

**Nevins M, Camelo M, De Paoli S, et al. A study of the fate of the buccal wall of extraction sockets of teeth with prominent roots. *Int J Periodontics Restorative Dent* 2006; 26:19-29. (26 refs)**

**Purpose:** The purpose of this study was to determine the fate of thin buccal bone encasing the prominent roots of maxillary anterior teeth following extraction.

**Materials and Methods:** A multicenter randomized controlled trial evaluated the prognosis of the buccal plate after extraction in the esthetic zone. The study included three male and six female patients who had a minimum of 2 periodontally compromised, prominent maxillary anterior teeth that were candidates for extraction. The buccal plate was compromised but intact enough to support bone formation in the extraction socket. Tooth extraction was performed by raising a partial-thickness flap to preserve the periosteum on the surface to protect the remaining thin buccal bone. The sockets were curetted to remove granulation tissue. A randomization procedure was used to allocate the teeth to either the test or the control group. 19 extraction sockets were allocated to the test group and were grafted with Bio-Oss, while the 17 control sites healed spontaneously. Each patient went directly from the extraction surgery for a CT scan. After 30-90 days, a second CT scan was performed. The mean time period until the second CT scan was performed was  $67.78 \pm 18.85$  days for Bio-Oss treated extraction sites and  $85.53 \pm 16.52$  for the control sites. Since a crest width of 6 mm is regarded to be sufficient for implant placement, the most coronal site in which the crestal width was 6 mm was identified. These sites were marked with a straight line. Perpendicular to this line and in the middle of the socket, a second straight line was drawn. The parameter "height at crest width 6mm" was defined as the distance between the floor of the nose and the 6-mm-crest-width line. The control and test sites were measured, and the change in height at crest width 6 mm was evaluated. Based on the postsurgical CT scan, implants were placed at the discretion of the surgeon. During implant placement, a total of 10 biopsies (5 control and 5 test) were harvested for the purpose of histologic evaluation.

**Findings:** A total of 36 teeth were extracted and the distribution of extracted teeth was similar in the two groups. There was no significant difference between the test and control groups regarding the height at a crest width of 6 mm at baseline. At the time of re-entry surgery, the control sockets had lost more height ( $5.24 \pm 3.72$  mm) than the test teeth ( $2.42 \pm 2.58$  mm). The difference was statistically significant. In 16 of the 19 test sites (84%) treated with Bio-Oss, the crest height was maintained after tooth extraction or showed a loss of less than 20%. In contrast, only 5 of the 17 control sockets remained stable (29%), while 12 (71%) showed a loss of more than 20% in height. A multiple stepwise regression was performed to analyze the degree of correlation between the height at crest width of 6 mm at the second surgery and the other parameters (treatment received, height at crest at baseline, number of teeth extracted, sex of the patient, and days until the next CT scan). In this analysis, height at crest width of 6 mm at the end of the observation period was significantly correlated with the heights at crest width of 6 mm at baseline ( $p=0.00002$ ), the treatment received ( $p=0.0109$ ), and with the time elapsed between CT scans ( $p=0.0607$ ).

**Histologic Results:** Bio-Oss granules could be identified in the biopsies from the test sites. In the apical portions, they were integrated and interconnected with each other by a cancellous bone scaffold. Some granules surrounded by soft tissue were seen in the more coronal part of a few specimens. There were no signs of inflammation or foreign body reactions. New bone formation was seen in the control sites. The reduced crestal portion of the newly formed bone was composed of woven and parallel-fibered compartments. In the more apical portion, preexisting bone was extensively reinforced by new bone apposition.

**Conclusions:** There were a significant number of buccal plates lost to create deformities in the edentulous ridge requiring additional grafting at the time of implant placement in the control group compared to those sites that received Bio-Oss. Some sites healed correctly with no treatment, but they were unable to be identified before extraction. Therefore, it seems prudent to introduce an osteoconductive substance into the prominent roots to avoid loss of the buccal plate and the resulting compromises in implant placement.

**Araujo MG, Wennstrom JL, Lindhe J. Modeling of the buccal and lingual bone walls of fresh extraction sites following implant installation. Clin Oral Impl Res. 2006;17:606-14. (20 refs.).**

**Purpose:** To determine whether modeling of the alveolar ridge that occurs during tooth extraction and implant placement was influenced by the size of the hard tissue walls of the socket and whether it continues after the first four weeks of healing.

**Materials and Methods:** Six beagle dogs about 1 year old, were used in the study. The third premolars and the first molars in both quadrants of the mandible were used as experimental teeth. The mucoperiosteal full thickness flaps were elevated, the experimental teeth on the right side were first hemisected and the distal roots were removed. The implants (4.1 mm wide x 6 or 8 mm long Straumann) were placed in the freshly extracted sockets. The flaps were replaced to allow a semi-submerged healing. Two months later, the same procedure was repeated on the left side of the mandible. The animals were sacrificed 1 month after the second implant procedure. The mandibles were dissected and each implant site was removed and ground sectioning was done for histological examination. The examinations were done at 1) SLA-the marginal termination of the rough surface, 2) C-the crest of the buccal or lingual bone wall, and 3) B/I-the most coronal point of contact between bone and implant. The assessments were done at the SLA level and 1, 2, 3 mm apical of SLA.

**Findings:** The gingiva in the premolar-molar regions as well as the peri implant mucosa at clinical checkups after the first 2 weeks had no signs of inflammation.

Histological examination- Implant sites after 4 weeks of healing: The marginal gap present between the implant and the walls of the socket were occupied by the connective tissue and newly formed bone. In the premolar sites, no residual bone defect was seen in the buccal aspect, but at the lingual aspect, a  $1.5 \pm 0.6$  mm deep angular hard tissue defect was present. The number of bone multicellular units was larger in the lingual than in the buccal socket wall. In the molar sites, the depth of the residual hard tissue gap at the buccal was  $1.7 \pm 1.5$  mm and at the lingual it was  $1.4 \pm 1.7$  mm. Osteoclast presence was seen on the outer surface of the buccal and lingual walls. The buccal bone wall was thicker than its counterpart at the premolar sites and lingual bone width was similar to the premolar sites.

Implant sites after 12 weeks of healing: In the premolar sites, no residual hard tissue gap was found on the buccal aspect. The crest of the buccal bone and the level of the bone to implant contact was about 2 mm apical of the SLA border. In the lingual, the shallow marginal defect remained. The lingual bone wall had a width similar to that observed at the 4 week interval. In the molar sites the buccal bone crest was located at  $1 \pm 0.7$  mm apical of SLA, and the marginal level of bone to implant contact was  $0.8 \pm 0.8$  mm apical of the SLA border of the implant.

**Conclusion:** The implant placement failed to preserve the hard tissue dimension of the ridge following tooth extraction. Marked hard tissue alterations were observed during healing following tooth extraction and implant placement in the socket.

