11 (37-73)
NS		
3-month healing period		
All Threads	31 \pm 8 (20-47)	39 \pm 15 (22-69)
.03		
3 Best	54 \pm 13 (35-71)	68 \pm 13 (42-84)
.04		

In conclusion, test implants (fluoride-modified) exhibited a better bone response than control implants. They had greater shear strength and an increased bone-to-metal contact ratio. However, surface characterization analysis revealed slightly greater values for the control implants, a finding that might indicate that surface morphology and physiochemical relationships not measured in this study may be significant. Additionally, time had a positive effect involving the intimate bone-to-implant relationship.

Ellingsen JE. Surface configuration of dental implants. *Periodontology* 2000 1998; 17:36-46.

Purpose: To review the effects of surface configurations of dental implants.

Materials and Methods: Author opinion and lit review.

Findings and Conclusions: Most biomaterials used in implantology are not specifically developed for this purpose but were available before they were used as biomaterials. When implant is placed in bone, a series of reactions take place on the implant surface. The implant is exposed to a series of different ions, to polysaccharides, carbohydrates and proteins as well as to cells such as chondroblasts, fibroblasts and osteoblasts.

Surface macrostructure: To obtain optimal healing of the bone close to the implant surface, stability of the implant bed is important. Introduction of threads cylindrical implants, improves implant stability. Screw shaped implants have been found to be in closer contact with bone than implants without threads. Threads changes stress distribution compared to implants without threads. Cylindrical implants will transfer the stress to the apical part with axial loads and to the neck and apical part with horizontal loads. Excessive and insufficient stress has been suggested to promote bone resorption at the neck region. Increased retention was observed with increased screw diameter and increased thread length. Minute threads with a depth of 0.1 mm were suggested to improve capacity to carry load. Implants surface with many small peaks were suggested to improve strength compared with a surface with high but few peaks.

Surface microstructure: improved retention in bone has been reported with rough surfaced implants. The roughness should be considered on 3 different levels: macro-, micro-, & ultrastructural, each has different effects on living tissues. Material's irregularities need to be at least 100 μm for complete bone growth into these cavities or pores causing mechanical interlocking. The optimal pore size for bone ingrowth depends on the material. Surface roughness on micrometer scale influences the function of the cells, the matrix deposition, & the mineralization. Cells appear to use microtopography of the material for orientation and migration. Also microtopography may influence mesenchymal cells differentiation into fibroblasts, chondrocytes or osteoblasts. The benefit of increasing roughness on micrometer scale reaches a maximum level between 1 and 1.5 μm .

Surface ultrastructure: there is tissue response to biomaterial irregularities on the nanometer level. Implants with thick heterogeneous oxide layer have slightly improved response in bone, particularly in the first weeks after implantation. This difference is not observed after longer healing period.

Surface chemistry of implants: the chemical properties of the biomaterial surface play an important role for the tissue responses to the material. A material with a surface that is accepted by the tissue seems to exhibit improved integration with bone, either due to passive growth, leading to a tight connection between implant and bone, or by stimulation that probably leads to a bone implant bonding. Cell adhesion is sensitive to variations in the surface organization of the material on the anatomic level. The mechanisms that lead to bone bonding or to a firm connection between the biomaterial and bone are not completely known. Proteoglycans, fluoride ions, adsorption of proteins and covalent bonding all play a role.

Kleinheinz J, Bucher A, Druse-Losler B, Weingart D, et al. Incision design in implant dentistry based on vascularization of the mucosa. Clin Oral Impl Rest 2005; 16:518-23. 28 (Refs)

Purpose: To establish recommendations for incisions based on reliable knowledge of the distribution patterns and course of the vascular system in the oral mucosa.

Materials and Methods: Two different techniques were used to demonstrate the macro- and micro-architecture of the arterial vascular system in 7 edentulous human cadavers.

Vascular corrosion cast: 150 ml of red-colored rubber base was injected into the external carotid arteries on both sides and the head was immersion-fixed. This allowed the demonstration and macroscopic evaluation of vessels ranging from small calibers up to a diameter of 200µm. The specimens were then sectioned for evaluation.

Indian ink injection: 4 ml of colored India ink and formalin were injected into the facial, lingual and maxillary arteries. The colored areas of the mucosa were inspected, photographed and resected in the edentulous area of the alveolar ridge.

Following macroscopic preparation, single arteries were identified and their position and relationship to adjacent structures and their course from the exit from the bone up to the capillary system were described i.e., macroscopic evaluation. Microscopic evaluation of the microvascularization was also carried out.

Findings: After dissolution of the surrounding soft tissues the vessels were demonstrated directly on the underlying bony surface.

Vascular territories of the maxilla: In the posterior part, the vestibular gingival was supplied by branches of the infra-orbital artery, and the palatal mucosa by branches of the descending palatine artery. Anteriorly, the supply was based on the facial artery regarding the vestibular parts and partially on the infra-orbital artery. In 66% palatal parts were supported by the descending palatine artery and in 33% by the anterior superior alveolar artery.

Vascular territories of the mandible: the posterior lateral part of the alveolar ridge was supplied by facial artery and the anterior part by the inferior labial artery and in 50% additionally by the mental artery. In 73% the lingual mucosa was supported exclusively by the sub-mental artery and in 27% additionally by the sublingual artery. Lingual supply had overlapping, but overlapping was found in 20% of the cases in the vestibular part covered by the facial artery.

Crossing area on the edentulous alveolar ridge: A visible vestibular-oral separation line between the two supply areas at the center of the edentulous segments was demonstrated in edentulous spaces, free-end situations and totally edentulous jaws.

Microscopic evaluation of the alveolar mucosa: 1) the main course of the supplying arteries is from posterior to anterior. 2) These vessels run parallel to the alveolar ridge in the vestibule most of the time, only gingival branches stretch to the alveolar ridge. 3) The crestal area of the edentulous alveolar ridge is covered by a 1-2 mm wide vascular zone with no anatomizes crossing the alveolar ridge.

Recommendations for incision: 3 decisive areas for incision are: 1) the crestal part of the edentulous region. 2) the bordering papilla in cases of partially dentate jaws and 3) the area of the releasing incision at the anterior and posterior limit of the incision.

- The midcrestal incision seems to be the ideal choice for the edentulous area of the planned implantation. Making the cut in the avascular zone prevents the risk of cutting through anastomoses or cutting out avascular areas of the mucosa.

