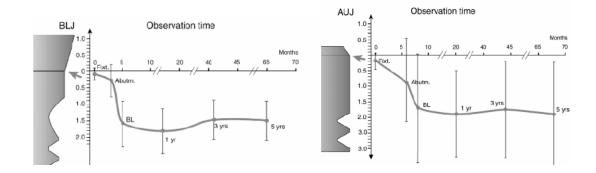
Astrand P, Engquist B, Dahlgren S, et al. Astra tech and Brånemark system implants: a 5-year prospective study of marginal bone reactions. Clin Oral Implants Res. 2004:15;413-20.

**Purpose:** To compare the treatment results with Astra Tech and Brånemark system implants after 5 years of function, primarily with regard to changes in the marginal bone level, and also regarding survival and other clinical parameters of interest.

Materials and Methods: Sixty-six patients with edentulous jaws were included in the study. The mean age of the patients was 61.1 years. The implants used were: 184 Astra Tech implants 3.5mm and 187 Brånemark implants 3.75mm. The implant lengths varied between 9 to 19mm. A two-stage technique was used for installation of both implant system. The healing time was 3 months in the lower jaw and 6 months in the upper jaw. The following clinical variables were recorded at the baseline (delivery of the prosthetic) and at the annual follow-ups: Pain, implant stability, plaque accumulation, BOP, and suprastructure complications. Intraoral radiographic examinations of all implants were performed at baseline, 1, 3 and 5-year follow-ups. For each implant, the radiographs were evaluated regarding marginal bone height and its change over time.

**Findings and Conclusions:** A steady state of marginal bone levels had been established after the baseline examination and that no change of clinical significance occurred during the 5-year follow-up. At the 5-year, the bone level of the upper jaw fixtures was situated 1.9mm from the reference point at Astra Tech implants and 2.2 mm at Brånemark implants. In the lower jaw were 1.1 and 1.9 mm respectively. The marginal bone level changes were not statistically significant over time and there were no differences between the systems. The major postoperative changes of the marginal bone level took place between place between fixture insertion and baseline. The cumulative survival rate after 5 years was 98.4% for the Astra and 94.6% for Brånemark system. The difference in the survival rate was not statistically significant.



Gray JL, Vernino AR. The interface between retained roots and dental implants: a histologic study in baboons. J Periodontol 2004;75:1102-6.

**Purpose:** To evaluate the effects following healing of inadvertent placement of implant s in contact with or in close proximity with retained root tips in baboons.

**Materials and Methods:** The study was conducted on 10 female baboons aged 10-15 years. 12 teeth were extracted from each baboon (the maxillary and mandibular premolars and first molars). 120 loaded and non-loaded implants were placed. Implant placement was done using a full thickness flap approach 6 weeks after the extraction. The implant size was 3.75x10 mm. and were acidetched, pure titanium, self taping, external hex implants. Block sections were obtained. Sections were examined and photographed with a camera mounted on a microscope.

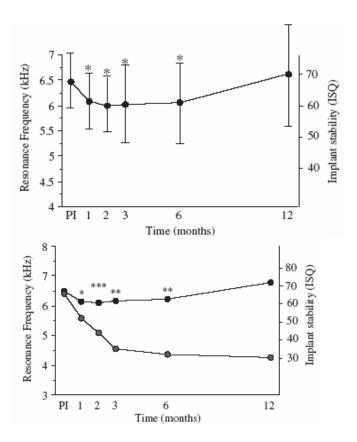
**Findings and Conclusions:** All implants were clinically successful (no mobility, excessive probing depth, or inflammation). 10 implants were histologically determined to be in contact or close proximity with a retained root tip. No apparent inflammation was associated with these implants. Hard tissue deposits were noted on the implant surface in some cases. The collagen fibers between the root and the implant were randomly oriented. It was not possible to determine whether the calcified material was bone or cementum. The presence of root tips did not jeopardize the implant in any way.

Glauser R, Sennerby L, Meredith N. Resonance frequency analysis of implants subjected to immediate or early functional occlusal loading: Successful vs. failing implants. Clin Oral Impl Res 2004; 15 (4): 428-434.

**Purpose:** To analyze the development of implant stability during the first year and possible differences between failing and successful implants according to an immediate/early-loading protocol.

Twenty-three patients received 81 implants and **Materials and Methods:** prostheses according to an immediate/early loading protocol. Immediate implant placement after extraction was performed in 31 sites and GBR procedures were also needed in conjunction with implant therapy in 62 sites. All prosthetic applications were included, such as single crown, or partial and full prostheses. Patients with a smoking history, increased occlusal wear, or existing parafunctional habits were also included in the study. Inclusion criteria required all implants to have primary stability and no pre-existing signs of pathology or acute infections. All implants were placed according to a modified drilling technique designed to allow for low insertion torque during the first 2/3 of each implant and increasing insertion torque for the final 1/3. Implants that required simultaneous GBR were grafted with Bio-Oss and covered with Bio-Gide membrane to cover any implant exposure. All implants were Branemark MKII or MKIV design, ranging in size from 3.75 – 5.0 mm and with a machined titanium surface. Most of the cases (71%) received immediate provisional prostheses, ranging from single crowns to provisional metal or fiber-reinforced framework with acrylic veneering. The remaining patients received provisional restorations no later than 11 days post-operatively, mainly due to technical considerations. These provisional restorations remained in place for 1 year, during the time of study for evaluation purposes. Resonance frequency analysis was performed on each implant at insertion, prothesis connection, 1, 2,3, 6, and 12 months post-operatively. At each evaluation, the provisional prosthesis was removed and a transducer was connected to each abutment for a single implant and Resonance frequency was determined, using multiple transducers, and converted to Implant Stability Quotient (ISQ), ranging from 1 (low) – 100 (high) in measuring stability.

**Findings and Conclusions:** Nine out of 81 implants failed after 1 year, yielding an 11.1% failure rate. However, 47 implants (58%) were lost during follow-up, but were counted as successful. The following chart indicates mean RF and ISQ values for all implants. The ISQ values were statistically decreased from baseline at 1-3 and 6 months post-operatively. Failed implants demonstrated decreasing RF & ISQ values at each interval. After 1 month, only 2 of 9 failed implants were clinically failed and removed. The remaining 7 failed implants were lost during subsequent evaluations, but continued to demonstrate decreasing stability.



Gastaldo J, Cury P, Sendyk. Effect of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of interproximal papilla. J Periodontol 2004; 75: 1242-1246.

**Purpose:** To evaluate the effect of the vertical (distance from the base of the contact point to the bone crest) and horizontal distances between adjacent implants (group 1) and between a tooth and an implant (group 2) on the presence or absence of the interproximal dental papilla; and (2) determine whether the interaction between the vertical and horizontal distances might be associated with the presence of the papilla.

Materials and Methods: 48 patients (28 women, 20 men; mean age, 45 years; range, 19-72) who had implant supported fixed prothesis a minimum of 18 months to 6 years participated. 176 interproximal areas were evaluated: 96 interproximal sites in group 1 and 80 in group 2. All exams were performed by the same person using a specifically designed 0.5mm increment periodontal probe. Readings were rounded to the nearest millimeter or half-millimeter. Clinical parameters assessed were the following: (1) presence/absence of a papilla; (2) distance from the base of the contact point to the bone crest (D1); (3) inter-implant or inter-implant/tooth distance (D2); (4) distance from the base of the contact point to the tip of the papilla (D3); (5) gingival index (GI). Papilla was defined as present when on visual exam it filled the entire proximal space or part of this space and exhibited a triangular or trapezoidal shape. Quantitatively it was measured perpendicularly by the distance from the base of the contact point to the tip of the papilla (D3). Any clinical signs of inflammation excluded that sample from the study. Vertical measurements (D1) were obtained after anesthesia and by inserting the probe vertically on the facial aspect of the contact point until the bone was sounded. Horizontal measurements (D2) was obtained between the shoulders of adjacent implants or implant and tooth surface.