**Chung DM, Oh T, Lee J, Misch CE, et al. Factors affecting late implant bone loss: a retrospective analysis. . Int J Oral Maxillofac Implants 2007;22:117-26. (68 refs.)**

**Purpose:** To evaluate factors affecting late implant bone loss.

**Materials and Methods:** In this retrospective clinical trial, 339 endosseous root form dental implants placed between April 1981 and April 2002 and in place for more than 3 years were clinically evaluated for presence or absence of suppuration, modified bleeding index (mBI), modified plaque index (mPI), Gingival index (GI), PD and width of keratinized mucosa (KM). Patients dental records were reviewed to reveal dates of implant placement, types of implants and surfaces, and any significant medical history. In addition, average annual bone loss (ABL) was calculated by evaluating periapical radiographs and panoramic radiographs. Two sets of radiographs, one obtained at least 1 year after implant loading (baseline) and the other obtained during the research period (follow-up) were compared to determine annual osseous change. The radiographs were digitized and images were analyzed using image analysis software. Patients were asked to complete a questionnaire regarding their satisfaction with their implants. The examiner remained blinded during the clinical examination, and calibration trials were conducted to assure interexaminer reliability.

**Results:** The average service time of the dental implants was 8.1 yrs.

- The differences in average ABL among different implant systems failed to reach statistical significance.
- The average periapical ABL was 0.14 mm, the average panoramic ABL was 0.01 mm, and the average overall ABL was 0.12 mm. The difference between the periapical ABL and panoramic ABL was not statistically significant.
- The average ABL was significantly influenced by type of implant prosthesis, implant location, implant length, and implant diameter.
- The average ABL for implants supporting fixed prostheses was twice that of implant supporting removable prostheses (0.14 mm vs 0.07 mm).
- ABL was significantly greater for posterior implants than for anterior implants.
- When peri-apical ABL was used as the primary variable, only the difference between short and long implants was significant (0.19 mm vs 0.12 mm).
- Analyses of clinical parameters used to assess the degree of soft tissue health revealed that implants that were long, had smooth, had less than 2 mm of KM, or supported removable prostheses were associated with significantly greater gingival inflammation and plaque accumulation than their counterparts.
- A significant difference in mBI was found between smooth-surface (0.57) and rough-surface implants (0.41).
- No correlation between clinical parameters and average ABL.
- ABL was 3 times greater in smokers than in non-smokers with the difference statistically significant.
- Significantly less plaque accumulation was observed in smokers versus non-smokers (0.86 vs 1.33).
- Implants in diabetics versus non-diabetics differed significantly only in mPI (1.81 vs 1.28).
- 81.2% said their general satisfaction was "excellent" and 17.4% said it was "good". There were no "poor" experiences. Less than 50% of the subjects responded "excellent" to the question regarding ease of cleaning of the implants.
- Overall, implant length showed statistical significance in relation to predicting average ABL. Periapical ABL was 0.09 mm less in the long implants group than in the short implants group.

**Conclusions:** Within the limitations of current retrospective clinical trial, it can be concluded that shorter implants, wider implants, implants supporting fixed prostheses, and implants placed in smokers were associated with greater average ABL.

**AC:** It is one of those statistical articles. There are so many confounding factors. But it is still a good article to give a summary on ABL.

**Joos U, Wiesmann HP, Szuwart T, Meyer U. Mineralization at the interface of implants. Int. J. Oral Maxillofac. Surg. 2006;35:783-790. (105 refs.)**

**Purpose:** To provide insight into the complex process of mineral formation around implants.

**Materials and Methods:** Literature review with author's opinions.

**Findings and Conclusions:**

Influence of bone properties on osseointegration: The properties of bone are directly related to the features of the mineralized extracellular matrix adjacent to implants in two ways: 1) the macroscopic and microscopic implant geometry and insertion approach determine the principal bone-implant relationship; and 2) the properties of bone have a major impact on the load-related characteristics of the microenvironment adjacent to implants. The fixture design should be coincident with primary stability. The quality of the primary implant stability is dependent on the geometric relation between implant shape and the surgically created host site. Intimate contact between implants and bone directly after insertion is predicated on the fact that cortical bone has an elasticity of up to 5% (cancellous bone has a higher elasticity). Implants should have an intimate contact with the bone directly after insertion. The implant must permit the transmission of forces without threading the biomechanical competence of the bone's mineral properties (i.e. the implant should not cause microfractures of the mineralized matrix.) With dental implants, symmetrical implant forms achieve a secure implant fixation within the bone. The threads of implants represent macroscopic surface features that permit mechanical interlocking of the implant within bone. Thread containing implants can be inserted in bone by a self-cutting procedure or by preparation of the implant bed through a thread cutter. Histological studies have shown that self-cutting screws are associated with a higher bone-to-implant contact at the crestal area. A histological evaluation by Meyer et al. (2003) demonstrated that screw-shaped parabolic implant systems have a high congruency between the implant and the surrounding bone tissue (i.e. a direct contact between implants and bone was achieved over large surface areas directly after insertion of the fixture.) If implants are inserted in a mechanically preconditioned implant site, threading the elasticity of cortical bone (i.e. osteotome technique, larger discrepancy between the diameter of the final bur and the implant) the primary stability will decrease.

Influence of bone biology on osseointegration: Osseointegration at implants within the bone repair and regeneration process occurs between the implant surface and the tissues covering the implantation bed. Bone repair (modeling) is associated with a matrix vesicle-initiated mineralization of the newly synthesized extracellular matrix. Regeneration (remodeling) occurs through a balance of dissolution and formation of collagen-associated biominerals. Periosteal cells, cortical cells, and cells derived from the surrounding soft tissues and marrow cells are responsible for the features of biomineral formation. The condition of the bone microenvironment such as temperature, oxygen tension, vascularity and load affects the cell response at implant surfaces. Tissue maintenance and emergence is dependent on the extent of surgical trauma directly at insertion. It is also dependent on load-related deformations under implant load. The initial stage of osseointegration depends on state of cells and matrix at the surface of the artificially created implant site. The extent of cell deformations in the microenvironment of implants determines the fate of the subsequent mineralization process. Phenotype plasticity is defined as the adaptive behavior that bones display when challenged with a changing mechanical environment. The adaptive mechanisms in bone remodeling include the basic multicellular units or BMUs. Carter and Giori (1991) proposed that proliferation and differentiation of the osteoblasts responsible for peri-implant tissue formation are regulated by the local environment. This concept is based on the theory by Frost (2002) which states that bone cells within the bone tissue that experience a loading history of physiological strain will become osteogenic assuming an adequate blood supply. Physiological bone loading (500-3000 microstrains) permits mature bone formation. Higher peak strains (> 5000 microstrains) are considered to be hyperphysiological and result in immature bone mineral formation and fibroblastic cell pattern. If healing tissue is exposed to excessive strains, fibrogenesis will occur.