- For esthetic reasons, only marginal incisions should be used in the frontal region. Releasing incisions in the vestibulum should be avoided because they will cut obliquely through defined esthetic zones and not at their borders.
- Releasing incisions should be carried out, if at all, only at the anterior border of the incision line to avoid cutting through the vessels coming from posterior to anterior.
- Trapezoid flaps with anterior and posterior releasing incisions are avoidable in most cases because the surgical field can be adequately visualized and mobilization using incising of the periosteum can be achieved by anterior incision only.
- If it is essential not to touch the marginal mucosa, an incision in the vestibulum parallel to the alveolar ridge with tunneling preparation is recommended.
- The papilla will be included in the incision in the anterior maxilla and reconstructed using microsurgical techniques during preparation and wound closure. In the lateral or posterior segment or in the event of a single posterior tooth in a free end situation the papilla can be left untouched by making the releasing incision in front of the papilla.

Conclusions: The results suggest midline incisions on the alveolar ridge, marginal incisions in dentated areas, releasing incisions only at the anterior border of the entire incision line, and avoidance of incisions crossing the alveolar ridge.

Lazzara RJ and Porter SS. Platform switching: a new concept in implant dentistry for controlling postoperative crestal bone levels. Int J Periodontics Restorative Dent 2006; 26: 9-17.

Purpose: To introduce the concept of platform switching and provide a foundation for future development.

Materials and Methods: Literature review and opinion article.

Findings:

(1) Understanding of crestal bone loss.

- As long as the soft tissue covering the implant remains closed during healing, crestal bone remodeling does not typically occur around the top of the submerged implant, and the height of the surrounding remains at crestal bone levels. However, when the implant is exposed, crestal bone changes start. This is the same phenomenon of the one-stage implant, too.
- Hermann et al. (2001) found that the formation of the about 2.0 mm distance between the implant-abutment junction (IAJ) and the crestal bone location.
- Berglundh and Lindhe (1996) also reported that peri-implant mucosa has a minimum thickness (approximately 3 mm) and the body attempts to re-establish this minimum soft tissue dimension.
- Ericsson et al. (1995) described 2 types of inflammatory lesions in the peri-implant soft-tissues. One is “plaque-associated” inflammatory cell infiltration (P/ICT), and the other is “abutment” inflammatory cell infiltration (aICT).
- Peri-implant soft tissue (1.75 mm) = aICT (0.75mm) + connective tissue (1.0 mm)

(2) Radiographic observations

- The dimensional mismatch between the implant surface and the prosthetic component is 0.45 mm $[(5.0 - 4.1)/2]$ or 0.95 mm $[(6.0 - 4.1)/2]$.
- In radiographs of platform switching implants, there was no vertical bone loss in crestal bone height.

(3) Biologic rationale

- With the increased surface area, there is a reduction in the amount of crestal bone resorption necessary to expose a minimum amount of implant surface to which the soft tissue can attach.
- By repositioning the IAJ inward, the overall effect of the aICT on crestal bone may be reduced. Also, the inflammatory infiltrate confines within $\leq 90^\circ$.

Conclusions: Platform switching is a method for preserving crestal bone around the top of wide-diameter implants.

Lee D-W, Park K-H and Moon I-S. Dimensions of keratinized mucosa and the interproximal papilla between adjacent implants. J Periodontal 2005; 76:1856-1860.

Purpose: The purpose of this study was to evaluate the effects of the width of keratinized mucosa at the interproximal region between implants, the distance from the base of the contact point to the crest of bone and the distance between the two implants on the dimension of the interproximal papilla between two implants.

Materials and Methods: A total of 72 interproximal papillae between two adjacent implants placed in 52 subjects, between the ages of 40 to 60 years and who had implant supported fixed prosthesis in posterior sites for more than 12 years were evaluated in this study. All patients in this study had good oral hygiene without any inflammation of the mucosa around the implants. A radiographic material consisting of a 2:1 mixture of an endodontic sealer and barium sulfate were placed with a probe on the tip of the papilla and a periapical radiograph was taken using a paralleling technique (RL). The films were subsequently digitized. In order to evaluate the length between the crestal bone to tip of the papilla, a line was drawn connecting the abutment-fixture junction between the two implants and two parallel lines were drawn (1) passing through the tips of the papillae and (2) passing through the tips of the crestal bone. Probes calibrated at 1, 2, 3, 5, 7 & 10 mm were used to measure the width of keratinized mucosa from the mucogingival junction to the tip of the interproximal papilla (WK) between the adjacent implants. The vertical distance from the base of the contact point and the interimplant crestal bone was measured (CC). Using the same probes the distance from the base of the contact point to the tip of the papilla was measured. To calculate the distance between the bases of the contact point to the interimplant crestal bone, this value was added to RL (contact point to the crestal bone [CC]). The horizontal distance between the two adjacent implants was measured at the fixture-abutment interface level (HD).

Findings and Conclusions: The mean value of RL was 3.3 ± 0.5 mm. The mean WK was 4.5 ± 1.7 mm. The mean CC was 4.7 ± 1.2 mm. The mean HD was 3.1 ± 0.5 mm. The results show that RL was significantly related to WK between the two adjacent implants. However RL was not related to other variables such as CC and HD.

Neves FD, Fones D, Bernardes SR, et al. Short implants – An analysis of longitudinal studies. Inter J Oral Maxillofac Implants 2006; 21: 86-93.

Purpose: To evaluate the use of short implants and their clinical success.

Materials and Methods: The MEDLINE database was searched for longitudinal studies between 1980 and 2004. The analysis was conducted for Brånemark-compatible system. Including studies through manual search, 31 studies were found eligible for this study.

Inclusion criteria: (1) English-language journal
 (2) Brånemark-compatible system
 (3) Follow-up period of at least 1 year

Exclusion criteria: (1) Using advanced surgical studies
 (2) Emphasizing peri-implant tissues
 (3) An immediate loading
 (4) Prosthetic or orthodontic studies
 (5) Focusing on surgical techniques of fixation

Findings: (1) Failure rate of short implant (26 studies)

		3.75 mm			4.00 mm			5.00 mm		
	Total # of implants Placed/lost	7	8.5	10	7	8.5	10	7	8.5	10
Total	16344/786	1894/184	60/0	1783/112	66/5	16/0	164/9	14/4	15/2	96/3
%	4.8	9.7	0	6.3	7.5	0	5.4	28.6	13.3	3.2

- The total rate of failures: 4.8%
- Relatively few implants 8.5 mm in length or 5 mm in diameter were placed, because these are relatively new designs. Therefore, analyses of these were difficult.

(2) Timing of implant failure (23 studies)

- 54.9% (430) of failures occurred before the prosthesis connection.
- 25.9% (159) of failures occurred during the first year of function.

(3) Risk factors (30 studies)

- Poor bone quality - 66.7% (22 out of 30, 31, or 33 (?) studies)
- Jaws (maxilla or mandible) - 45.4% (15 studies)
- Occlusal overload - 27.2% (9 studies)

Conclusions: Short implants can be used as a treatment option.