Findings and Conclusions: In group 2 (tooth-implant), when the distance from the base of the contact point to the crest of bone (D1) was between 3 and 5mm, the papilla was present most of the time (p<0.05). The distinction being when D1>5mm then the absence of a papilla became greater than 50%. In group 1 (implant-implant), only when D1 was 3 or 3.5mm was the papilla present most of the time (81-82%) (p<0.05). Anything less or greater than 3-3.5mm, the papilla was either absent completely or achieving only 50% presence. The papilla filled the entire space only when D1 was 3mm in group 1, and 3-4mm in group 2. In both groups, when D2 was 3, 3.5, or 4 mm, the papilla was present most of the time (81-88%). However, when D2 was 2 or 2.5 mm, the papilla was absent 100% of the time (p<0.05). Analysis of the interaction between D1 and D2 found that when D2 was ≤2.5mm, the papilla was absent, independent of D1. Otherwise, when D2 was ≥3mm, an interaction between D1 and D2 was present. The gingival index was recorded as 0 in 94% of the areas and 1 in 6%.

Gapaki R, Wang H, Mascarenhas P, Lang N. Critical review of immediate implant loading. Clin Oral Impl Res 2003;14:515-27. (117 Refs)

**Purpose:** To critically review and analyze currently available literature in the field of immediate implant loading and discuss, based on scientific evidence, factors that may influence this treatment modality.

Materials and Methods: Literature review from past 20 years.

**Findings and Conclusions:** A majority of immediate implant loading studies reported similar success rates when compared to the traditional 2-stage approach (Buser et al 1988, Piattelli et al 1993, Henry and Rosenberg 1994, Salama et al 1995, Bijlani and Lozade 1996, Chiapasco et al 1997, Tarnow et al 1997, Randow et al 199, Scortecchi 1999, Gatti et al 2000, Horiuchi et al 2000, Jaffin et al 2000, Malo et al 2000, Colomina 2001, Cooper et al 2001, Ganeles et al 2001). Nonetheless these finding do not imply that submerged wound healing is no longer necessary. Further studies are needed to identify the appropriate indications that may suit either approach. Several factors may influence the results of immediate implant loading. These could be divided into: surgery-, host-, implant- and occlusion-related factors. Surgery related factors:

Primary implant stability: This is the most important determining factor on immediate implant loading. Functional loading placed on an immobile implant is an essential ingredient to achieve osseointegration. If an implant is placed in the soft spongy bone with poor initial stability, it often results in the formation of connective tissue encapsulation. Micromovement of >100 microns are sufficient to jeopardize healing by forming fibrous encapsulation instead of osseointegration.

Surgical technique: Gentle surgical placement is also a key element. Excessive surgical trauma and thermal injury may lead to osteonecrosis and result in fibrous encapsulation of the implant. It has been shown that temperature over 47 degrees(C) for 1 min causes "heat necrosis" in the bone.

With a proper surgical/prosthodontic technique followed, the crestal bone loss around immediately loaded implants (0.14-0.6 mm) seems to be in the normal range when compared to a submerged protocol.

# Host-related factors:

Bone quality and quantity: Histological data on immediately loaded implants have demonstrated not only a direct BIC, but also a favorable bone quality around the fixtures. An implant placed in compact dense bone is more likely to ensure initial stability and hence better able to sustain such immediate forces. Implants are as stable at the time of placement as when measured at 3-4 months post-surgery, when placed into dense bone (Friberg et al 1999). Fine trabecular bone on the other hand may be unsuitable for immediate loading implant techniques regardless of anatomic location and further studies are needed to understand the predictability function of this type of location.

Wound healing: Metabolic diseases that directly affect bone metabolism such as osteoporosis/penia or hyperthyroidism may influence implant wound healing.

Some data have demonstrated that early load increased BIC and allowed faster remodeling process when compared to unloaded controls (Piattelli et al 1997). Implant related factors:

Implant design/configuration: In general, screw implant design develops higher mechanical retention as well as greater ability to transfer compressive forces. The screw design also minimizes micromotion of the implant and improved initial stability while the thread increases surface area. The cylinder type implant would appear contraindicated for immediate or early loading due to lowering of primary stability and less resistance to vertical movement and shear stress.

Implant surface coating: Rough implant surfaces render a significant increase of BIC. But studies involving immediate loading have shown no significant differences in implant success when surface coating types are analyzed.

Implant length: For every 3 mm increase in length, the surface area of a cylinder-shaped implant increases by an average of 20-30%. One study has reported 50% failure rate with immediate loading for implant lengths <10mm. Though >10mm, >14 mm have been recommended, the critical length and diameter of immediately loaded implants remains to be determined.

# Occlusion-related factors:

Quality and quantity of force: Vertical forces applied during function are less detrimental to implant stability rather than oblique or horizontal forces. It is often suggested that patients with parafunctional habits should be excluded or at least well informed about potential risks involved when immediate loaded cases are being planned.

Prosthetic design: Cross arch splinting as well as potential load and movement caused by prostheses removal should be avoided in immediately loaded implant cases. Careful occlusal analysis, such as assessment of parafunctional habits and distribution of occlusal support by remaining teeth, is also essential when immediately loading implants.

Ganeles J, Wismeijer D. Early and immediately restored and loaded dental implants for single-tooth and partial-arch applications. IJOMI 2004;19(SUPPL): 92-102.

**Purpose:** To summarize findings, data, and conclusions relating to reduced healing times and protocols for single-tooth and partial-arch clinical implant situations

Materials and Methods: Medline literature review and author's opinion

Findings and Conclusions: As defined from the ITI Concensus Conference, "immediate loading" was defined as placement of a restoration in or out of function within 48 hours of implant placement. "Early loading" was defined as placement of a restoration after 48 hour and before 3-6 months post-operatively. A review of six studies on implant survival with early loading indicated a high success rate of 98.2% for 1,046 implants in 611 patients. Each study reported similar short-term success rates, but long-term data was not available. Roughened surface implants, infraocclusion, and surgical techniques for increased initial stability were similar strategies used to achieve high implant success. To create increased initial stability, osteotomy sities were underprepped or the lateral bony walls were condensed with osteotomes before final implant placement. A review of studies relating to immediate restoration and loading of implants revealed similar success rates despite the variety of implant systems utilized. Immediate loading of single-tooth implants demonstrated a 96.7% success out of 287 implants. Similar strategies of surgically maximizing implant stability and eliminating direct occlusal contacts were incorporated in studies of single-tooth implants. Success rates of 82.4 – 100% were observed for single-tooth implants placed into extraction sockets and immediately loaded. Under-drilling, self-tapping, and use of implants with macro-geometric features (threads) were utilized for the majorities of these studies. No differences in success for immediately loaded implants were noted for single vs. multiple tooth situations, except 1 study observed a significantly lower success rate (81%) for single-tooth for machined surface implants. Two studies have compared machined vs. roughened surface implants with immediately loaded restorations and demonstrated significantly high success rates for roughened surface implants, especially with poor bone quality. Studies evaluating immediately loaded implants in various bone types generally utilized an insertiong torque of 30-35 Ncm as a requirement for immediate loading. Soft tissues changes with immediately loaded implants have indicated ~.5 mm gingival recession, comparable to conventionally loaded implants. Limited data is available to suggest immediate restoration of implants maintains gingival contours or provides better esthetic outcomes than conventionally loaded implants.

Fugazzotto PA. Success and failure rates of osseointegrated implants in function in regenerated bone for 72-133 months. Int J Oral Maxillofacial Implants 2005; 20:77-83. (17 Refs)

**Purpose:** The purpose of the study was to evaluate the long term stability of titanium plasma-sprayed (TPS) cylindric implants and the stability of the surrounding regenerated bone under function 72-133 months after placement.

Materials and Methods: IMZ TPS cylindrical implants, cylindrical TPS implants, or TPS threaded Straumann implants, of various lengths and diameters were placed in 319 patients. In all implants, resorbable tricalcium phosphate (TCP) and/or demineralized freeze-dried bone allograft (DFDBA) was used as particulate grafting material with an expanded polytetrafluoroethylene (e-PTFE) membrane. The patients, 181 female and 138 male with a mean age of 49 years, were followed continually through maintenance visits until the time of current statistical compilation. All patients were seen at least every 6 months post-therapy. At that time, all prostheses were removed, the individual implants were examined for mobility, and clinical parameters (Gingival Index, bop, and probing depth to the base of sulcus) were recorded. Radiographs were obtained at yearly intervals and were compared to those taken at the time of implant restoration under 2x magnification. Probing depth measurements were also compared to those made in preparation for the study. Implants were deemed successful if the implant was immobile; there was no pain, suppuration, or peri-implant radiolucency; and vertical bone loss was less than 1.5 mm in the 1<sup>st</sup> year in function and less than 0.2 mm annually in subsequent years in function. Cumulative success rates were calculated using the following formula: CFR=PCFR + IFR x ((100-PCFR)/100) where CFR is the cumulative failure rate, PCFT is the previous cumulative failure rate, and IFR is the number of failed implants during the interval divided by the number of implants at the beginning of the interval.