Analytical methods: Histological and biochemical assays are used to determine the molecular features of the cell and the composition of the extracellular matrix in the implant microenvironment (i.e. staining, immunostaining, electrophoresis, and blot techniques). Genetic probes are utilized to assess gene expression of multiple phenotypic markers by cell microarrays. Mineralogical studies are used to determine the mineralization seen at the implant interface. Imaging studies using the  $\mu$ CT may provide insight into the formation of mineralized extracellular matrix around implants. Transmission electron microscopy, scanning electron microscopy, atomic force microscopy, and X-ray or electron diffraction analysis can all be utilized to investigate the inorganic aspect of bone minerals.

Features of *in vivo* mineralization at implants: *In vivo* mineralization at implant surfaces is related to the mineralization of collagen in the extracellular matrix. Anderson (1995) showed that matrix vesicles serve as the initial site of calcification in all skeletal tissues. Matrix vesicles as membrane-invested particles of 100 nm diameter are located in the extracellular matrix and are present on implant surfaces. These are regarded as the nucleation core complexes that are needed for mineral induction. Albrektsson (1981) proposed that mineralization began through the initial deposition of a collagen-containing matrix. This matrix was then mineralized to a state of mature bone mineral. A thin 20-50 nm electron-dense deposit was found to separate the implant from the mineralized bone matrix. The loss of mineralized matrix has been found to occur around the crestal portion of implants. This phenomenon has been observed in the different stages of implant loading as a decrease of radiological marginal bone height around implants. Animal studies have shown that this increased marginal bone loss may be related to occlusal overloading. Strains exceeding 4000 microstrain seen at the crestal bone level have been associated with loss of mineralized matrix.

Features of *in vitro* mineralization at implants: In conventional osteoblast cultures, mineralizing osteoid is only observed in multi-layered structures that form nodules over a period of time. To assess bone-like mineral formation at biomaterial surfaces *in vitro*, an analytical evaluation of the crystal structure has to be performed. The presence of initial calcified structures on material surfaces, either precipitated from the extracellular fluid or induced by cellular activity is currently being investigated to improve the subsequent osteoblast activity on these materials.

**Lioybavina-Hack N et al. Significance of primary stability for osseointegration of dental implants. Clin Oral Impl Res 2006;17:244-50.**

**Purpose:** The purpose of the present study was to examine histologically the significance of the primary stability of titanium dental implants for the establishment of osseointegration, using an experimental capsule model for bone augmentation.

**Materials and Methods:** Sixteen, 6-month-old male albino rats of the Wistar strain were used in the study. In each rat, percutaneous incisions were made at both sides of the mandible, 5mm coronal to its inferior border. The masseter muscle was exposed, and a muscle-periosteal flap was elevated from the mandibular ramus with a periosteal elevator leaving the bone denuded. A rigid, non-porous hemispherical Teflons capsule with an internal diameter of 6mm, a height of 4mm and a peripheral collar was fixed to the ramus with 4 mini-screws. Prior to fixation, a hole was prepared in the mid-portion of the capsule to fit the circumference of an ITIs HC titanium implant with a diameter of 2.8mm and a length of 4mm. On one side of the jaw, the (test) implant was placed through the hole in such a way that its apex did not make contact with the mandibular ramus. This placement of the implant did not ensure primary stability, and the implant could be moved by small forces. On the other side of the jaw, a similar (control) implant was placed in the hole of the capsule in such a way that contact was made between the implant and the surface of the ramus. This provided primary stability of the control implant. After 1, 3, 6 and 9 months, four animals were killed, and the mandibles were dissected free. Undecalcified sections were cut through the capsule and the inserted implant perpendicular to the lateral surface of the mandibular ramus. In total, four sections per block with a thickness of 100–125  $\mu$ m representing the mid-portion of the implants in the two perpendicular planes were stained with toluidine blue and subjected to histometric analysis.

Histometric analysis In the prepared sections, the following parameters were assessed:

(1) The implant height (IH), the length of the implant surface available for osseointegration, (2) The height of the peri-implant bone (PIB) was recorded from the apex of the implant to the most coronal level of new bone formed in the capsule. (3) The extent of direct bone–implant contact (osseointegration)(OB) was recorded from the apex of the implant and (4) The amount of mineralized bone in contact with the implant (MOB) was recorded as the length of mineralized bone-to-implant contact.

**Results:**

*Primary stable implants (controls):* The results of the histometric analysis showed that the IH available for osseointegration was similar for all control implants, with a mean of 3.2  $\pm$  0.1mm.

One-month specimens: Only two specimens were available for histometric analysis in the 1-month observation group. The mean height of PIB was 44.3  $\pm$  8.3% (range 38.4–50.2%) of the IH. On average, 38  $\pm$  8.5% (range 32–44%) of the implant surface was in direct contact with the newly mineralized bone and the bone marrow (OB), while 28.1  $\pm$  2.3% (range 14.4–41.7%) was in direct contact with the mineralized bone (MOB). The new bone had the appearance of a woven bone with irregular trabeculae and large marrow spaces.

Three-month specimens: The height of PIB was 74.6  $\pm$  10.6% (range 61–82.1%). The mean extent of osseointegration (OB) was 52.9  $\pm$  26.4% (range 22.4–67.6%), and on average, 28.9  $\pm$  10.9% (16.4–35.7%) of the implant surface was in direct contact with mineralized bone. The lower portions of the newly formed bone had the appearance of lamellar bone, while the top layer was woven bone. Osteoid seams and resorption lacunae were often observed on trabeculae adjacent to the bone marrow, which contained fat cells. Osseointegration was also observed inside the hollow cylinders of all implants.

Six-month specimens: The height of PIB was 88.2  $\pm$  2.3% (range 85.7–91.1%). The mean extent of osseointegration (OB) was 64.6  $\pm$  18.1% (range 45.9–87%), and the length of mineralized bone in contact (MOB) averaged 52.6  $\pm$  17.6% (range 30.3–70%) of the implant length. The portions of the

newly formed bone facing the capsule surface were less organized and contained larger marrow spaces than the portions near the implants.

Nine-month specimens: Three primary stable implants were available for histometric analysis. The mean height of PIB was 94.1  $\pm$  5.7% (range 88.6–100%), the mean extent of osseointegration (OB) was 81.3  $\pm$  23.2% (range 54.6–96.1%), and the mean length of mineralized bone in contact with the implant (MOB) was 69.6  $\pm$  28.5% (range 36.8–87.1%) of the implant.

*Non-stable implants (test):* Histological analysis did not reveal any osseointegration at any observation time of the 11 implants without primary stability.