Paolantonio M, Dolci M, Scarano A, d'Archivio D, et al. Immediate implantation in fresh extraction sockets. A controlled clinical and histological study in man. J Perio 2001; 72:1560-71. 69 (Refs)

Purpose: To report histologic findings after immediate implantation in fresh extraction sockets without the use of membranes in humans in comparison with implants placed in healed, mature alveolar bone.

Materials and Methods: 48 patients, aged 24-66 years with a non-contributory medical history who needed implant placement in 2 symmetrical quadrants of the mouth in which 4 or more fixtures had to be placed in edentulous ridges not requiring augmentation procedures were selected. Once fixture placed in these quadrants represented the control implant (CI). Similarly, one of the fixtures placed in a fresh extraction socket in the symmetrical quadrant represented the test implant (TI). All implants were TPS solid screws. The immediate implant site had to belong to type 1 class of the Salama and Salama preoperative classification (4 walled sockets with minimal bone resorption, sufficient bone of 3-5 mm beyond the apex, acceptable discrepancy between the fixture head and the neck of the adjacent teeth, if present and manageable gingival recession). The marginal bone loss on T1 had to belong to A1 (no LOA), B1 (1/3rd LOA) or C1 (1/2 LOA) class of Becker et al. scheme. T1 and C1 were inserted in separate surgical sessions. An attempt was made to obtain, as much as possible, a tight contact between the T1 and the socket's walls by an appropriate choice of implant diameter. The neck of the fixture was placed exactly at the level of the crestal ridge to obtain maximal bone preservation. No filling materials were placed between the implant neck and the alveolar margins. Good primary stability was obtained for each fixture. Primary wound closure was obtained. Second stage surgery was done 6 months after. 6 months after second surgery, TI and CI were removed by an appropriate diameter hollow drill to obtain histologic specimens for 48 fixtures in maxilla and 48 fixtures in the mandible. For each T1 and C1, the % of direct BIC (DBC) was calculated. 6 months after the second surgery and before the implant removal, mSBI, mPI were recorded for each TI and CI. Marginal bone loss from the time of implant placement to the time of fixture removal was calculated using radiographs. Data were analyzed.

Findings: No significant differences in the clinical and radiographic parameters were observed between the 2 experimental categories. In the maxilla, DBC averaged 64.8% in T1 and 62.3% in C1 without a statistically significant difference between the 2 categories. Similarly, in the mandible, mean DBC from T1 was 70.6% and 67.9% from C1, which again lacked statistical significance. Histologic examination of specimens from T1 and C1 always showed an appearance of osseointegration. Only 3 specimens showed interposition of connective tissue between the implant surface and the newly formed bone in the coronal 1.5 to 2 mm. A common finding in both groups was the observation of actively secreting osteoblasts in the coronal part of the alveolar crest. Conversely, in the remaining areas, osteoblasts were present only inside the bone marrow spaces. In the apical portions from both T1 and C1, small osseous trabeculae were observed in tight contact with the implant surfaces. In no sections were signs of bone resorption present. Numerous osteocyte lacunae seemed to be in contact with surface irregularities produced by the plasma spray, without a presence of empty spaces or connective tissue between bone and implant. In the supracrestal connective tissue, collagen fibers showed a perpendicular orientation towards the TPS surfaces; on the contrary,

the fibers ran parallel to the fixtures when they faced a machined surface. A similar osseointegration process was observed in both T1 and C1 groups.

Conclusions: This study demonstrates that when a screw-type dental implant is placed without the use of barrier membranes or other regenerative materials into a fresh extraction socket characterized by favorable anatomic conditions, the clinical outcome and degree of osseointegration do not differ from implants placed in healed, mature bone.

Park SH, Sorenson WP, Wang HL. Management and prevention of retrograde peri-implant infection from retained root tips: two case reports. Int J Perio Rest Dent 2004; 24:422-33. 47 (Refs)

Purpose: To report surgical management of an Implant peri-apical lesion (IPL) from an undetected root tip using GBR technique.

Materials and Methods:

Case 1: A Branemark Mark III implant was placed in November 2002 in a 56 year old man with a missing maxillary right second pre-molar extracted 8 years previous. No pathology or root fragment could be detected from PA and panoramic views pre-operatively. A radiopaque object resembling a retained root tip was noticed adjacent to the implant on the final radiograph. Normal healing had occurred at 1-week evaluation when sutures were removed. 22 days later, clinical evaluation revealed an incision line opening, with an exposed healing abutment and fluctuant buccal swelling at the apical portion of the implant. The patient reported persistent tenderness on pressure. No sup-puration or fistula was noted. Since the patient had discontinued taking antibiotics he was put on 500-mg amoxicillin tid x 14 days with 0.12% CHX mouthrinse. Fistula formation was noticed in January and persisted until the site was surgically entered. Azithromycin 500 mg tid also failed to subdue the infection. Radiographic osteolysis was noticed in January 2003. A full-thickness flap was raised, and a 6-7 mm diameter periapical implant defect filled with abundant granulomatous tissue was noted. The implant was not mobile, as adequate cortical bone was still engaged with the coronal portion of the implant. Retrieval of the retained root was not possible without the removal of the implant. The implant and the root tip were removed. The osteolysis was limited to the cancellous bone and did not expose the adjacent teeth. The defect was rinsed with sterile saline and slightly overfilled with DFDBA mixed with 250 mg tetracycline and a wide body Mark III implant was placed simultaneously. Biomend was used to cover the bone. IPL- associated symptoms had completely disappeared at the 1-week evaluation. Increased radiodensity was evident 5 months after grafting. At second stage surgery, bone formation was confirmed.

Case 2: A 74 year old man with controlled hypertension presented with advanced mobility of the maxillary left first premolar. Moderate gingival inflammation and a PD of 5-6 mm were noted. No fistula was noted. Vitality test was inconclusive for the left canine. A radiolucency of 8-9 mm in diameter was present extending from the left first premolar to the left canine. On April 1, 2002, the first pre-molar was extracted. Radiographic assessment revealed a persistent radiolucency in the extraction site. The retained root was not detected on the first radiograph. On October 7, 2002, a fractured root tip was noticed on the radiograph. On March 7, 2003, a full-thickness flap was reflected and the root tip was retrieved from the buccal aspect. The buccal osseous plate was decorticated, and the ridge was augmented with Puros and a resorbable collagen membrane. In July 2003 the site was reentered for implant placement. Good defect repair was noted, with clinically hard bone-like tissue and an ITI implant was successfully placed and healed well.

