Crestal bone loss around submerged and non-submerged implants during the osseointegration phase with different healing abutment designs: a randomized prospective clinical study.

Sánchez-Siles M¹, Muñoz-Cámara D², Salazar-Sánchez N², Camacho-Alonso F¹, Calvo-Guirado JL³.


Abstract

OBJECTIVE: To evaluate peri-implant crestal bone loss during the osseointegration period, comparing submerged and non-submerged implants with healing abutments of different design.

MATERIALS AND METHODS: A total of 90 Avinent® dental implants (Avinent Implant System, Barcelona, Spain) were placed in 90 patients. All were sited in the posterior mandibular zone to replace teeth 3.6 or 4.6. Patients were divided randomly into three groups: submerged (n = 30), non-submerged with anatomical healing abutment (n = 30), and non-submerged with esthetic healing abutment (n = 30). Peri-implant crestal bone loss was evaluated in intraoral radiographs taken at baseline, 1, and 3 months after implant placement.

RESULTS: Peri-implant crestal bone loss at the end of the (3-month) osseointegration period was lowest in the submerged group (0.11 ± 0.14 mm), followed by the esthetic non-submerged group (0.15 ± 0.06 mm), but without statistically significant difference between these groups (P = 0.234). The greatest bone loss was produced in the non-submerged group with anatomical healing abutments (0.37 ± 0.12 mm), with significant differences between this group and the other two (P < 0.001).

CONCLUSIONS: On the basis of these findings, bone resorption during the osseointegration period using the non-submerged technique varied significantly depending on the morphology of the healing abutment used. The non-submerged technique with an esthetic healing post-produced an equally predictable outcome compared with the submerged technique.
Review finds failure rates lower for delayed loaded submerged dental implants.

McReynolds D\textsuperscript{1}, Duane B\textsuperscript{1}.

Evid Based Dent. 2015 Dec;16(4):112-3.

Abstract

**DATA SOURCES:** PubMed, Web of Science, Cochrane Oral Health Group Trials Register, ClinicalTrials.gov, CenterWatch.com, ClinicalConnection.com.

**STUDY SELECTION:** Randomised and non-randomised studies were included comparing implant failure rates in any group of patients receiving submerged versus immediately loaded non-submerged dental implants. Selection was conducted independently by three reviewers.

**DATA EXTRACTION AND SYNTHESIS:** Titles and abstracts of all reports identified through the electronic searches were read independently by the three authors. Studies were selected based on inclusion and exclusion criteria, with disagreements resolved through discussion. Study quality was assessed using the Cochrane risk of bias tool. Implant failure and post-operative infection were the dichotomous outcome measures evaluated. Weighted mean differences (WMD) were calculated and meta-analysis conducted.

**RESULTS:** Twenty-eight studies, consisting of six randomized clinical trials, 14 controlled clinical trials and eight retrospective analyses were included. 23 studies were considered to be at high risk of bias, one at moderate risk and four at low risk of bias. The relative risk (RR) of failure was higher in immediately loaded implants $RR = 1.78$ (95\% CI: 1.12-2.83). The number needed to treat (NNT) to prevent one patient having an implant failure is 50 (95\% CI: 25-100). Analysis suggests the possibility of publication bias.

**CONCLUSIONS:** The difference between immediately loading and delayed loading of an implant statistically affected the implant failure rate. No statistically significant effects on the occurrence of post-operative infection were observed between the two techniques. Results should be interpreted with caution due to lack of control of confounding factors, the retrospective design of some studies included and the small cohort sizes within the studie.
Immediately loaded non-submerged versus delayed loaded submerged dental implants: a meta-analysis.
Chrcanovic BR¹, Albrektsson T², Wennerberg A³