The amount of newly formed PIB in the capsules with the instable implants increased gradually from one to 9 months. The total height of the new bone was similar to that observed in the contralateral capsules containing stable implants at the corresponding observation times. However, despite the presence of newly formed bone near the implant surface, a layer of connective tissue was always interposed between the implant and the new bone. In four specimens, such dense connective tissue had apparently penetrated the capsule through a gap that had developed between the capsule sealing and the implant surface.

**Conclusion:** The results indicate that primary stability is a prerequisite for successful osseointegration. Moreover, primary instability of implants will result in fibrous incapsulation of the implants.

**Chung DM, et al. Factors affecting late implant bone loss. Int J Oral Maxillofac Implants 2007;22:117-26. (80 refs.)**

**Purpose:** To evaluate the factors affecting late implant bone loss.

**Materials and Methods:** 339 endosseous root form dental implants in 69 patients which were placed between April 1981 and April 2002 were analyzed. One hundred and ninety-eight (58.4%) were placed in the maxilla and 141 (41.6%) were placed in the mandible. The implants were divided based on the following factors: 1) surface characteristics (smooth vs. rough), 2) length (short < 10 mm vs. long > 10 mm), width (narrow < 3.75 mm, regular 3.75-4 mm, or wide > 4.0 mm), 3) the amount of keratinized mucosa (< or > 2 mm), 4) location (anterior vs. posterior, maxilla vs. mandible), 5) type of prosthesis (fixed vs. removable), and 6) type of opposing dentition. The clinical parameters which were recorded were: 1) modified plaque index, 2) gingival index, 3) modified bleeding index, and 4) probing depth. The changes in marginal bone were evaluated in each implant using periapical radiographs, panoramic radiographs or both. The difference between the bone loss from the initial and final radiographs for each implant was calculated for the total bone loss for that implant. The patients were asked to complete a questionnaire regarding their satisfaction with their implants.

**Findings:** The difference in average alveolar bone loss (ABL) among different implant systems was statistically not significant. The difference between the periapical ABL and panoramic ABL was not statistically significant ( $p > 0.05$ ). The average ABL for implants supporting fixed prostheses was twice that of implants supporting removable prostheses (0.14 mm vs. 0.07 mm). The ABL was significantly greater for posterior implants than for anterior implants. The ABL between short and long implants was significant (0.19 mm vs. 0.12 mm). The soft tissue assessment revealed that implants that were long, had smooth surfaces, had < 2 mm of KM, or supported removable prostheses were associated with significantly greater gingival inflammation and plaque accumulation than their counterparts. The ABL was approximately 3 times greater in smokers (0.32 mm) than in nonsmokers (0.12 mm) and this difference was statistically significant. The implants placed in patient with diabetes were compared to implants in patients without diabetes. Only the difference in marginal plaque index between the 2 groups was significant (mPI of 1.81 vs. 1.28).

**Conclusion:** From this retrospective clinical trial, we can conclude that shorter implants, wider implants, implants supporting fixed prostheses, and implants placed in smokers were associated with a greater average ABL.

**McGuire M, Scheyer ET. A randomized, double-blind, placebo-controlled study to determine the safety and efficacy of cultured and expanded autologous fibroblast injections for the treatment of interdental papillary insufficiency associated with the papilla priming procedure (PPP). J Perio. 2007;78:4-17. (54 refs.)**

**Purpose:** The purpose of this study was to assess the efficacy and safety of using autologous fibroblast injections following a minimally invasive papilla priming procedure to augment open interproximal spaces.

**Materials and Methods:** Twenty-one non-smoking, systemically healthy patients participated in the study. For each subject at least two open interproximal spaces were selected and the study was designed to that extraneous factors such as oral hygiene compliance, parafunctional habits etc, would be controlled within each subject prior to the study. At baseline and all subsequent study visits, the treated sites were examined clinically, defect measurements were recorded using a UNC probe, and photographs were taken. Radiographs and study impressions were taken at baseline and 4 months. The secondary efficacy analyses included change of the following parameters from baseline to the 4 month visit: distance from the tip of the papilla to the alveolar crest and from the base of the contact area to the alveolar crest, probing depth, interproximal width of papilla, plaque index, inflammation score, tissue texture and color, and patient and clinician perception of change was also evaluated. Digital image analysis and the diagnostic models were used to confirm clinical measurements. A visual analog scale (VAS) was used by the examiner and subject to assess the defect change from baseline to 2,3, and 4 months. The VAS was based on current appearance and each visit was given a score for 0-100. 100 indicating no defect.

Five-seven days prior to the first treatment, all subjects underwent plaque removal and teeth were scaled and root planed as needed at all study sites. The PPP consisted of an orban knife being inserted from the facial (not penetrating the lingual or the mesial and distal sulcus) at the base of the papilla. A 12B blade was inserted into the space, and the incision was carried toward the apex of the papilla perpendicular to the initial incision. For each subject at least two open interproximal spaces were selected and randomized to receive autologous fibroblast injections or placebo injections beginning 1 week following the (PPP); two additional injections were performed from day 7-14 following the initial injections.

**Findings:** The primary efficacy failed to show significant treatment effect at 4 months, but the treatment areas showed a statistically significant mean percentage increase from baseline in papillary height at 2 months. The analysis at months 3 and 4 showed no indication of efficacy. The authors note that this difference was borderline statistically significant at month 2, suggesting that test treatment was superior to placebo. The examiner and subject VAS, however was superior for the test sites over the placebo. This indicates that over time, there was some change in the distance from the tip of the papilla to the base of the contact area, and the test and placebo treatments were statistically significantly different. Based on safety data, the test treatment was deemed safe.

**Conclusions:** While there was a noted visual increase in papillary insufficiency as described by the examiner and subjects' VAS, the other methods of detecting change, measuring dental arch molds, using a probe to measure from the tip of the papilla to the interproximal contact etc, failed to show evidence of treatment effect. This paper reports only those findings of the first 4 months of a 12 month study. A subsequent paper will report on the long-term results.

**Ingemar Abrahamsson and Claudio Soldini. Probe penetration in periodontal and peri-implant tissues An experimental study in the beagle dog. Clin. Oral Impl. Res. 2006;17: 601–5.**

**Purpose:** The purpose of the present study was to further analyze the histological level of probe penetration in healthy periodontal and peri-implant tissues.