Findings and Conclusions: IPL is a preventable disease. Antibiotics prescribed immediately after extraction may reduce the residual bacterial load. Proper radiographic assessment for residual infection or any pathology and past history of the extracted teeth cannot be overlooked. Once a residual infection or retained root tip has been detected radiographically or during surgery, removal of the source of infection must proceed

prior to implant placement. A GBR technique can then be performed if bone augmentation is deemed necessary for future implant placement. However, once IPL is initiated, early surgical intervention should take place within 1 month of onset to limit the extent of disease progression. Antibiotics should be used only as an adjunct to suppress disease progression until definitive surgical intervention.

Rokni S, Todescan R, Watson P, et al. An Assessment of Crown-to-Root Ratios with Short Sintered Porous-Surfaced Implants Supporting Prostheses in Partially Edentulous Patients. Int J Oral Maxillofac Implants 2005; 20:69–76.

Purpose: To determine whether there is any relationship between c/r ratio and crestal bone loss with short sintered porous-surfaced implants supporting prostheses in partially edentulous patients.

Materials and Methods: 199 implants were used to restore 74 partially edentulous patients with fixed prostheses. The implant used was the Endopore dental implant system, an endosseous tapered root-form press-fit design. All of the implant models had a 1-mm machined smooth collar region, while the remainder of the implant length had a sintered porous-surface structure. Implants were categorized according to their length (“short” versus “long”) and estimated surface area (“small” versus “large”). “Short” implants had lengths of 5 or 7 mm, while “long” implants were either 9 or 12 mm in length. “Small” implants had estimated surface areas of ≤ 600 mm², while “large” implants had estimated surface areas > 600 mm². Other data collected included crown to root ratio (measured on articulated diagnostic casts), whether or not the implants were splinted, and standardized sequential radiographs. Post treatment records, including standardized periapical radiographs of all implants in this group of patients, were collected at baseline (1 month after seating of the definitive prosthesis), after 6 months, and yearly thereafter.

Findings and Conclusions: The mean c/r ratio was 1.5 (SD = 0.4; range 0.8 to 3.0), with 78.9% of the implants having a c/r ratio between 1.1 and 2.0. Neither c/r ratio nor estimated implant surface area (small or large) affected steady-state crestal bone levels. However, implant length and whether the implants were splinted did appear to affect bone levels. Long implants had greater crestal bone loss (0.2 mm more) than short implants; splinted implants showed greater crestal bone loss (0.2 mm more) than non-splinted ones. These differences were statistically significant.

Implant length (mm)	Estimated surface area (mm ²)	Location			Total n (%)
		Anterior maxilla n (%)	Posterior maxilla n (%)	Posterior mandible n (%)	
9 (mini)*	512	19 (54.3)	20 (17.2)	4 (8.3)	43 (21.6)
7 (regular) [†]	527	0 (0.0)	24 (20.7)	17 (35.4)	41 (20.6)
5 [‡]	530	0 (0.0)	2 (1.7)	0 (0.0)	2 (1.0)
7 (wide body)*	638	0 (0.0)	16 (13.8)	13 (27.1)	29 (14.6)
9 (regular) [†]	640	13 (37.1)	40 (34.5)	14 (29.2)	67 (33.7)
12 [†]	781	3 (8.6)	14 (12.1)	0 (0.0)	17 (8.5)
Total		35 (100.0)	116 (100.0)	48 (100.0)	199 (100.0)

*Diameter = 3.5 mm.

[†]Diameter = 4.1 mm.

[‡]Diameter = 5.0 mm.

Sader MS, Balduino A, Soares GA, Borojevic R. Effect of three distinct treatments of titanium surface on osteoblast attachment, proliferation, and differentiation. Clin. Oral Impl. Res. 2005, 16:667- 675.

Purpose: To investigate the behavior of osteoblasts from femora of Balb/c mice when incubated onto ground titanium samples and roughened titanium surfaces.

Materials and Methods: Titanium preparation: Sheets of commercially pure titanium were cut into 10x10mm and 20x10mm sheets. Sheets received 1 of 3 surface treatments:

- 1) Ground with an abrasive 600 grits silicon carbide (SiC) paper. (Ground-Ti)
- 2) Blasted with alumina oxide particled. (Blasted-Ti)
- 3) Samples from the Blasted-Ti group were submitted to a further double chemical etching with a 4% hydrofluoric acid solution (60 s), followed by a 4% hydrofluoric acid solution and by an 8% hydrogen peroxide solution (15 s).(Blasted-etched-Ti)

Osteoblasts were incubated onto the different surfaces. Samples were examined with scanning electron microscopy (SEM) before and after incubation of cells. Surface topography was measured by a contact profilometer. Cell viability was measured using MTT assay. Cell differentiation was investigated by monitoring alkaline phosphatase (ACP) activity.

Findings and Conclusions: Ground-Ti surfaces presented parallel grooves, typical of the grinding process with silicon carbide papers. Blasted-Ti surfaces showed an irregular rough morphology with aluminum-rich particles incrustated on the titanium surface, while Blasted-etched-Ti surfaces displayed a uniform and smooth surface, suggesting the removal of the alumina particles.

Osteoblasts adhered to and spread on all samples tested. However, on rough surfaces, osteoblasts did not spread completely and acquired a polygonal morphology. Cell proliferation rate was diminished at the beginning of incubation on rough surfaces. Cell differentiation reached its peak on the 21st day and then started decreasing. ALP activity was not affected by the titanium surface treatments. The results showed that rough surfaces caused a delay and not impairment in the proliferation and differentiation of osteoblasts.

Schenk, Robert K, Daniel Buser. **Osseointegration: a reality. Periodontology 2000 vol 17; 1998:22-35.**

Purpose: To study the process of Osseointegration.

Materials and Methods: literature review and author opinion.

Findings: Osseointegration: it's a direct structural and functional connection between ordered, living bone and the surface of a load bearing implant.

Prerequisites for Osseointegration: Bioinert materials do not release any harmful substances and therefore do not elicit adverse tissue reaction e.g. Titanium. The degree of mechanical interlock increases with the roughness of the substrate (implant).

Primary stability and adequate load: the primary stability of implant depends on their appropriate design and precise press fitting at surgery. The primary stability must counteract all forces that could create micro motion between the implant and the surrounding tissue.

Stages of Osseointegration:

1. Incorporation of woven bone formation.
2. Adaptation of bone mass to load (lamellar and parallel-fibered bone deposition).
3. Adaptation of bone structure to load (bone remodeling).