Findings and Conclusions: A total of 607 implants (331 mx/276 md) were placed in 319 patients and followed for 78-133 months after restoration. In the first 51 months (subject of an earlier publication), 7 implants were lost and 2 were failing. Between 72-133 months, the 2 failing implants at 51 months were lost. One other implant was lost in a patient who received no professional care for 4 years and the exfoliated implant was covered with calculus to within 1 mm of its apex. Two implants were classified as failing and demonstrated 2-3 mm alveolar bone loss on their buccal aspects, but were immobile and did not bleed on probing. After 84 months in function, the cumulative success rate for TPS implants in regenerated bone was 98.8% for the maxilla, 97.4% for the mandible, and 98.3% overall. The cumulative success rates for TPS implants in regenerated bone at 133 months was 97.2% for the maxilla, 97.4% for the mandible, and 97.4% overall. The regenerated bone proved capable of supporting implants and withstanding functional forces in a variety of clinical situations in a healthy, predictable manner. If implants are housed in an adequate quantity of regenerated bone, and problematic implants are identified relatively early after functional loading, these osseointegrated implants should demonstrate long-term success rates comparable to those of implants placed in nonregenerated native host bone.

# Crismani A, Bernhart T, Bantleon H and Cope J. Palatal Implants: The Straumann Orthosystem. Semin Orthod 11: 16-23. (28 Refs)

**Purpose:** To evaluate the criteria for diagnosis, treatment plan, placement, clinical uses, orthodontics mechanics, removal and complications of palatal implants

Materials and Methods: Literature review and author's opinion

**Findings and Conclusions:** Palatal implants are titanium screws with a machined or modified surface (SLA: sand blasted, large grit, acid etched). Two different palatal implants were review in this paper: The flange fixture and the Straumann Orthosystem. The flange fixture implants has been widely used in the palate for maximum orthodontics anchorage. This implant is a 5.5 mm diameter perforated flange, it has a self-tapping screw-shaped endosseous body with a machined surface and length of either3 or 4 mm and threaded diameter of 3.75mm. The Staumann Orthosystem is a single unit self-tapping palatal implant which has a length of either 4 or 6 mm, a diameter of 3.3 mm and a SLA surface. Its 2.5mm transmucosal collar has a highly polished surface. Palatal implants are primarily indicated for maximum anchorage. Also can be used for: Opening or closing spaces in the maxilla, Mesialazing or distalizing maxillary segments, correct intercuspations, and dental asymmetries combined with midline shifts, partially edentulous patients, shifting the point orthodontics force application in the posterior region so that the anterior teeth can be moved in all three dimensions, stabilizing teeth during treatment of Class II or III elastics, if the action of the elastic is to be confined to the mandible and for uni/bilateral maxillary expansions in adults. For treatment planning lateral Cephalograms and dental computed tomography are needed to obtain information about bone volume available in the hard palate and the alveolar bone volume. For placing transmucosal Orthosystem implants, the palatal mucosa is removed with a mucosal trephine and an elevator. Then the pilot hole is created in the cortical bone of the hard palate followed osteotomy preparation with the ortho profile drill. The self-tapping implant is seated in the osteotomy by hand then slowly screwed to place with a ratchet. During the 12-week healing period, the implant is covered with a healing cap. After the healing time they can be loaded directly or indirectly for moving teeth in the upper jaw and, with intermaxillary elastics, also in the lower jaw.

- 1. According to Wehrbein et al. Safety margin in the anterior and middle thirds of the hard palate for palatal implants placement on the basis of lateral cephalograms is approximately:
- 2 mm vertical bone volume 3-4 mm vertical bone volume
- 4-5 mm vertical bone volume
- 2. Bernhart et al. Dental computed tomography (low-dose technique) of the alveolar process found all of the following except:
- 95% of the patients did have enough vertical bone volume for 4mm length implants
- Lower radiation dose results in loss of accuracy
- Vertical bone volume tended to decrease distally
- No changes in image accuracy
- 5% of the patients did not have enough vertical bone volume for 4mm length implants

Covani U, Barone A, Cornelini R, Crespi R. Soft tissue healing around implants placed immediately after tooth extraction without incision: A clinical report. Int J Oral Maxillofac Implants 2004;19:549-553.

**Purpose:** To evaluate implants placed immediately after tooth extraction without incision or primary flap closure and to observe the peri-implant soft tissue healing.

Materials and Methods: Fifteen patients needing extraction of a hopeless tooth with immediate placement of a dental implant were included in the study. Inclusion criteria included: 1) at least 4 mm of bone beyond apex, 2) no acute infection or inflammation, 3) no systemic pathologies affecting bone healing. All patients underwent initial therapy and diagnostic radiographs before any implants were For each surgical procedure, the hopeless tooth was extracted "atraumatically" and the socket was debrided. Implant osteotomy site was prepared with standard drills and implants were placed at the level of the buccal-lingual bony crest. All implants demonstrated good primary stability. Any sites with peri-implant bony defects >2mm were excluded from the study and underwent a GBR procedure with flap reflection. All sites were covered with a patch of benzyl ester of hyaluronic acid and the socket was sutured to partially cover the implant site. Patients were placed on amoxicillin, anti-inflammatories, and chlorhexidine rinse. After 6 months, a 2<sup>nd</sup> stage surgical procedure removed any overlying soft tissue and a healing abutment was placed. The following clinical parameters were measured, utilizing a fabricated acrylic stent, at implant placement and during the 2<sup>nd</sup> stage surgery: 1) implant mobility, 2) levels of mesial & distal papillae, 3) width of keratinized gingiva on buccal surface, 4) position of MGJ, 5) peri-implant radiolucency and marginal bone loss. Periapical radiographs were taken to determine the final 2 parameters with the acrylic stent in place.

Findings and Conclusions: Max. & mand. premolars accounted for 9 of 15 teeth, while 3 max. incisors and 3 max. & mand. canines accounted for the remaining teeth. All implants demonstrated no complications with post-surgical healing. After 1-3 weeks post-operatively, all implants demonstrated soft tissue closure. Only 2 cases displayed cover screw exposure 3-4 months after placement. No peri-implant bony defects were found after  $2^{nd}$  stage uncovering, while 4 implants had excessive bone growth over the top of the cover screw. No peri-implant radiolucencies were noted and no changes to the MGJ were observed. Positions of the mesial and distal papillae were shifted apically .55mm  $\pm$  .24 mm; minimal changes in soft tissue levels were noted. No implants required additional mucogingival surgery to improve soft tissue appearance. Immediate placement of implants after tooth extraction caused no residual peri-implant bony defects and maintained adequate soft tissue architecture for acceptable esthetics.

Chen ST, Wilson TG, Hämmerle CHF. Immediate or early placement of implants following tooth extraction: Review of biologic basis, clinical procedures, and outcomes. Int J Oral Maxillofac Implants 2004; 19(SUPPL): 12-25. (92 Refs)

**Purpose:** To discuss the biologic basis, indications and clinical outcomes of immediate and delayed implant placement.

**Materials and Methods:** A literature review of articles discussing immediate and delayed implants published between 1990 and June 2003.

A MEDLINE search and review of the bibliography from 2 review articles were used to identify articles. Included studies were randomized clinical trials, nonrandomized cohort studies, case control studies and case series which had at least 10 cases. A follow-up period of at least 12 months was required if success and survival rates were reported.

**Findings and Conclusions:** A total of 31 studies met the criteria for inclusion. Eighteen reported survival rates and 19 studies reported clinical radiographic and reentry data. The studies included were not uniform w/ their definitions of immediate, delayed and late. Most studies defined immediate implant placement occurring during the same procedure as extraction of the tooth being replaced. Delayed implants were most often placed 4-8 weeks following extraction. Late placement was 6+ months post-extraction.