**Materials and Methods:** 4 beagle dogs were used. Extractions of all mandibular premolars and the first, second and third maxillary premolars were performed. Three months later, 4 experimental implants (Institute Straumann AG, Waldenburg, Switzerland) were installed. The implants had a total length of 12mm (intraosseous portion 9mm) and a diameter of 3.3mm. A 6-month period of plaque control was initiated. The plaque control program included cleaning of implant surfaces and teeth with a toothbrush and a dentifrice at 5 days/week. At the end of the 6-month period, probing assessments were performed. Probing depth was determined at the buccal aspect at two of the implants and at the bilateral first mandibular molars. A pressure-controlled TPS probe was used. Immediately following the probing depth assessment, a metal periodontal probe was inserted into the previously probed site and to the corresponding depth. The probe tip was attached to the implants and the teeth using a light curing flowable composite material. The animals were sacrificed and the mandibles were removed and placed in the fixative. Implant and tooth regions were dissected. The tissue samples were dehydrated in serial steps of alcohol concentrations and subsequently embedded in methyl-methacrylate resin. The sections were reduced to a final thickness of approximately 20 µm and stained in toluidine blue.

**Histometric analysis:** All histometric measurements were performed in a Leica DM–RBEs microscope. Sixteen implant and 16 tooth sections were used. In each section, the following landmarks were identified and used for the linear measurements:

**Implant sections:** PM – the marginal portion of the periimplant mucosa, BC – the marginal level of the bone crest, B – the marginal level of mineralized bone in contact with the implant, aJE – the level of the apical termination of the junctional epithelium and TP – the apical position of the metal probe tip.

**Tooth sections:** GM – the gingival margin, BC – the marginal level of the bone crest, aJE – the level of the apical termination of the junctional epithelium and TP – the apical position of the metal probe tip. The vertical linear distances between the landmarks were determined.

**Statistical analysis:** Descriptive statistics including mean values and standard deviations were calculated for each variable and dog.

**Results and Conclusions:**

**Implants:** The peri-implant soft tissues (PM-BC) were on average 2.90mm high. The distance between PM and aJE, i.e., the extension of the junctional epithelium, was 1.70mm, while the height of the connective tissue interface (aJE-BC) was 1.20mm.

The mean probe tip extension (PM-TP) was 1.86mm, i.e., 0.16mm longer than the junctional epithelium. The distance between the probe tip and the marginal bone (TP-BC) was on average 1.04mm.

**Teeth:** The height of the gingiva was on average 2.67mm. The vertical dimension of the junctional epithelium (GM-aJE) and the supracrestal connective tissue portion (aJE-BC) was 1.74 and 0.93mm, respectively. The probing depth (GM-TP) was on average 1.64mm, i.e. within the dimension of the barrier epithelium. The distance between the probe tip and the marginal bone (TP-BC) was on average 1.03mm.

This experiment showed that under healthy conditions, the probe tip penetration in the soft tissues at teeth and implants is similar when a probing force of 0.2N is used. Probing around implants using a moderate force is a valuable diagnostic tool in the maintenance of implant patients.

**Crismani AG, Bernhart T, Schwarz K, et al. Ninety percent success in palatal implants loaded 1 week after placement: a clinical evaluation by resonance frequency analysis. Clin Oral Implant Res 2006;17:445-50. (40 refs)**

**Purpose:** To study the behavior of early loaded palatal implants by resonance frequency analysis (RFA) and whether shorter healing periods might be justified in order to accelerate the orthodontic treatment.

**Materials and Methods:** Twenty patients (7male, 13 female), with age ranging from 15.3 to 47.9 yrs received one palatal implant for maximum orthodontic anchorage. The vertical bone height at the implant site was assessed by low dense dental computed tomography. The implants used were 4mm in length and 3.3mm in diameter. The palatal mucosa was removed using a punch and the cortical bone was indented with around bur and the hole for accommodating the implant was drilled with a counter sink. The self tapping implant was inserted by hand with a wrench. The palatal implant stability was carried out at the time of surgery, 5-8 days after surgery at first orthodontic loading and subsequently once a week over a period of 12 weeks using resonance frequency analysis.

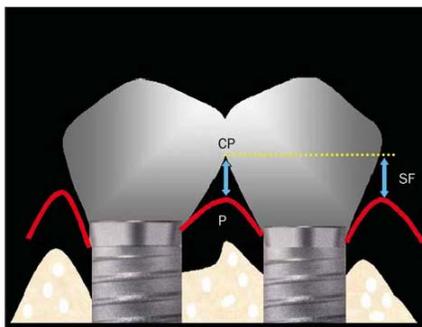
**Findings:** Eighteen implants remained stable and 2 implants were lost. The mean orthodontic force applied was  $272.2 \pm 73.2$  cN. The implant stability quotient (ISQ) value at the time of surgery averaged  $69.4 \pm 3.9$ . The mean implant stability quotient value 6.7 days after insertion was  $69.8 \pm 3.6$ . Statistically significant differences were noted between the mean implant stability quotient values measured at the time of first loading (ISQ=  $69.8 \pm 3.6$ ) and the mean ISQ value 2 weeks post surgery ( $67.9 \pm 4.6$ ,  $p=0.005$ ), and the mean ISQ value measured 3 weeks post surgery ( $67.8 \pm 5.2$ ,  $p=0.04$ ). The final implant stability quotient value (ISQ) 12 weeks post surgery was  $69.8 \pm 3.5$ , and equaled the one measured at the time of first loading.

**Conclusion:** The results from this study indicate the possibility of loading palatal implants earlier than recommended. An orthodontic loading of palatal implants 6 weeks post surgery with a force up to 400 cN seems to be justified. Further investigations are necessary to evaluate the behavior of early loaded palatal implants beyond 12 weeks.

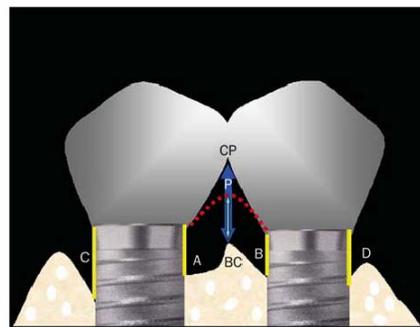
**Novaes AB Jr., Papalexiou V, Muglia V, Taba M Jr. Influence of interimplant distance on gingival papilla formation and bone resorption: clinical-radiographic study in dogs. *Int J Oral Maxillofac Implants* 2006;21:45-51. (27 Refs)**

**Purpose:** To determine clinically and radiographically, the effect of interimplant distance on crestal bone resorption and presence of papillae after prosthetic restoration with a distance of 5 mm between the interproximal contact and the crestal bone.

**Materials and Methods:** Six young adult male mongrel dogs were used in this study. After anesthesia, a flap was raised in the region of the 4 mandibular premolars and the teeth were sectioned in the buccolingual direction and extracted with forceps. After a healing period of 3 months, a horizontal crestal incision was made from the distal of the canine to the mesial of first molar, and implants were placed such that 2 adjacent implants were 2 mm apart (group 1), while the other 2 were 3 mm apart (group 2). During the 12 week healing period, the animals received monthly prophylaxis and after 12 weeks, temporary restorations were fabricated such that the distance between the contact point and the crestal bone was 5 mm. Definitive metallic crowns were also made similarly. 8 weeks after placing the restorations, clinical and radiographic examinations were done. Clinically the distance from the contact point (CP) to the tip of the interimplant papilla (P), and the height of the papilla at the free surface (SF) were measured. Using radiographs, the distance from CP to bone crest (BC), BC to P, and vertical bone resorption at A, B (interimplant regions) and C, D (distal extension regions) were measured. The data were subjected to statistical analysis.