Incorporation of woven bone formation: The first bone tissue formed is woven bone. This is felt like orientation of its collagen fibrils; numerous, irregularly shaped osteocytes with relatively low mineral density. Woven bone is an ideal filling material for open spaces and for the construction of the first bony bridges between the bony walls and implant surfaces. Woven bone formation clearly dominates the scene within the first 4-6 week after surgery.

Adaptation of bone mass to load (lamellar and parallel-fibered bone deposition): Starting in the second month the microscopic structure of newly formed bone changes, either toward the well known lamellar bone, or toward an equally important but less known modification called parallel fibered bone. Parallel fibered bone is an intermediate between woven and lamellar bone, lamellar bone is strongly birefringent.

Adaptation of bone structure to load (bone remodeling): This is the last stage of remodeling and starts around the 3rd month. Remodeling starts with osteoclastic resorption, followed by lamellar bone deposition. After 2-4 months a new osteon is completed. In healthy skeleton, resorption and formation are not only coupled but all balanced

Osseointegration of Implants: Coronal part of the dental implant becomes firmly anchored within compact bone, where as the apical segment is exposed to cancellous bone and bone marrow. In cortical bone Primary stability is obtained by press fitting which lead to direct bone implant contacts. Primary contact was found at 3 month in about 20% of the implant surfaces. When screw implants were used at 3 month it is partially or completely filled by lamellar bone. In cancellous bone the volume density of bone matrix is 20-25% where as in cortical bone it is about 80-90%. Cancellous bone contributes much less to the primary stability. Secondary bone implant is achieved by bridging the intertrabecular marrow space. The percentage of bone to implant contact in the cancellous part of the implant site reaches the same or even higher value then for the cortical lining.

Schüpbach P, Glauser R, Rocci A, et al. The human bone-oxidized titanium implant interface: A light microscopic, scanning electron microscopic, back-scatter scanning electron microscopic and energy-dispersive X-ray study of clinically retrieved dental implants. *Clin Implant Dent Relat Res.* 2005; 7 suppl 1: 36-43.

Purpose: To analyze the human bone-oxidized titanium interface at a high-resolution level.

Materials and Methods: 12 clinically retrieved implants were used for histologic analyses.

(1) 6 TiUnite™ (regular platform Mk III and IV, Brånemark system) – 9 implants in the posterior mandible (2 implants - immediate loading, 7 implants - 2 month early loading)

(2) 1 Nobel Perfect™ implant

(3) 5 mini-implants with an oxidized surface – diameter 2.3 mm, non-loaded.

(4) 1 unused oxidized implant

These implants were retrieved after 5 to 9 months of healing and observed by light microscopy, scanning electron microscopy (SEM), back-scatter scanning electron microscopy (BS-SEM), and energy-dispersive X-ray (EDX).

Findings:

1. Light Microscopy

- Similar bone morphology was shown around the implants in spite of different time periods.
- The integration process occurred by growth from adjacent bone surfaces toward the surface (distance osteogenesis) and by bone formation directly on the surface oxide (contact osteogenesis).
- Bone formation directly on the oxidized implant surface was shown as a narrow zone of bone that followed the contour of the implant.

2. SEM

- Oxidized implants showed a porous surface texture with both micropores of between 1 and 7 μm in diameter and nanopores with orifices of less than 1 μm .
- The in growth and anchorage of bone were independent of the pore size, and bone was also present in nanopores.

3. BS-SEM

- The intimate contact of bone with oxide layer and the presence of bone in the pore were present.

4. EDX

- The bone-implant interface showed high peaks for titanium, calcium, and phosphorus.
- Bone was observed in the orifices of the pores and extending down to the very bottom of the pores.

Conclusions: The bone can grow into the pores of the surface oxide layer. So, there is a strong interlock between the bone and the oxidized implants.

Schultes G., Gaggl A. Histologic evaluation of immediate versus delayed placement of implants after tooth extraction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92:17-22.

Purpose: to compare the healing of bone and soft tissue adjacent to implants that were inserted immediately after the extraction of teeth with the healing of bone and soft tissue adjacent to implant placed after the extraction socket had healed.

Materials and Methods: 8 beagle dogs with mean age of 16 months and a mean weight of 12.3kg. They were in 2 groups, each group having 4 dogs. In immediate implant placement 2 premolars were extracted and the bed was enlarged with core drill to fit the 11mm long and 5mm diameter implant. 2 implants were placed in this group of 4 dogs and remained covered with mucosa for 8 months. In delayed implant placement premolar teeth were extracted, after 6 month the alveolar ridge was explored and 2 screw implants were placed, the implants were allowed to heal subgingivally for 8 months. After 6-8 weeks postoperatively all animals were injected with fluorochromic bone marker. After eight months the dogs were killed with high dose ketamines. The mandibular implant section and the tooth bearing mandibular segment were removed for histologic and histomorphologic examining. The specimens were cut so that 3 slices of each implant and each neighboring premolar were obtained. Several measurements were recorded, including the percentage of bone remodeling on the implant surface, percentage of mineralized bone apposition surface and that of double marked bone surface, the rate of mineral apposition relative to cutting surface and the percentage of resorption in the region around the implant and the premolar.

Findings: In immediate implant placement the mean osteointegration surface measured 75% where as in late implants it was 80%. The main difference in the length of bone to the implant contact area was in the region of the neck of the implant. In the immediate implant, there was a deficiency of bone because of resorption, where there was a longer soft tissue implant interface. Soft tissue and bone histology findings were similar in both implants.

Conclusions: Osteointegration of the implants took place as a pseudoankylosing healing process. New hard and soft tissues around dental implants were seen after both types of implant placement.

Schropp I, Isidor F, Kostopoulos L, Wenzel A. Interproximal papilla levels following early versus delayed placement of single-tooth implants: a controlled clinical trial. *Int J Oral Maxillofac Implants* 2005; 20:753-61.

Purpose: To evaluate the dimensions of the interproximal papillae and the clinical crown height following early and delayed placement of single-tooth implants 1 week after crown placement and at follow-up visit approximately 1.5 years after crown placement.

Materials and Methods: In this prospective, randomized clinical study 45 consecutive patients were treated with Osseotite implants in the maxillary or mandibular anterior or premolar region using the early or delayed implantation protocol. The implants in the early group were placed between 3-15 days following extraction and those in the delayed group were placed approximately 3 months after extraction. No membranes were used. Grafting with autogenous bone was confined to the delayed group during implant placement, whereas grafting of these types of defects was done at abutment connection surgery in both groups. After 3 months, a 1- or 2-piece EP healing abutment was connected to implants to allow guided soft tissue healing for 4-6 weeks followed by permanent crown fabrication. Clinical photographs of the implant crown, including at least 1 adjacent tooth on each side, if present, were obtained 1 week after seating of the prosthetic restoration and at follow-up at 16-18 months later. Blinded evaluation of the interproximal papillae mesial and distal to the implant restoration, as well as the clinical implant crown height, was carried out. The interproximal spaces were assessed using a modification of the Papilla Index described by Jemt: a score of 0= no papilla or a negative papilla; 1=less than half of the height of the proximal area occupied by soft tissue; 2= at least half of the height of the proximal area occupied by soft tissue. Likewise, the clinical crown height was evaluated: 1=too long; 2=too short; 3=appropriate. CAL at the sites adjacent to the implant was also recorded at both times. Statistical analysis was done.