Healing of extraction sites. Following extraction of the tooth, healing has been described in 5 stages. The 1st stage is initial clot formation. The 2nd stage occurs over 4-5 days, during which granulation tissue replaces the clot and endothelial cells. Over 14-16 days, connective tissue replaces the granulation tissue. By 7 to 10 days osteoid is seen at the periphery and base of socket. In the 4<sup>th</sup> stage, calcification of the osteoid is evident at the base and periphery and by 6 weeks bone trabeculae fill the socket. The 5<sup>th</sup> stage is characterized by complete epithelial closure in 24-35 days. Maximum osteoblastic activity occurs between 4-6 weeks following extraction, seems to slow down after 8 weeks and is minimal by 16 weeks. Four articles have measured, intraoperatively, the apicocoronal and buccolingual changes following extraction. 3.1-5.9 mm loss in BL ridge has been reported. Schropp (2003) has demonstrated ~50% reduction in BL width, and 0.8 mm apicocoronal height over a 12-month period, most of the change occurring w/in the first 3 months. Radiographic evidence demonstrates, over 12 months, bone formation within the socket occurs simultaneously w/ loss of crest height, again, the majority of these changes occurring in the first 3 months following extraction. The level of bone in the healed socket did not reach the level of bone on adjacent teeth. Although the evidence is insufficient, the rate and pattern of resorption, and potential for complete bone regeneration may be affected by altered socket wall due to pathology or trauma. Clinical Outcomes. Healing of Implant site. Only 6 papers reported comparative data on immediate, delayed and late implant placement. Observation periods ranged from 1-4.5 years. No significant difference was noted on radiographic crestal bone level of probing depths. demonstrated significantly more bone fill and less crestal resorption w/ immediate implant placement in conjunction w/ DFDBA + nonresorbable membrane compared to

using a nonresorbable membrane alone. Other studies have demonstrated less incidence of membrane exposure using collagen membrane as opposed to a nonresorbable membrane. Early placement consistently demonstrated better reduction of dehiscence defects than late implant placement. Defect height reduction and defect area reduction ranged from 86-97% for delayed placement sites and 77-95% for immediate placement sites. The authors suggest that implants be placed within the confines of the socket in order to capitalize on the healing potential of the socket.

**Survival rates**. Eighteen studies discussed survival rates with a follow-up of at least 12 months. With immediate or delayed placement, 3studies demonstrated a 96.1-100% survival rate with hydroxyapatite-coated implants; 8 studies demonstrated 93.6-100% survival rate of machined implants; 2 studies demonstrated 100% survival w/ titanium plasma sprayed; 1 study showed 97% survival w/ grit-blasted/acid etched surface; and 4 studies demonstrated 89.3-99.4% with mixed surfaces. There were no reports regarding the long-term clinical success with regards to peri-implant tissues, function or esthetics. **Local Pathology**. There is insufficient evidence regarding local pathology on the success and survival of immediate implants. Four studies discuss the placement of implants following extraction of teeth due to root fracture, perforation or combined endodontic-periodontic lesions as being similar to healed ridges; however, other studies have demonstrated that teeth with chronic periodontitis have a slightly elevated failure

**Systemic antibiotics**. In most studies broad-spectrum antibiotics were used, however controlled studies are needed to determine the effects on treatment outcome.

rate.

**Bone integration**. Bone healing is dependent on clot stabilization in the space between the implant surface and the wall of the socket. Four studies demonstrate if the horizontal defect, defined and the greatest distance measured perpendicular to the implant surface, 2 mm or less can spontaneous heal and osseointegration occurs if the implant surface is rough. In sites where the defect is >2mm, bone fill is not predictable. Wilson (2003) demonstrated bone fill in this situation using collagen membrane and sandblasted/acid etched surface implants. An animal study showed bone-implant contact improved when a barrier membrane in combination with bone graft.

Clinical Indications. Esthetics. Insufficient evidence is found regarding esthetics w/ immediate implant placement. Nonsubmerged and flapless procedures require further investigation in terms of esthetic outcome. Healing of the soft tissue following extraction allows for more tissue for improved flap adaptation. The authors suggests that soft tissue healing presents an advantage, however, the timing of implant placement should also take into consideration the bone resorption which occurs in the first 3 months.

**Augmentation procedures**. Delayed implants allow for bone regeneration from the base and periphery of the extraction socket. The authors suggest this may decrease the need for augmentation to fill the horizontal defect; however, the resorption of buccal bone which occurs may increase the need for augmentation in the buccolingual dimension. The studies reviewed reported findings of at least 12 months and have demonstrated short-term survival rates and clinical outcomes supporting immediate and delayed implant placement; however, more longitudinal, long-term studies, studies addressing healing of non-submerged implants, esthetic outcomes and augmentation techniques are needed.

Carvalho W, Casado PL, Caula AL, Barboza EP. Implant Dent 2004;13:328-35. (68 Refs)

**Purpose**: To discuss important aspects to plan rehabilitation, using dental implants, in the area of first molars.

**Materials and Methods:** Authors' description and literature review.

Findings and Conclusions: BONE QUANTITY: THE SHAPE AND CONTOUR OF THE RESIDUAL ALVEOLAR RIDGE: Atwood and Tallgreen concluded that the amount of bone loss occurring the first year after tooth loss is almost 10 times greater than the following years and that the posterior mandible resorbs at a rate approximately 4 times faster than the anterior mandible. There are two distinct pathways in the attempt to replace first molars areas using dental implants: 1) preservation of osseous structures, placing (or not placing) an implant immediately into a fresh extraction socket, or 2) augmentation of osseous structures in deficient alveolar ridge sites for oral implant placement. BONE QUALITY: DENSITY IN THE POSTERIOR REGION: Bone density in the posterior maxilla is generally type D4 or D3 and in the mandible D2 to D4. This would lead to the choice of implant design and surface treatment developed specifically to such different types of bone density to increase the BIC. HA sprayed resorbable blast media or acid-attacked implant surfaces have been selected.

OTHER ANATOMIC CONSIDERATIONS: The maxillary first molar region: They include decreased bone quantity, poor bone density and presence of maxillary sinus or antrum (pneumatized). The mean ridge heights range from 9.3 and 3.23 mm, the highest and lowest values being 13.8 and 0.8 mm, respectively. The ridge widths generally proved to be sufficient for placement of endosseous implants. The mandibular first molar region: A prerequisite for the implant surgery on the posterior region of the mandible is the localization of the mandibular canal. CT scans in addition to precise measurement of distance between the bone crest and the mandibular canal hava an additional advantage in presurgical planning, because they reveal the horizontal dimension and shape of the mandible, and the topography and buccolingual location of the mandibular canal. In the study of Tamas, the buccal position of the IAN was observed only in 6% of the mandibles. Oliveira et al. showed an average distance of 14.7 mm from the residual alveolar process and the roof of the mandibular canal in the edentate patient radiographically. The lingual mandibular bone concavity increases the risks of fenestrations or perforations during implant installation, if a proper buccal-lingual angulation is not performed. BIOMECHANICAL CONCERNS: They include unfavorable stress distribution owing to bone density, anatomic reasons that lead to the placement of inadequate number and length of implants and excessive loads compared with anterior regions. Occlusal force correlates positively with muscle cross-sectional size, and its has been known that unilateral Occlusal forces increase as the bite point moves posteriorly, not only because the dental lever arm gets shorter, but because more muscles groups are active. The maximum bite force differs from the mastication force and parafunction can increase these forces as much as 3-fold applying significant stress to the bone-implant interface.IMPLANT SELECTION: 1) Single narrow/ medium diameter implant: Single narrow (3-3.5 mm) or medium (3.75-4 mm) are incapable of predictably