**Fig 4** Diagram showing the clinical measurements made. The CP-P distance was measured, as was the distance between a line extending from the contact point and the tip of the papilla in the distal extension area of the restoration (the CP-DE distance).



**Fig 5** Diagram showing the radiographic measurements made. Bone resorption was measured in the areas between the implants (A/B) and in the distal extension around the implants (C/D). The distances between the contact point and bone crest (CP-BC) and between the bone crest and the papilla (BC-P) were also reported.

**Findings:** No statistically significant differences in distance were noted between the two groups from CP to P, although in group 2 the distance was slightly more. There was a statistically significant difference between CP-P and CP-SF in group 1, but not in group 2. There was no statistically significant difference in distance between the CP and BC in the two groups although the distance was slightly more in group 2. The vertical bone loss at A/B and C/D were slightly greater in group 1 than in group 2 although not statistically significant.

**Conclusions:** In dog mandibles, distances of 2 and 3 mm between implants did not present significant differences in the formation of papilla or in crestal resorption when a prosthetic restoration with 5 mm between CP and BC was fabricated.

**Berglundh T, et al. Histopathological observations of human periimplantitis lesions. J Clin Periodontol 2004;31:341-47. (18 refs.)**

**Purpose:** The purpose of this study was to analyze periimplantitis lesions in man as they present in biopsies obtained from implant sites exhibiting clinical signs of inflammation and progressive bone loss.

**Materials and Methods:** Soft tissue biopsies were obtained from 12 implant sites in six patients. The implants had been in function between 4 and 21 years and were, with one exception from the maxilla. The clinical and radiographic examination performed prior to biopsy revealed that all sites exhibited advanced bone loss, severe inflammation including suppuration, swelling and/or fistula, and seven of the 12 implants were mobile at the time of biopsy. A soft tissue biopsy was obtained from either the mesial or distal aspect of each site and sections were prepared for histometric and morphometric analysis.

**Findings and Conclusion:** All of the biopsies from the implant failure and periimplantitis treatment groups (including mobile and non-mobile implants at removal) had similar histopathological characteristics. A keratinized oral epithelium outlined the biopsies and was continuous with a pocket epithelium. The marginal aspect of the pocket epithelium was wide and exhibited rete ridges that projected into the infiltrated connective tissue. In most sections the inflammatory cell infiltrate reached a position that was apical of the pocket epithelium. The results of the morphometric assessments (MA) of the composition of the inflammatory cell infiltrate showed that in apical, ulcerated areas of the pocket epithelium, deposits of microbial plaque could be observed. The MA also showed that about 60% of the lesions were occupied by inflammatory cells (38.8% plasma cells, 10% collagen, and 9.3% vascular structure, 5.7% fibroblasts, 5.2% macrophages, 6.6% lymphocytes, 4.2% PMN's, and 20.3% residual tissue).

The size of the connective tissue at mobile implant sites was on the average 3.39 squared mm while the corresponding non-mobile implants was 3.88 squared mm. The author concludes that this indicates that the presence of inflammatory lesions in the periimplant soft tissues may not have been influenced by implant mobility.

**Jeffcoat MK. Safety of oral bisphosphonates: Controlled studies on alveolar bone. Int J Oral Maxillofac Implants 2006;21:349-53. (23 refs.)**

**Purpose:** To present safety data from 2 controlled studies of oral bisphosphonates.

**Materials and Methods:**

Study 1) 335 patients (162 males and 173 females, aged 30 to 79 years) with moderate or severe periodontal disease were included in the study. A diagnosis of osteoporosis was not an inclusion criterion for the study. Subjects were randomized to either 70mg alendronate or a placebo once weekly. Initial treatment was done and subjects were examined at 2 clinic visits (screening and baseline) prior to randomization and once every 3 months thereafter for 2 years. Maintenance treatment was performed every 3 months. The primary safety endpoint was osteonecrosis of the jaws (ONJ). Tooth-related safety data, such as caries and gingival index, were obtained. The primary efficacy endpoint was the change in alveolar bone height (ABH).

Study 2) The consecutive analysis of 3-year results was performed from 25 patients (102 implants) receiving oral bisphosphonates (alendronate or risendronate) versus 25 age-matched patients (108 implants) who did not receive bisphosphonates. All patients were postmenopausal women with osteoporosis. Following implant placement, patients were followed for at least 3 years with oral examination, radiographs, and routine maintenance. Coded digital radiographs were used to provide yearly measurements of bone loss and were examined for evidence of ONJ. Mobility, pain, infection, and ONJ were assessed clinically as well.

**Findings:**

Study 1) A significant gain in ABH was seen in the test group (periodontal bone loss 4.16±.11mm baseline, 3.75±.18mm 2 years) relative to the control group (periodontal bone loss 4.22±.13mm baseline, 4.61±.23mm 2 years) in lower mandibular BMD at baseline. This significant difference was not observed in the test group with normal BMD at baseline (4.33±.13mm baseline, 4.49±.21mm 2 years) compared with the control group (4.32±.11mm baseline, 4.31±.18mm 2 years). No cases of ONJ were observed and fewer teeth were lost in the test group than in the control group.

Study 2) 100% of the implants placed in the test group subjects were successful, compared with 99.2% in the control group subjects. There was no significant difference between the 2 study groups.

**Conclusions:** In the 2 controlled studies presented, oral bisphosphonates were not found to pose a risk to alveolar bone compared to placebo.

**Oh TJ, Shotwell JL, Billy EJ, and Wang HL. Effect of flapless implant surgery on soft tissue profile: A randomized controlled clinical trial. J Periodontol 2006;77:872-82.**

**Purpose:** To examine the soft tissue profile changes of single-tooth implants in the premaxillary region after flapless implant surgery.

**Materials and Methods:** 24 patients who required single-tooth implant replacement in the premaxillary region were participated in this study. The subjects were randomly assigned to one of two groups: IL (immediate loading) or DL (delayed loading). The IL group had their implants loaded with a temporary crown in occlusal contact immediately after fixture placement, and the temporary crown was replaced with a permanent crown 10 to 14 days later. The DL group had their implants loaded 4 months after implantation. All patients received a root-form endosseous implant (Zimmer Dental), 3.7 (22 implants) or 4.7 mm (2 implants) in diameter and 10 or 13 mm in length, via a flapless surgery.