Findings: Both for mesial and distal papillae, significantly higher scores, more favorable scores, were recorded at 1.5 year follow-up compared with baseline. No significant differences between the early and delayed groups were found at either time point. Testing the difference between the groups by logistic regression, an OR of 7.2 was found, which means that the risk of presenting with no papilla or a negative papilla at baseline was 7.2 times greater in the delayed group than in the early group. There was statistically significant soft tissue fill at the 1.5 year follow-up for both groups. A statistically significant correlation between papilla score recorded 1 week after seating of the crown and CAL at the adjacent tooth surface was found for the distal papilla but not for the mesial papilla. At 1.5 year follow-up, the scores for neither the mesial nor distal papillae correlated with the CAL. No correlation was found between papilla scores mesial and distal to the implant crown and patient age at baseline; however, at the 1.5 year follow-up, papilla scores correlated significantly with age. Only patient age was shown to be a risk indicator of having a papilla score of 0 or 1 two years after implant placement. Patients 52 years or older had a significantly higher risk of presenting a papilla occupying less than half of the height of the proximal area at follow-up than younger patients. The percentages of the papilla scores did not differ considerably from sites not associated with a bone defect at 1.5 years. Assessment of clinical crown height showed no significant differences between the baseline and follow-up examination.

Conclusions: In the present controlled clinical investigation, no significant differences were found between early and delayed placement of single-implants in regard to interproximal papilla dimensions 1.5 years after crown placement.

Schwartz-Arad D, Herzberg R, Levin L. Evaluation of long-term implant success. J Periodontol 2005; 76:1623-28. 43 (Refs)

Purpose: To review some of the relevant literature regarding marginal bone loss (MBL), and to propose guidelines to evaluate the long-term implant success with MBL.

Materials and Methods: Literature review and author's opinion.

Findings:

Neck portion:

Wiskott and Belser suggested that smooth surfaces do not provide adequate biomechanical coupling with the bone surrounding the implant neck. Hammerle compared the marginal bone loss between the implants placed at the level of the alveolar crest and 1mm below it, and found more MBL around the more apically placed implants. He concluded that this could have implications for the lack of integration of the smooth neck. Joly et al. demonstrated that MBL did not depend on the neck length as long as the smooth/rough border was placed at the level of the alveolar crest. Norton described that MBL values were 0.3 to 0.4mm with the new neck module design of Astra-Tech implants (microthreads and with grid blasted with TiO₂ particles).

One-piece vs. Two-piece implants:

Hermann et al. have shown that peri-implant crestal bone reactions differ radiographically under such conditions as submerged or non-submerged, and are dependent on a rough/smooth implant border in one-piece implants and the location of the interface (microgap) between the implant and abutment/restoration in two-piece configurations. Evidence indicates that the polished neck portion of an implant may not osseointegrate.

Radiographs of MBL during the 1st year following abutment connection:

During the 1st year after abutment connection, the MBL rate is normally higher than in subsequent years. The abutment of MBL during the healing period and the 1st year following abutment connection was 1.5mm. It was concluded that after the 1st year a reliable prognosis of an implant can be made in each case. The factors that cause this 1st year higher MBL rate are not completely understood. However, there is evidence that the implant neck module design, the formation of a biological width, and the microgap are all responsible for this phenomenon at some level.

Radiographic long-term MBL:

Long-term mean MBL values have been widely reported, ranging from 0.2 to 1.2mm for up to 20 years follow-up. There is a consensus that most implants demonstrate MBL dynamics corresponding to Albrektsson's pattern of bone resorption (pattern I). One MBL pattern is related to hydroxyapatite (HA) –coated implants, demonstrating a low rate of bone resorption during the first few years(4-10years) followed by significant MBL values that may occur over a short period (pattern II). Furthermore, this MBL pattern is found when changes occur in occlusion or in a patient's health status. The 3rd MBL pattern consists of continuous progressive bone resorption at a steady linear rate beyond the 1st year followed by an almost stable bone level (pattern III). This pattern resembles Albrektsson's pattern, but demonstrates a longer linear resorption period after abutment connection. The 4th pattern consists of continuous bone resorption at all times (pattern IV), which is evident in most failures and can be symptomatic.

Evaluation of long-term implant success:

An implant that causes clinical symptoms is faulty. Although reports on the dynamics of MBL over time are incomplete, the MBL rate changes during the life of an implant at different stages. The long-term prognosis of an implant cannot be established based only on 1st year MBL calculations. Follow-up is essential to determine and predict a future clinical course. In this proposed MBL criteria, in a low rate of MBL during the first 3 years, the MBL pattern (I, III or IV) is still undetermined in an asymptomatic implant (according to Albrektsson's clinical parameters). Frequent follow-up is recommended to decide whether it is a failing implant (pattern IV).

Conclusions: Universal success criteria should be revised along with this proposed pattern of MBL.

Steinemann SG. Titanium – the material of choice? Periodontology 2000 1998; 17:7-21. 22 (Refs)

Purpose: The purpose of the article was to discuss the biomechanical properties of titanium, the host reaction to the foreign body, and the appropriateness of its use in dental implants.

Materials and Methods: Literature review.

Findings and Conclusions: Corrosion is the visible destruction of metal. The noble metals silver and gold have a resistance to corrosion that is nearly a factor of 100 lower than high-grade stainless steel and titanium. Metals are released by the corrosion process and some of them are toxic to cells. Stainless steel, cobalt-base alloy, and titanium show similar high levels of corrosion resistance, but the tissue reactions differ with minor rejection reactions observed for the two classical alloys that comprise the cell-toxic nickel and cobalt as essential components. Corrosion is essentially an atomic process so that, in principle, the interaction for all components of a metal must be considered. The foreign body interferes with life processes such as oxidation-reduction reactions and chemical reactions. In water and tissue fluid, corrosion occurs as an electrochemical process in which oxidation of the metal is coupled to reduction, yielding a hydroxide that precipitates on the metal surface. The crucial characteristic is that electron exchange occurs at the metal surface. It is a foreign body reaction of a chemical kind that can lead to denaturation of the tissue in contact with metallic implants. Gold shows massive reactions for any of these complexes, whereas titanium is fully inert. To determine the effects of this corrosion burden, the identity and stability of the first formed hydrolysis products must be considered. Nickel is a main component of stainless steel, the metal largely used for fracture treatment implants. The hydroxide is the first-formed corrosion product, and the metal concentration in the contact tissue around implants is on the order of the toxicity threshold for nickel. The sequestration reaction for stainless steel implants is the consequence.