withstanding molar masticatory function and occlusion loading forces. There will be a discrepancy between the implant length and width and the size of the restored crown. Cantilevering forces are created on the crown and implant and these forces could contribute to screw loosening and eventual implant or abutment fatigue or cause periimplant bone loss. To reduce the risk of implant failure and increase the ability of posterior implants to tolerate Occlusal forces, it may be beneficial to create a wider base by using a wide implant (5-6 mm) or placement of two narrow or medium-diameter implants at one site.2) Single wide-diameter implant: Wang et al. evaluated the stress induced in the implants and concluded that under horizontal loads, the maximal stress in bone and implant was highest in 3.25 mm narrow diameter implant, whereas the use of a 5 mm wide diameter or two 3.75 mm implants performed equally. The choice should be influenced by the quality and quantity of the bone and the availability of adequate mesiodistal space. 3) Double narrow or medium-diameter implants: Double implants more closely mimic the anatomy of the roots being replaced and double the anchorage surface area. Saaduon et al. reported that a minimum of 12.5 to 14 mm of interdental space is needed to successfully replace double standard implants for a missing molar. Misch also suggested placing implants on a diagonal position when there is insufficient interdental space and the ridge width is wide. Single versus double implants: Balshi et al. reported a 3 year cumulative success rate of 99% with 0.1 mm marginal bone loss for one implant and 0.24 mm with two implants. The authors hypothesize that the decreased access between the implants in the two-implants could be a contributing factor. Bahat and Handelsman reported higher failure rates for single wide-diameter implant (2.3%) as compared with

double implants (1.6%) placed in the posterior region. **Implant** Clinical situation Advantages limitations selection One narrow Inappropriate emergence ≤7 mm of mesiodistal or medium profile and esthetics diameter Inadequate space biomechanical implant stability Immediate implant Usuallyrequires recent extraction sites or osseous placement Biomechanical grafting One-wide Needs 7-10 stability mm of 8-11 mm of md space diameter Wide abutment buccolingual ridge width implant A "backup/rescue implant" or screw wider implantfor immediate replacement is not available 11-12.5 mm of md space Gain additional space: enameloplasty or orthodontic repositioning Biomechanical Insufficient md space stability More difficult oral hygiene Double Elimination of the narrow or anterior-posterior 12.5 to 14 mm of md medium cantilever space diameter Reduction of the implants rotational forces

Restoring first molars with one wide diameter implant or double implants provides more surface area and better biomechanical properties than single narrow or medium-diameter implants.

loosening

Reduction of screw

Buser D, Martin W, Belser U. Optimizing esthetics for implant restorations in anterior maxilla: anatomical and surgical considerations. Int J Oral Maxillofac Implants 2004;19(suppl):43-61. (66 Refs)

**Purpose**: To present anatomical and surgical considerations for implant therapy that lead to successful esthetics in the anterior maxilla, with long-term stability of the peri-implant tissues.

**Materials and Methods:** Literature review.

**Findings and Conclusions:** The main esthetic objectives of implant therapy from a surgical point of view are the achievement of a harmonious gingival margin without abrupt changes in tissue height, maintaining intact papilla, and obtaining or preserving a convex contour of the alveolar crest.

In 1999 the Swiss Society of Oral Implantology proposed the SAC classification system to categorize the level of difficulty of a given treatment from a surgical and prosthetic point of view. The S represents simple, A advanced and C complex treatment procedures. All esthetic indications have been placed in either the A or C category.

## POTENTIAL CAUSES OF ESTHETIC IMPLANT FAILURE:

Anatomic factors: The concept of biologic width, once described for natural teeth, can also be applied to osseointegrated implants. Animal studies have demonstrated a relative thickness of the peri-implant soft tissues of approximately 3mm. the underlying bone structure plays a key role in the establishment of esthetic soft tissues in the anterior maxilla. Two anatomic structures are important: the bone height of the alveolar crest in the interproximal areas and the height and thickness of the facial bone wall. The interproximal crest height plays a role in the presence or absence of peri-implant papillae. Clinical studies around teeth demonstrate that a distance of 6 mm or more from the alveolar crest to the contact point reduces the probability of intact papillae. The height of peri-implant papillae in single tooth gaps is independent of the proximal bone level next to the implant but is dependent on the interproximal bone height of the adjacent teeth. Having a facial bone wall of sufficient height and thickness is important for long-term stability of harmonious gingival margins around implants and adjacent teeth. Implants in sites with facial bone defects in the absence of bone reconstruction will result in soft tissue recession, potentially exposing implant collars and leading to loss of the harmonious gingival margin.

Latrogenic factors: The relationship of the position between the implant and the proposed restoration should be based on the position of the implant shoulder, because this will influence the final hard and soft tissue response. The implant shoulder position can be viewed in 3 dimensions: orofacial, mesiodistal, and apicocoronal. In the orofacial direction, an implant shoulder placed too far facially will result in a potential risk for soft tissue recession, because the thickness of the

facial bone wall is clearly reduced by the malpositioned implant. It could also lead to restoration-implant axis problems. Implants positioned too far palatally can result in emergence problems, as seen with ridge-lap restorations which can be unesthetic and difficult to maintain. Placement of an implant too close to the adjacent tooth can cause resorption of the interproximal alveolar crest to the level of that on the implant. With this loss comes a reduction in the papillary height. The saucerization which leads to loss of crestal bone on the adjacent teeth has 2 dimensions: the horizontal dimension measures about 1 to 1.5 mm and the vertical dimension amounts to 2mm. This minimal distance needs to be respected on implant placement to prevent vertical bone loss on adjacent teeth. Because this resorption will take place circumferentially it will also affect the height of the facial bone wall and can lead to undesired soft tissue recession. Esthetic failures can also be caused by improper implant selection, mainly because of the use of oversized implants. Wide-platform or wide-neck implants will reduce the amount of interimplant bone and increase the risk of extensive interimplant bone loss.

#### IDEAL IMPLANT PLACEMENT IN THE ANTERIOR MAXILLA:

When planning for an ideal 3-dimensional implant position, a distinction is made between so-called "comfort" and "danger" zones in each dimension: orofacial, mesiodistal and apicocoronal. Implant shoulder and the adjacent root surface should be at least 1 mm apart. With regard to the orofacial dimension, the position of the implant shoulder should be at the ideal point of emergence. In the apicocoronal positioning, the implant shoulder should be approximately 2 mm apical to the midfacial gingival margin of the planned restoration.

#### PRE-OPERATIVE ANALYSIS:

Risk assessment: The goal of risk assessment is to identify patients whose implant therapy carries a high risk of a negative outcome, e.g.: medically compromised (bone diseases, uncontrolled diabetes mellitus), active periodontal disease, smoking, oral hygiene/compliance, II-1 genotype testing and occlusion.

## ANATOMIC SITE ANALYSIS:

An optimal esthetic implant restoration depends on 4 anatomic and surgical parameters: 1) submucosal positioning of the implant shoulder; 2) adequate 3-dimensional implant positioning; 3) long-term stability of esthetic and peri-implant soft tissue contours, and 4) symmetry of clinical crown volumes between the implant site and contralateral teeth.

Orofacial ridge anatomy, including whether there is sufficient crest width and the presence or absence of facial bone atrophy should be assessed. Depending on the extent and morphology of the bone defect, a simultaneous or staged approach is necessary. Mesiodistally, the space should be equal to that of the adjacent tooth (centrals) or the contralateral tooth (laterals and canines). The most critical assessment remains the apicocoronal dimension. Because of the complexity of vertical hard/soft tissue grafting, patients with this condition are placed in high anatomic risk group. Interocclusal space must be assessed. Placing

the long axis of the implant through the incisal edge of anterior teeth is beneficial for patients with excessive vertical overlap. Location of anatomic structures is also important.

## SURGICAL PROCEDURE:

During surgery, the emphasis is on proper implant selection to avoid oversized implants, careful and low-trauma soft tissue handling, and implant placement in a proper position using either a periodontal probe or a prefabricated surgical guide. If missing, the facial bone wall is augmented using a proper surgical technique, such as GBR with barrier membranes and appropriate bone grafts and/or bone substitutes. Finally precise wound closure using a submerged healing modality is recommended. Following a healing period of 6-12 weeks, a reopening procedure is recommended with a punch technique to initiate the restorative phase of therapy.

Bischof M, et al. Implant stability measurement of delayed and immediately loaded implants during healing. A clinical resonance frequency analysis study with sandblasted-and- etched ITI implants. Clin Oral Impl Res 2004; 15:529-39. (54 Refs)

**Purpose:** To generate RFA(resonance-frequency analysis) data with ITI implants and determine the parameters governing the ISQ values at implant placement, and to evaluate the capacity of the RFA method to follow the early interfacial events as the torque test method and, to evaluate the possible changes in implant stability during the healing phase when implants are submitted or not submitted to loading.