The parameters evaluated were implant success rates, the papillary index, marginal levels of the soft tissue, Probing depths, modified bleeding index, modified plaque index, soft tissue thickness, width of the keratinized mucosa, and patient satisfaction. All of the clinical measurements were performed at baseline (at the time of loading), 2, 4, and 6 months after implant loading.

**Results:**

(1) The implant survival rate

- IL: 75 % (9/12)
- DL: 100 % (12/12)

(2) The papillary index

- IL: Continuous increase from baseline to 6 months
- DL: No significant changes from baseline to 6 months
- There were no significant differences between 2 groups.

(3) Marginal levels of the soft tissue

- IL: 0.17 mm at 6 months
- DL: 0.39 mm at 6 months
- There was the difference between 2 groups at baseline, but after that, there was no difference between 2 groups.

(4) Probing depth

- There was no significant difference between 2 groups.

(5) Modified bleeding index

- There was no significant difference between 2 groups.

(6) Modified plaque index

- There was no significant difference between 2 groups.

(7) Width of the keratinized mucosa

- There was no significant difference between 2 groups.

(8) Patient satisfaction

- IL: 1.00 ("excellent" – all)
- DL: 1.17 ("excellent" – 10/12, "good" – 2/12)

**Conclusions:** There is no clinically significant differences between immediate loading and delayed loading implant via a flapless surgery.

**Lindeboom JAH, Tjiook Y, and Kroon FHM. Immediate placement of implants in periapical infected sites: A prospective randomized in 50 patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101: 705-10.**

**Purpose:** To evaluate the outcome of immediate placement of implants when used in the replacement of teeth with chronic periapical lesions.

**Materials and Methods:** 50 patients (25F and 25M, mean age: 39.7 years) were used in this study. All subjects were placed with Frialit-2 Synchro implants in the single tooth of a maxillary anterior or premolar area. All treated teeth showed radiographic signs of chronic periapical periodontitis. After extraction, sterile paper points were inserted into the apical defect of both groups and left in place during 10 seconds for sampling bacterial growth. In the delayed group, the implant surgery was performed after a healing period of 12 weeks. During surgical procedure, primary stability (>25N/cm) of the implants was achieved. In the case of bone augmentation, autogenous corticocancellous bone from retromolar or chin regions was harvested and a bioresorbable collagen membrane (Bio-Gide) was placed.

**Results:**

- (1) Implant success rate
  - Immediate-placed implant group (IP): 92% (23/25)
  - Delay-placed implant group (DP): 100% (25/25)
- (2) Bone resorption
  - Mesial bone: No difference between IP and DP (0.49 mm vs. 0.52 mm)
  - Distal bone: No difference between IP and DP (0.53 mm vs. 0.52 mm)
- (3) Assessment of mid-buccal esthetics
  - Ideal gingival marginal level: IP (61%) < DP (84%)
- (4) Assessment of interdental papilla
  - Both group showed 72% full regeneration of the papilla.
- (5) Assessment of ISQ level at 6 months
  - No difference between IP and DP: 64.5±3.9 vs. 64.5±4.4
- (6) Microbiologic analysis
  - In 21 cases of IP and 20 cases of DP, microorganisms were cultured. The most prevalent bacteria were *Fusobacterium nucleatum* (70%) and *Peptostreptococcus micros* (42%).
  - Cases of the failures of IP: one case showed *Fusobacterium nucleatum* and *Peptostreptococcus micros*, but the other case didn't show any cultured bacteria.
  - No significant difference was found between the 2 groups with regard to periapical flora at the start of treatment.

**Conclusions:** Immediate placement of single tooth implants in the periapical lesions was a predictable treatment.

**Davies JE. Understanding peri-implant endosseous healing. J. Dent. Educ. 2003 Aug; 67(8):932–49.**

**Purpose:** The purpose of this paper is to examine some of the more important concepts and mechanisms that comprise the biological cascade of early peri-implant bone healing.

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

**Findings and Conclusions:** The process of contact osteogenesis, new bone forms first on the implant surface. Since no bone is present on the surface of the implant upon implantation, the implant surface has to become colonized by bone cells before bone matrix formation can begin. This is also what happens at bone remodeling sites where a resorption surface of old bone is populated with osteogenic cells before new bone can be laid down. The common factor linking normal tunneling remodeling and contact osteogenesis is that bone is formed for the first time at the appropriate site by differentiating osteogenic cells. We call this *de novo* bone formation.

In Class III and Class IV bone, optimizing contact osteogenesis by implant surface design to ensure early stability is of great importance because, in the absence of sufficient cortex to provide stability recruitment of osteogenic cells to the implant surface and subsequent bone formation is the only way in which implant stability can be achieved in such bony sites.

The first and most important healing phase, osteoconduction, relies on the recruitment and migration of osteogenic cells to the implant surface, through the residue of the peri-implant blood clot. The most important aspect of early peri-implant healing is the recruitment of osteogenic cells and their migration to the implant surface. Among the most important aspects of osteoconduction are the knock-on effects generated at the implant surface, by the initiation of platelet activation, which result in directed osteogenic cell migration. The second healing phase, *de novo* bone formation, results in a mineralized interfacial matrix equivalent to that seen in the cement line in natural bone tissue. These two healing phases, osteoconduction and *de novo* bone formation, result in contact osteogenesis and, given an appropriate implant surface, bone bonding. The third healing phase, bone remodeling, relies on slower processes.

Healing patterns in cortical and trabecular bone are different and reflect the evolved form and function of this tissue. Cortical healing relies on osteonal remodeling, while trabecular healing can invoke the phenomena of osteoconduction and *de novo* bone formation that, combined, result in contact osteogenesis. Trabecular bone, previously characterized as "poor quality" bone, is far better adapted to rapid healing than cortical bone.

Osteoconduction is a term that encompasses the recruitment and migration of populations of osteogenic cells to the implant surface through the residue of the peri-implant blood clot. Blood cell activities in this initial clot, particularly the activation of platelets and leukocytes, are a function of implant surface microtexture. Osteoconduction, *de novo* bone formation, and bone remodeling are not unique to the peri-implant environment, but also occur, as an outcome of evolutionary development, during both bone remodeling and fracture healing, and can thus be considered as critical hallmarks of bone healing and regeneration.

Peri-implant angiogenesis will also be important at this stage, although currently we know little about the effect of implant surface design on this aspect of peri-implant healing. It can be concluded that treatment outcomes employing endosseous implants are critically dependent upon implant surface designs that optimize the biological responses of early endosseous peri-implant healing.

**Lioubavina-Hack N, Lang NP, Karring T. Significance of primary stability for osseointegration of dental implants. Clin Oral Impl. Res. 17, 2006; 244-50. (39refs.)**

**Purpose:** To examine histologically the significance of the primary stability of titanium dental implants for the establishment of osseointegration during bone augmentation by GTR.