Titanium is a reactive metal and it spontaneously forms a dense oxide film at its surface. The unwanted reaction product becomes a potent barrier against dissolution of the metal. The unwanted reaction product of corrosion is not an ion. This is an important finding because uncharged hydrolysis products have no affinity for reaction with organic molecules. Corrosion of titanium gives no chemical burden and no case of local or systemic reaction for titanium has been documented. The contact between tissue and an implant raises the local metal concentration by orders of magnitude. Metals can act as haptens: the ion can unite with a protein to form an antigen, and nickel, cobalt and chromium are known allergens. Titanium behaves totally different in that no proton exchange and liganding with biological molecules is possible.

The corrosion reaction products are available and can be taken up by the cells and may or may not be toxic to the cells. The variety of chemical interactions in tissue near the foreign body and at the artificial interface is great. Fibroblast cells in contact with titanium, niobium, zirconium and tantalum can proliferate but do not in proximity with other metals. In the experimental series of osteoblasts cultured on pure metal discs, growth inhibition is absent for titanium and zirconium, relatively weak for tin and aluminum, and strong or total for zinc, iron, copper, molybdenum, vanadium, nickel, silver, niobium and tantalum. The inhibition of osteoblast cell growth for any metal other than titanium and zirconium suggests that these elements only have the capacity for osseointegration. Titanium can bind to living tissue and to bone. The word "osseointe-

gration" was coined and defined as "a direct structural and functional connection between ordered, living bone and the surface of a load carrying implant". The chemistry of osseointegration involves titanium and is a very complex process. A detailed mechanism is found in the article describing the titanium mechanism and comparing it to other metals. Titanium is the metal of choice due to its tissue compatibility and osseointegration. Although titanium has limited mechanical strength, its properties are favorable for making surgical implants intrinsically safe and damage tolerant.

Strbac GD, Monov G, Cei S, Kandler B, Watzek G, Gruber R. Cathepsin K levels in the crevicular fluid of dental implants: a pilot study. J Clin Periodontol 2006; 33:302-308. 54 (Refs)

Purpose: To determine the concentration of cathepsin K secreted into the gingival crevicular fluid (GCF) around dental implants and its correlation with clinical parameters of healthy implants and implants demonstrating clinical signs of peri-implantitis.

Materials and Methods: Forty implants in 19 (13 female and 6 male) patients with (experimental group) and without (control group) peri-implantitis were used in this pilot study. Peri-implant crevicular fluid was collected with paper strips which were inserted into the base of the implant pocket for 30 seconds. Samples were collected for the buccal and lingual surfaces of the implants. The adsorbed volume of the peri-implant crevicular fluid was determined by impedance measurement. Peri-implantitis was then assessed clinically by the following parameters: 1) Pocket Depth (PD); 2) Marginal Bleeding Index (MBI); 3) Marginal Plaque Index (MPI); and by radiographic evidence of bone loss around the fixtures. Peri-implantitis was considered to be positive when the following measurements were exceeded: 1) PD > 3.00 mm; 2) MBI > 1.00; and 3) MPI ≥ 1.00. Radiographic loss of peri-implantitis supporting bone was considered to be positive when exposed implant threads were visible. For the determination of cathepsin K and total protein levels, cathepsin K was eluted from the filter strips and the levels of cathepsin K were analyzed with an immunoassay technique. Total protein levels in the eluted samples were determined with the bicinchoninic method. Median cathepsin K levels in the peri-implantitis and control groups were compared with the Mann-Whitney test. Regression analyses were performed in order to correlate cathepsin K levels with clinical parameters. Absolute amounts of cathepsin K per time of collection were correlated with the adsorbed volumes to filter strips and with the total eluted protein.

Findings:

	Peri-implantitis	Control	Statistical Significance
Cathepsin K per filter strip normalized to time of collection	22.4 pmol/sample (3.7-56.3)	10.1 pmol/sample (0-33.5)	Difference was significant
Normalized to adsorbed volume of the gingival crevicular fluid (median concentration)	1.7 nM (0.4-4.6)	2.2 nM (0.01-6.4)	Not significant
Cathepsin K normalized to protein within gingival crevicular fluid	0.09 nmol/μg (0.01-2.5)	0.07 nmol/μg (0-2.4)	Not significant

Absolute cathepsin K levels in the crevicular fluid of all implants demonstrated a positive correlation with the clinical parameters of PD (R=0.25; p=0.03), MPI (R=0.28; p=0.01) and MBI (R=0.32; p < 0.01). Absolute cathepsin K levels in the crevicular fluid also correlated with the adsorbed volume of GCF (R=0.51; p < 0.01) but not with adsorbed total protein (R=0.02; p=0.84). Cathepsin K values normalized to protein adsorbed to filter strips did not correlate with any of the investigated clinical parameters. Regression analysis with volume as the independent variable and cathepsin K as the dependent variable demonstrated a strong correlation with the variables (R=0.51; p < 0.01). Total protein per filter strip did not correlate with the total amount of cathepsin K. (R=-0.02; p=0.84). Subanalysis between the 2 groups demonstrated a correlation between age and adsorbed volume in the peri-implantitis groups, but not in the control group. Comparison of the subgroups resulted in significant differences between male and female and between the maxilla and mandible, but not between buccal and lingual sites when analyzed for the parameters adsorbed volume and cathepsin K normalized to time.

Conclusions: The total amount of cathepsin K and the volume of crevicular fluid adsorbed to filter strips were both higher in the peri-implantitis group than in the control group. There was a positive correlation between the total amount of cathepsin K with the clinical parameters of peri-implantitis and the volume adsorbed to the filter strips after standardizing intra-crevicular fluid sampling. Even though the total amount of cathepsin K correlated with the adsorbed volume obtained by intra-crevicular sampling, evaluating cathepsin K does not provide any information about the status of the disease other than that provided by volume measurements alone. Thus, evaluating cathepsin K with a combination of the intra-crevicular sampling method and immunoassay does not meet the requirements of a detection marker for peri-implantitis.

The Straumann SLA implant surface: clinically proven reduced healing time.

Purpose: To describe the Straumann SLA implant surface characteristics.

Materials and Methods: Literature review.