Materials and Methods: 18 patients (10 males and 8 females) were classified as delayed loaded group (DL), and 18 patients (9 males and 9 females) as immediate loaded group (IL). The patients with type IV bone or requiring an augmentation procedure were excluded. For the DL group, implant placement (23 in the maxilla and 20 in the mandible) was according to a classical one-stage procedure. For the IL group, the placement (38 in the maxilla and 25 in the mandible) was according to IL protocol, and the prosthesis was placed within 2 days. After 3-4 months of loading, the final prosthesis was delivered. During surgery, implant sites were categorized as follows: type I (7.6%), type II (61.3%), and type III (31.3%). All implants in both groups passed the 1-year control. The ISQ (ISQ value: implant stability quotient value) was measured at implant placement (ISQi), and after 1,2,4,6,8,10, and 12 weeks (ISQf), and ISQ variation (dISQ; between implant placement and the last time point) were measured by Ostell®. The results were statistically analyzed.

Findings and Conclusions: The difference of ISQi and ISQf between the jaws was significant (mandible; 59.8+6.7 (n=61), maxilla; 55.0+6.8 (n=61), and mandible; 63.9+6.0, maxilla; 57.9+6.0, respectively). Only primary stability in type I and III was statistically different. The difference of procedure (immediate or delayed), implant location, the implant diameter, and length did not affect the ISQi and ISQf. Bone quality significantly affected primary implant stability, but did not offset implant stability after 12 weeks. The difference of the variation (dISQ) after 3 month healing was not statistically different. The increase in stability was higher for the implants placed in the mandible (4.1+6.0 vs. 1.9+4.8), the difference was statistically significant. For the maxillary implants, the ISQ increase was statistically significant after 12 weeks only; for the mandibular implants, the ISQ increase was statistically significant after 6 weeks and later. In the DL group, 1 implant (8 mm in type III bone) was failed after 2 weeks, the ISQ i was 48 and the ISQ at failure was 43. In the IL group, 1 implant (8 mm in type III bone) failed after 4 weeks, the ISQ i was 53 and the ISQ at failure was 46. Implant stability varied according to the jaw and bone type. Over a 3-month period, the RFA method did not reveal any decrease in implant stability in both groups, though torque-test method can do. A correlation between the interfacial events and implant stability could not be evidenced, therefore, no conclusion could be achieved on the similarity or dissimilarity of the IL and DL implant healing patterns.

Bernard JP, Schatz JP, Christou P et al. Long-term vertical changes of the anterior maxillary teeth adjacent to single implants in young and mature adults: A retrospective study. J Clin Periodontol 2004; 31:1024-1028.

**Purpose:** To assess the effect of the continuous tooth eruption process on the position of teeth adjacent to implant-born restorations of patients in mature adulthood compared to changes appearing in patients in their late adolescence

Materials and Methods: Twenty-eight patients received 40 implant restorations for replacement of missing anterior teeth. Patients were divided by age into 2 groups: 1) "young adult group" – 14 patients with 21 implants and age range 15.5-21 years & mean age 18.4 years, 2) "mature adult group" – 14 patients with 19 implants and age range 40-55 years & mean age 43.6 years. One tooth adjacent to each implant was used to determine any possible eruption progression after implant placement. Follow-up assessment of implant restorations and "control" teeth was done at 1 year or more (mean time = 4.2 years). Implants and control teeth were checked clinically for PD, GI, mPI, mobility, BOP, and suppuration. Radiographs were taken, using "parallel technique," to evaluate changes since immediately after implant placement. All radiographs were digitized to determine post-placement eruption of control teeth, utilizing different points on implants and control teeth as references. Distances between these reference points were calculated and comparisons between the immediate post-op and follow-up radiographs were performed.

**Findings and Conclusions:** Control teeth and implants remained periodontally healthy throughout the study. For the "young adult" group, all implant restorations demonstrated infra-occlusion with the adjacent teeth. The range of changes in the vertical position of the control teeth as compared to the implants was .1 -1.65mm, with a mean= .69mm. For the "mature adult" group, all patients showed similar results as the "young adult" group with a range of vertical changes .12 -1.86 mm and a mean= .67mm. No differences were found between male and females or position of the implant (canine, lateral, or central). Vertical changes between control teeth and implants were noted for both groups despite the large age difference between patient groups. Clinicians must also consider continued vertical eruption of teeth adjacent to implants in "older" adults, as well as "young" adults.

Basa S, Varol A, Turker N. Alternative bone expansion technique for immediate placement of implant in the edentulous posterior mandibular ridge: A clinical report. Int J Oral Maxillofac Implants 2004;19:554-8. (19 Refs)

**Purpose:** To evaluate the effectiveness of a split-crest bone augmentation technique for concomitant implant placement in thin posterior mandibular ridge.

**Materials and Methods:** 30 patients were selected for the present study. 125 implants (60 tapered Frialit implants and 65 Camlog implants) ranging 4.3-5.5 mm in diameter and either 8, 11 or 13 mm in length were placed in thin edentulous posterior mandibular ridges immediately following crest split. Average buccolingual width was 3-4 mm at crestal level. Buccal concavity was determined via preoperative probing.

- The PRP was prepared before the surgery.
- Patients were sedated using midazolam via IV route.
- One buccal incision was made on the edentulous ridge along with two vertical releasing incisions on buccal and lingual sides.
- Following full thickness flap reflection, a horizontal osteotomy line was cut using a flexible diamond disk. Inferior horizontal osteotomy cut was also outlined. The two horizontal osteotomy outlines were deepened about 2-3 mm in the cortical bone, and united with vertical bony cuts made mesially and distally. Fine osteotomes were used for complete mobilization of the split window.
- After cleaving the outer cortex of the bony window, implants were placed in the 3-4 mm of spongious bone.
- The split crestal bone was placed back to the lateral side of the implants and fixed with a cortical bone screw, which were crossed from the buccal plate to lingual cortex (bicortical fixation).
- The mixture of prepared PRP and Cerasorb (beta tricalcium phosphate) applied to the surface of implants and the residual space created after the split bone window positioned back. Resorbable sutures were placed.
- Antibiotic and analgesic coverage was given to all patients.
- Second stage surgery and implant loading was were initiated after thorough clinical and radiographic evaluation (PA, PANO, and CT), at 3-4 month.

**Findings and Conclusions:** None of the patients complained of lip paresthesia. All implants osseointegrated. Second stage surgery was performed at 3-4 months in all cases. The median Periotest value (PTV) was -4 and five implants showed PRV of 2. The PTVs, radiographs, CT scans and periodontal health were the critical parameters used to determine whether the implants could be loaded at 3-4 months instead of 6 months. Except only 5 implants from 2 patients, 120 implants were loaded at 4 months after simultaneous ridge augmentation via presented surgical technique.

The authors concluded that the presented alternative split-crest technique using mixture of PRP and Cerasorb can shorten the osseointegration period. However, authors also stated that the long-term outcome and evaluation in this case series were limited.

Sütpideler M, et al. Finite element analysis of effect of prosthesis height, angle of force application, and implant offset on supporting bone. IJOMI 2004;19:819-25. (32 Refs)

**Purpose:** To evaluate, through finite element modeling, the effect of an offset on the force transmission to bone-supporting implants aligned ineither a straight-line configuration or an offset configuration, and to examine the differing prosthesis heights and different directions of force application.

Materials and Methods: 3-dimensional finite element analysis (FEA) compared stress distribution of a 3-implant straight-line configuration to a 3-implant configuration with various offset patterns. This benchtop model simulated posterior mandible conditions. Model dimensions were as follows: 1) mesiodistal 25mm; 2) buccolingual 11mm; and 3) superior-inferior 22mm. At superior and inferior surfaces a cortical bone layer of 2mm thick was simulated, all additional bone modeling simulated cancellous bone. 3 titanium implants (3.75mm diameter x 10mm length) were placed 7mm apart (center to center) and 3.5mm from mesial and distal surfaces of the model. An implant supported prosthesis fabricated of type IV gold alloy framework with the following dimensions was simulated (M-D25mm; B-L 11mm; O-G 5mm). Partran finite element software (MSC Software, Santa Ana, CA) was used to create the model. Six different FEA models were created and meshed with 8-node hexahedral solid elements. The models represented the following arrangements: 1) Straight line (no offset); 2) Center implant placed buccal (1.5 mm offset); 3) Center implant buccal (3.0mm offset); and all of these models fitted with a prosthesis at two heights of 6 and 12 mm's. All materials in the FEA were assumed to be homogenous, isotropic and linearly elastic and were assigned Moduli of elasticity and Poisson's ratios to provide model parameters of behavior in order to generate data.200N of force simulating occlusal loading were applied to the center axis of the middle implant through the prosthesis for all conditions of offset, angle of force, or prosthesis height. Forces were applied at 0,15,30,45, and 60 degrees to vertical. Stress in the superior surface of bone adjacent to the implant platform was analyzed. Data were used to determine maximum principal stress (tensile), minimum principal stress (compressive), and Von Mises stress under the different loading conditions.