**Materials and Methods:** Sixteen, 6-month-old male albino rats were used. In each of them, muscle-periosteal flaps were elevated on the lateral aspect of the mandibular ramus on both sides. Small perforations in the ramus were produced by means of a round bur. A rigid, non-porous hemispherical Teflon capsule with an internal diameter of 6mm, a height of 4mm and peripheral collar was fixed to the ramus with 4 mini-screws. Prior to fixation, a hole was prepared in the mid-portion of the capsule to fit the circumference of an ITI HC (Hollow Cylinder) titanium implant with a diameter of 2.8mm and a length of 4m. On one side of the jaw, chosen at random, the implant was placed through the hole in such a way its apex did not make contact with mandibular ramus (test). On the other side of the jaw, a similar implant was placed in the hole of the capsule in such a way that contact was made between the implant and the surface of the ramus (control), providing primary stability. After 1, 3, 6, and 9 months, four animals were killed for histological study. The following parameters were assessed: 1) IH; the implant height, the length of the implant surface available for osseointegration, defined as the distance from the contact of the implant with the inner surface of the capsule to the apex of the implant. 2) PIB; the height of the peri-implant bone, from the apex of the implant to the most coronal level of new bone formed in the capsule. 3) OB; the extent of direct bone-implant contact (osseointegration) from the apex of the implant. 4) MOB; the amount of mineralized bone in contact with the implant, the length of mineralized bone-to-implant contact.

**Findings:** All primary stable implants presented increasing percentages of direct bone-to-implant contact during the experimental period, reaching about 80% of the entire implant length after 9 months. Primary unstable implants, on the other hand, failed to present osseointegration at any observation time., despite the formation of considerable amount of new PIB inside the capsules. A gradual increase from 28.1% to 69.6% in mineralized bone-to-implant contact was observed from 1 to 9 months around the primary stable implants. This increase occurred concomitant with the maturation of the newly formed bone that initially had the characteristics of woven bone, but later, presented thickening of the trabeculae and a reduction in the number and size of marrow spaces. The new bone adjacent to the implants was always more mineralized and contained smaller marrow spaces than that located in the periphery of the capsule or the new bone formed around unstable implants. Newly formed bone generated beyond the skeletal envelope by the use of GTR principle may lead to osseointegration.

**Conclusions:** The primary implant stability is a prerequisite for successful osseointegration. Primary instability of implants will result in fibrous encapsulation of the implants.

**Raghavendra S, Wood MC, Taylor TD. Early wound healing around endosseous implants: A review of the literature. *Int J Oral Maxillofac Implants* 2005; 20:425-31. (50 refs.)**

**Purpose:** To provide the clinician with a state-of-the-art review of the current literature related to early wound healing and the creation of an osseointegrated interface between living and nonliving structures.

**Materials and Methods:** Pubmed literature review from January 1997 to June 2004.

**Findings and Conclusions:**

1. Osseous wound healing and osseointegration

- Endosseous wound healing phases: Stage of hematoma, stage of clot resolution, stage of osteogenic cell migration, stage of new bone formation
- Definition of osseointegration (Branemark): A direct structural and functional connection between ordered living bone and the surface of a load-carrying implant. Histologically, this has been defined as direct anchorage of an implant by the formation of bone directly on the surface of an implant, without an intervening layer of fibrous tissue.

2. Osteoinduction and osteoconduction

- Peri-implant bone healing phases (Davies): Osteoconduction, de novo bone formation, and bone remodeling
- Osteoinduction (Albrektsson and Johansson): The phenotypic conversion of mesenchymal cells into bone-forming cells
- Osteoconduction (Albrektsson and Johansson): An appositional bone growth permitting bone formation on a surface or down into pores, channels, or pipes
- Contact osteogenesis (Osborn and Newesley): De novo bone formation directly on the implant surface
- Distance osteogenesis (Osborn and Newesley): Bone formation on the surfaces of existing peri-implant bone

3. Implant surface technology

(1) Implant surface topography

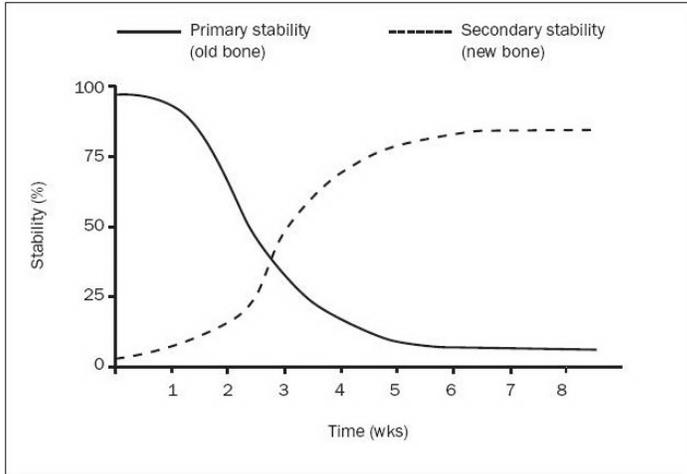
- Additive method: Titanium plasma spraying, hydroxyapatite (HA) coating, plasma coating, magnetron sputter coating, calcium phosphate and/or apatite coating
- Subtractive method: Abrasion through blasting with titanium oxides or other soluble or resorbable biomaterials, sandblasting with aluminous oxides, blasting and acid-attacking or etching
- Anodizing method
- Cold working method
- Sintering method
- Beading compaction method

(2) Implant surface chemistry: Charge affects the hydrophilic or hydrophilic characteristics of the surface. A hydrophilic implant surface is assumed to be advantageous during the initial phase of wound healing and the cascade of events that occurs during osseointegration.

(3) Implant surface roughness and bone formation: Animal studies and human clinical trials have documented the superiority of rough implants surfaces to turned surfaces in regard to survival. Also, there is clear evidence that rough-surfaced implants decrease the integration time and may decrease overall treatment time appreciably.

4. Timeline of osseointegration

The transition from primary mechanical stability, provided by the implant design, to biological stability provided by newly formed bone as osseointegration occurs takes place during early wound healing.



According to a canine model (Berglundh and coworkers), at 4 days following implant insertion, osteoclasts were observed and mesenchymal cells, vascular structures, and densely packed connective were found along the cut surface. At 7 days, first woven bone was seen along the implant surface and along the vascular unit. At 2 weeks, newly formed bone appeared to be extending from parent bone. At 4 weeks, marked formation of woven bone combined with lamellar bone was seen. At 8 and 12 weeks, there were marked signs of remodeling.

The events of wound healing and bone remodeling happen approximately 1.5 times sooner in dogs than would occur in the human. The critical time frame for human would be 2 to 3 weeks postplacement.