Findings: Titanium is among the most biocompatible materials known. The endosseous part of the implant, which appears grayish, is equipped with the SLA surface. The abbreviation SLA was introduced by Buser et al. in a histomorphometric study in 1991 and stands for Sand-blasted, Large grit, Acid etched. The SLA surface is produced by a large grit sand-blasting process with corundum particles that leads to a macroroughness on the titanium surface. This is followed by a strong acid-etching bath with a mixture of HCl/H₂SO₄ at elevated temperature for several minutes. This produces the fine 2-4µm micropits superimposed on the rough-blasted surface, as seen on SEM. The surface is not microporous and therefore provides no enclosed volumes to reduce vulnerability to bacteria. The chemical composition of the SLA is titanium oxide (TiO₂) using X-ray photoelectron spectroscopy.

In-vitro data: Surface roughness was shown to have an effect on the proliferation, differentiation, and protein synthesis of human osteoblast-like cells. PGE₂ production of MG63 human-like cells that serves as a marker for early differentiation is enhanced at increasing substrate roughness and is significantly higher on the SLA than on other surfaces. In-vitro studies have shown that osteoblasts grown on the SLA surface exhibit properties of highly differentiated bone cells suggesting that this surface is osteoconductive.

In-vivo data: the anchorage of implants in grown bone was analyzed in in-vivo studies. The rigid bone/implant interface was originally observed in a histological investigation. The bone-to-implant contact is found to be higher on rougher surfaces like the SLA surface. Buser demonstrated that a positive correlation exists between the percentage of bone-to-implant contact and the roughness value of similarly shaped implants under short-term healing periods of 3 and 6 weeks. Buser also studies the SLA surface biomechanically in jaw bone, evaluating the interface shear strength of SLA implants in the maxilla of miniature pigs and compared it to machined and TPS surface implants. Removal torque values for SLA and TPS surfaces, showed a significant difference to the machined surface. Histologically the SLA surface often showed fractures of bone trabeculae close to the implant surface, but an intact bone/implant interface, indicating a strong physical interlock between the rough titanium surface and bone. These findings indicate that SLA implants feature a greater bone-to-implant contact and higher removal torque values than comparably shaped implants with different surfaces.

Clinical data: In a prospective clinical study, Cochran et al. reported that 4.1 mm diameter ITI implants can be predictable and safely restored as early as six to eight weeks after implant placement for bone classes I to III and 12-14 weeks for bone class IV.

Conclusions: The performance of the rough SLA surface is superior to smooth surfaces with respect to bone contact levels and removal torques and thus early loading. The most important property of this surface is its high load bearing capability, as dem-

onstrated in the removal torque experiments. The SLA implant surface is optimized mechanically and topographically and is state of the art for dental implants.

Wennerberg A, Albrektsson T, Lindhe J. Surface Topography of Titanium Implants. Clinical Periodontology and Implant Dentistry. 4th edition. Pages 821-828. 23 (Refs)

Purpose: To describe the surface topography of commercially available titanium implants.

Materials and Methods: Literature review.

Findings and Conclusions:

1) Implant Surface/ Osseointegration: Many arguments have been made for the promotion of surface modifications. These arguments include the following: 1) Surface modified implants with a greater bone contact area can provide better mechanical stability between the bone and implant; 2) These implants may provide a surface configuration that would retain the blood clot forming after implant placement; and 3) Surface modified implants may further stimulate the bone healing process. Various studies have shown that a firmer bone fixation can be established with implants that have a roughened surface. There are several examples of methods that have been used to modify the surface topography of dental implants. These include grit blasting, titanium plasma spraying, etching, and/or coating. These surface conditioning methods result in irregularities of wavelength, height, and spatial dimension. Whether these surface irregularities promote an increased rate of implant incorporation into the bone is still currently under investigation.

2) Measurement of Surface Topography:

Instruments: Surface topography is described as the following: 1) the degree of roughness of the implant surface; and 2) the orientation of the irregularities on the implant surface. Surface roughness occurs in 2 planes: one perpendicular to the surface and the other in the plane of the surface. The orientation of the irregularities may be described as either isotropic or anisotropic. Isotropic is defined by surface structures without a dominating direction. The techniques involved in producing these surfaces include abrasive blasting, plasma spraying, etching, and oxidizing. Anisotropic refers to a surface which has a distinct and regular pattern. These surfaces are created by milling the surface to conform to a regular and distinct pattern. For proper topographical characterization of a surface, instruments must be used that both present both numerical and visual data. There are currently 3 groups of instruments such as mechanical contact stylus instruments, optical instruments, and scanning probe microscopes (SPMs) which provide data on topographical characteristics of implants. In evaluating the surface characteristics of the screw-type dental implants only the optical instruments may be used. An example of this instrument is the confocal laser scanning profilometers and interferometers.

Measuring and evaluating procedures: The threaded portion of a screw-shaped implant has 3 regions: top, flank, and valley regions. Of these 3 regions, the top has the roughest surface. The topography of an implant surface is defined in terms of form, waviness, and roughness. Waviness and roughness are also presented under the term texture. Undercuts that may be present in the surface are impossible to measure. The roughness describes the smallest irregularities in the surface. Form relates to the largest structure or profile. Surface roughness can also be described in terms of amplitude, spatial distribution and hybrid parameters. For the characterization of dental implants at least one parameter from each of the 3 groups: amplitude, hybrid and spacing must be included in the surface evaluation of the top, valley and flank regions. Amplitude parameters describe the vertical height of the irregularities and are determined in both 2D and 3D measurements. Spacing parameters are also described in 2D and 3D measurements and are defined as the space between the irregularities. Hybrid parameters are described by whether the irregularities have either rounded or pointed curvatures.

Surface Characteristics of some Commercially Available Implants: 1) Blasted surface (Tioblast- Astra): a surface blasted with titanium oxide particles which results in an isotropic surface. 2) Blasted + etched surface (SLA-Straumann): This surface is blasted followed by acid etching. 3) Etched surface (Osseotite- 3i): This surface is prepared in a 2 step procedure which results in an isotropic surface with a high frequency of surface irregularities. 4) Hydroxyapatite coated surface (Replace): Surface is prepared with a coating procedure providing a rough isotropic surface. 5) Oxidized surfaces (TiUnite): The surface is oxidized in a way that results in a progressive increase in thickness of the oxidized layer at the apical end resulting in a craterous, isotropic surface. 6) Titanium plasma sprayed (Bonefit and SteriOss): Plasma spraying results in a rough, isotropic surface that yields the

greatest surface area of all the surfaces presented. 7) Turned Surface (MK III- Nobel Biocare): Cutting marks from the machining process results in an oriented anisotropic surface.