**Findings and Conclusions:** Lowest stress was observed in direct vertical loading (0 degrees) for all prosthesis heights and all types of stress, and where the offset had only an insignificant improvement in only 2/6 models. Overall, the 3.0 mm offset showed the greatest improvement in stress reduction at all degrees greater than 0 for both prosthesis heights. However, changes in the angle of force application had a greater impact on resultant stress than did the offset, but in all cases the offset was able to compensate and reduce stress.

Olsen S, Ferguson SJ, Sigrist C, et al. A novel computational method for real-time preoperative assessment of primary dental implant stability. Clinical oral implants research 2005:16(1):53-59.

**Purpose:** to establish and experimentally validate a new methodology for planning of implant surgery which incorporates fully automatic, real-time structural analysis.

**Materials and Methods:** An optimized method for rapid finite element analysis (mathematical model) is a methodology that allows for structural analysis during presurgical planning for dental implant placement. This finite element solver is integrated into computer aided planning system for implant surgery. 9 implants were placed in pig mandibles and experimentally loaded and measured with axis-symmetrical benchmark model. The results from axis-symmetrical approach (experimental model) were compared to data from optimized finite element analysis (mathematical model).

**Findings and Conclusions:** No significant differences were found for both analysis and experimental testing. The optimized modeling methodology is able to reproduce the displacement field obtained from axis-symmetric model. A correlation with the prediction of the numerical model and the experimental results was found. Fast structural analysis can be integrated with surgical planning software allowing the initial axial implant stability to be predicted in real-time during planning. This analysis requires no excessive computer power unlike a 3D solid model construction.

Nedir R, et al. Predicting osseointegration by mean of implant primary stability. A resonance-frequency analysis study with delayed and immediately loaded ITI SLA implants. Clin Oral Impl Res 2004;15:520-8.

**Purpose:** 1) to evaluate the Osstell as a diagnostic tool capable of discriminating between stable and mobile ITI implants, 2) to evaluate a threshold implant stability quotient (ISQ) value obtained at implant placement (ISQitv) that might be predictive of osseointegration when assessed after 1 year of loading, 3) to compare the predictive ISQitv of immediate loading (IL) and delayed loading (DL) implants.

**Materials and Methods:** 2 subjects groups participated in this study. 18 subjects received 63 IL implants, of which 38 in maxilla and 25 in mandible. The prosthesis was placed within 2 days of implant placement. The other 18 subjects were treated with 43 DL implants, 23 in maxilla and 20 in mandible. The abutments were placed after a delaying loading period of 3 months. The ISQ was recorded with a transducer at implant placement, after 1,2, 4, 6, 8, 10, and 12 weeks. ISQ data was analyzed statistically.

Findings and Conclusions: 2 implants failed, one IL implant had ISQ at placement (ISQi) of 53, while one DL implant had ISQi of 48. The resonance frequency analysis method was not a reliable diagnostic tool to accurately identifying mobile implants. Implant stability could be reliably determined with ISQ  $\geq$ 47. All implant with ISQi  $\geq$  49 osseointegrated when left to heal for 3 months and all implants with an ISQi  $\geq$ 54 osseointegrated when immediately loaded. For DI implants < 49 ISQ and IL implant <54 ISQ should have a tighter follow-up schedule during healing period. Implants with ISQi 60-69 had their stability decrease during 8 weeks before returning to their initial values. Implants with ISQ>69 had their stability decrease during the 1<sup>st</sup> 4 weeks and remained stable afterward. Authors thought that these data might provide a rough guideline for loading protocols and implant monitoring during the healing phase.

Misch CE, Wang HL, Misch CM, et al. Rationale for the application of immediate load in implant dentistry: Part I. Implant Dentistry 2004;13(3): 207-17. (71 Refs)

**Purpose:** To address surgical trauma, bone loading trauma and treatment plans related to implant number in immediate loading, and to provide rationale for the application of immediate load

Materials and Methods: Literature review and authors' opinion

## **Findings and Conclusions:**

Terminology (according to the authors)

- The immediate occlusal loading protocol; in occlusal contact within 2 weeks.
- Early occlusal loading; in occlusion between 2 weeks and 3 months.
- Delayed or staged occlusal loading; occlusal load after more than 3 months.
- Nonfunctional immediate restoration; no direct occlusal load within 2 weeks primarily in partially edentulous patients.
- Nonfunctional early restoration; delivered prosthesis between 2 weeks and 3months in a partially edentulous patients.

Rationale for Implant immediate Loading. The immediate load concept includes all the advantages of the one-stage approach. The risk of overload could be decreased by splinting the implants. Over the last few years, several authors have reported on immediate loading in the completely edentulous patients, with 95 to 100% success rates.

Surgical Trauma: Alveolar and residual bone has a cortical and trabecular component. The bone is most often lamellar but during repair, such as healing after implant surgery, it becomes woven bone, so that it may respond more rapidly to the surgical trauma. Woven bone may form at a rate up to 60 µm/day, whereas lamellar bone forms at a rate of up to 10µm/day. The osteotomy preparation and insertion of implant cause a regional accelerated phenomenon (RAP) around the implant interface. On the day of surgery, the cellular connection of the implant surface does not yet exist. There is residual cortical and trabecular bone around the implant. Early cellular repair is triggered by the surgical trauma and begins to form an increased vascularization and repair process to the injured bone. Woven bone formation by appositional growth may begin to form as early as the 2nd week at a rate of 30 to 50 um/ day. The implant-bone interface is weakest and at highest risk of overload at approximately 3 to 5 weeks. Roberts reported a devitalized zone of bone for 1 mm or more around the implant as a result of the surgery. Thus, preserving more vital bone by decreasing the surgical trauma (thermal and mechanical) reduces the risk of overload, which may cause microfracture of bone or osteonecrosis along with fibrous tissue encapsulation. Ericksson and Albrektsson reported bone cell death at temperatures as low as 40°C. The temperature next to the drill ranged from 38°C to more than 41°C and required 34 to 58 seconds to return to baseline. The drill rpm of 2,500 produced less heat than when 2,000 rpm was used, and 1,250 rpm created the most heat and the longest recovery period regardless of the drill design. Other factors related to heat generated include the amount of bone prepared, drill sharpness, depth of the osteotomy, variation in cortical thickness, and the temperature of the irrigant. A

self-tapping implant may cause greater bone remodeling (woven bone) during initial healing compared with tapping technique. A proposed protocol for immediate load has been an insertion torque of 45 to 60 Ncm. This concept helps ensure the rigid fixation. However, the additional torque may actually result in damage and remodeling. Periostest, and a reverse torque test of 20 Ncm to evaluate the quality of the initial fixation.

Bone Loading Trauma; Once the bone is loaded, the interface begins to remodel again, but this time, the trigger for this process is strain transfer from occlusal function rather than the surgical trauma. The remodeling from mechanical strain may also be called bone turnover, and not only repairs damaged bone but also allows the implant interface to adapt to its biomechanical situation. Strain is defined as the change in length of a material divided by the original length and is measured as the percentage of change. Bone fractures at 1-2% strain; however, at levels of 20 to 40% of this value, bone starts to disappear or form fibrous tissue and is called the pathologic overload zone. According to Frost, the ideal microstrain level for bone is called the physiologic or adapted zone. The remodeling rate of the bone in the jaws of a dentate human, which is in the physiologic zone, is approximately 40% each year. In the mild overload region, bone begins a healing process to repair microfractures. mineralized This bone less and therefore

Histologic Evaluation: Short Term, Brunski found that the direct bone-implant interface may develop as long as the implant moved less than 100 µm. Szmukler-Moncler et al. indicated that micromotion beyond 150 µm resulted in fibrous tissue encapsulation. Romanos et al. evaluated a square thread implant design and found no statistical difference in monkeys between immediate- and delayed-loaded implants in terms of the bone-to-implant contact ratios (BIC). The bone next to the implants appeared mature and showed evidence of remodeling. A concept of mechanical stimulation around implants during initial healing was evaluated by Rubin and McLeod in 1994. In their animal study, the data demonstrated that brief exposures to low-amplitude mechanical strains could even enhance the bone-implant interface. Testori et al. reported that the BIC was 39% for the submerged, nonloaded implants (4 months) and 64% for the immediately loaded. Degidi et al. evaluated HA-coated square thread design implants in the posterior maxilla of two patients after 4 months of immediate load and observed a BIC range from 78 to 85% with no epithelial migration. Therefore, it appears that immediate loading does not increase risk of fibrous tissue formation, at least under the conditions of these studies.

Histologic Evaluation: Long Term, Piatelli et al. reported that early loaded implants in monkeys lead less marrow spaces and more compact bone than unloaded cases. They demonstrated greater bone contact in immediately loaded implants at 9 months. After 15 months, early loaded implants exhibited greater (almost twice) direct bone contact. In particular, early loaded screws demonstrated thicker lamellar and cortical bone than unloaded implants. This suggests that early occlusal loading may enhance bone remodeling and further increase bone density.

Immediate Load Treatment Plans, If the lower the stress applied to bone (force divided by the functional surface area that receives the load), the microstrain in the bone will be reduced. Therefore, one method to decrease microstrain and remodeling rate is to increase functional surface area. The surface area may be increased in a

number of ways, i.e., implant number, size, design, and body surface conditions. Implant Number In general, two different approaches are proposed; 1): Placing several more implants than the usual treatment plan. Three or more of the implants are then immediately restored with a transitional fixed prosthesis. Enough implants are left submerged for a healing period to allow delivery of a fixed prosthesis, even if all immediately loaded implants fail. If any of the implants survive, they are also used in the final restoration. Schnitman et al. proposed this protocol in 1990 and they suggested that this procedure be used only in the completely edentulous mandible, where moderate to abundant bone was present. Tarnow et al. also reported a similar protocol for a fixed prosthesis (96% survival). 2) Splinting all implants and initially loading all of the implants (1999, Scortecci). Compared with the traditional method, additional implants may also be used. By increasing implant number (rather than three to four implants), stresses on each implant and the risk of overload can be reduced. The increased number of implants not only decreases the risk of overload but also increases of the retention and reduces the number of pontics. Decreases in pontic number also decrease the risk of fracture. This approach helps compensate for the low bone density of maxillae and increased directions of force often found in the The most common number of implants used for a mandibular overdenture in the literature is four splinted implants in the anterior mandibl, and dates back to 1986. Reports of implants in the maxilla for overdentures are very The clinical reports in the literature for partially edentulous recent and are too few. patients missing multiple teeth most often suggest one implant for each missing tooth. Ericsson et al. found two out of 14 failures with immediately loaded single tooth titanium threaded implants (85%) compared with 100% for the staged healing implants. In a study by Malo et al., more implant failures occurred in immediate loading single implant cases (6.3%) than with splinted implants replacing multiple teeth (1.9%). In single tooth cases, implant size, design, or surface condition may be more important, since the implant number cannot be increased. In addition, the occlusal load may be reduced by eliminating the occlusal contacts. For example, Gomes et al. reported 100% survival rate when HA-coated screw-type implants to replace single teeth using a nonfunctional occlusal contact scheme. consider immediate loading protocol, a benefit/risk ratio should be carefully assessed on individual patient basis. A complete edentulous mandible restored with an overdenture supported by four or more implants is a very low-risk condition. If the patient cannot tolerate a mandibular denture and does not wear the device, an immediate load protocol would be a high benefit. The highest risk for immediate loading would be a posterior single tooth implant. Implant number cannot be increased, and implant length cannot engage cortical bone. When the single tooth replacement is out of the esthetic zone, very low benefit is obtained with the immediate restoration approach. Additional clinical studies to evaluate the associated risks, especially in the maxillary arch, are expected over the next several years. Until the profession has longer-term evidence and more multicenter studies, immediate occlusal loading will be a secondary treatment option, restricted on a case-by-case basis.

Hammerle CH, Chen ST, Wilson TG Jr. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. Int J Oral Maxillofac Implants. 2004; 19 Suppl: 26-8.

**Purpose:** To identify predictable and successful procedures for replacing extracted teeth with implant supported reconstructions.

Materials and Methods: Literature review and Authors conclusions.

**Findings and Conclusions:** The group developed a new classification that defined the timing for implant placement. There was a consensus that such a classification should be based on morphological, dimensional, and histological changes that follow tooth extraction and on a common practice derived from clinical experience. The new classification uses numeric descriptors – type 1 to 4 that reflect the hard and soft tissue changes as observed.

#### Consensus Statements:

- Bony healing of extraction sites proceeds with external resorption and a varying degree of bone fill within the socket.
- Implant sites with horizontal defect dimension of 2 mm or less, showed bone healing and ossteointegration of implants with a rough titanium surface. In sites with HDD larger than 2mm or with non-intact socket walls, barrier membranes or membrane supporting materials have been shown to be effective.
- Controlled studies on evaluating the need of systemic antibiotics on treatment outcomes are needed.
- Studies have shown that the survival rates of implants placed immediately is similar to that of the implants placed into healed ridges, similar results have been shown in areas where immediate implantation was done in extraction sockets of teeth associated with pathology.
- There are non controlled studies available evaluating esthetic treatment outcomes.

## Proposed clinical approaches:

- All candidates should meet the same screening criteria as regular implant patients, regardless of the timing of the implant.
- Use of antibiotics is advantageous when augmentation procedures are performed.
- Extraction techniques that result in minimal trauma to hard and soft tissues should be used.
- Factors of concern during site evaluation should include: Overall TX plan, esthetic expectations, soft tissue and bone quality, quantity and morphology, presence of pathology, and finally condition of adjacent teeth and supporting structures.
- Implant placement should be postponed if the residual ridge morphology precludes attainment of primary stability.

- In patients with thin soft tissue biotype, concomitant augmentation therapies at the time of implant placement is recommended, Where as the need for these procedures is reduced in cases of patients with thick soft tissue biotypes.
- The three dimensional positioning of the implant should be restoratively driven.

Hagi D, Deporter DA, Pilliar RM, Arenovich T. A targeted review of study outcomes with short endosseous dental implants placed in partially edentulous patients. J Periodontol 2004:75:798-804.

**Purpose:** Review current literature to determine the success of short implants (≤7 mm)

Materials and Methods: A MEDLINE literature review (1985-2001) was conducted and studies that satisfied the following criteria were included: 1) data suitable to calculate failure rates of implants ≤7mm vs. >7mm; 2) data separated into maxillary vs. mandibular results; 3) clearly defined "failure" criteria (actual implant loss); 4) minimum of 2 years for implant function. This search only revealed 21 studies and only 12 of these studies satisfied the previously mentioned criteria.

Findings and Conclusions: Eight studies included the use of machined threaded implants, while 2 reports involved acid-washed threaded implants and another 2 studies dealt with tapered, press-fit, sintered porous-surfaced implants. From the 8 reports of machined threaded implants, the range of failure rates for maxillary implants were 0 (N=11) - 18.2% (N=22) and mandibular failures were 1.5 (N=66) - 11% (N=37). Not enough data (N=16) on acid-washed threaded implants was available to reach any conclusions. For the sintered porous-surfaced implants, 46 maxillary and 32 mandibular implants resulted in no failures. Logistic regression analysis revealed textured threaded implants were more successful than machined threaded implants. Also, threaded implants performed better at lengths >7mm than ≤7mm. Pair-wise comparisons demonstrated significantly greater success was noted for textured threaded implants in the mandible vs. the maxilla, while machined surfaced threaded implants performed similarly in both arches. Not enough studies or data was available to make any definitive conclusions on implants with short length (≤7mm).