Abstract

The purpose of the present meta-analysis was to test the null hypothesis of no difference in the implant failure rate, postoperative infection, and marginal bone loss for patients being rehabilitated with immediately loaded non-submerged dental implants or delayed loaded submerged implants, against the alternative hypothesis of a difference. An electronic search without time or language restrictions was undertaken in March 2014. Eligibility criteria included clinical human studies, either randomized or not. The search strategy resulted in 28 publications. The inverse variance method was used for a random- or fixed-effects model, depending on the heterogeneity. The estimates of an intervention were expressed as the risk ratio (RR) and mean difference (MD) in millimetres. Twenty-three studies were judged to be at high risk of bias, one at moderate risk of bias, and four studies were considered at low risk of bias. The difference between procedures (submerged vs. non-submerged implants) significantly affected the implant failure rate (P = 0.02), with a RR of 1.78 (95% confidence interval (CI) 1.12-2.83). There was no apparent significant effect of non-submerged dental implants on the occurrence of postoperative infection (P = 0.29; RR 2.13, CI 0.52-8.65) or on marginal bone loss (P = 0.77; MD -0.03, 95% CI -0.23 to 0.17).

Healing of Bio-Oss® grafted marginal gaps at implants placed into fresh extraction sockets of incisor teeth in dogs: a study on the effect of submerged vs. non-submerged healing.
Mellati E¹, Chen S, Davies H, Fitzgerald W, Darby I.


Abstract

OBJECTIVES: To evaluate the effect of submerged vs. non-submerged (NS) protocols in healing outcomes of grafted marginal defects of immediate implants.

MATERIALS AND METHODS: The second maxillary incisors were extracted bilaterally in six greyhound dogs. Bone level reduced diameter implants were installed into the extraction sockets leaving orofacial gaps of 2 mm wide. Defects were filled with Bio-Oss® and covered with Bio-Gide®. On the one side, the flap was advanced to fully submerge the implant, and on the other, the flap was sutured to allow NS healing. After 3 months of healing, the dogs were sacrificed and block biopsies were obtained to perform histological and morphometric analysis.

RESULTS: All implants were clinically healthy and well integrated into bone. In the majority of the specimens, the original bone in the coronal 2-3 mm of the buccal crest had completely resorbed and was replaced by a regenerated bone wall consisting of Bio-Oss® particles surrounded by newly formed bone. Horizontal and vertical resorption of the buccal bone resulted in ≥1 mm exposure of the implant surface in one-third of implants. Minor differences existed in some aspects of hard tissue healing between submerged and NS.

CONCLUSION: There was very little difference in healing outcomes as well as modelling of the facial bone wall between the submerged and NS protocols in relation to immediate implant placement in this dog model.
Healing of Bio-Oss® grafted marginal gaps at implants placed into fresh extraction sockets of incisor teeth in dogs: a study on the effect of submerged vs. non-submerged healing.

Mellati E, Chen S, Davies H, Fitzgerald W, Darby I.


Abstract

OBJECTIVES: To evaluate the effect of submerged vs. non-submerged (NS) protocols in healing outcomes of grafted marginal defects of immediate implants.

MATERIALS AND METHODS: The second maxillary incisors were extracted bilaterally in six greyhound dogs. Bone level reduced diameter implants were installed into the extraction sockets leaving orofacial gaps of 2 mm wide. Defects were filled with Bio-Oss® and covered with Bio-Gide®. On the one side, the flap was advanced to fully submerge the implant, and on the other, the flap was sutured to allow NS healing. After 3 months of healing, the dogs were sacrificed and block biopsies were obtained to perform histological and morphometric analysis.

RESULTS: All implants were clinically healthy and well integrated into bone. In the majority of the specimens, the original bone in the coronal 2-3 mm of the buccal crest had completely resorbed and was replaced by a regenerated bone wall consisting of Bio-Oss® particles surrounded by newly formed bone. Horizontal and vertical resorption of the buccal bone resulted in ≥1 mm exposure of the implant surface in one-third of implants. Minor differences existed in some aspects of hard tissue healing between submerged and NS.

CONCLUSION: There was very little difference in healing outcomes as well as modelling of the facial bone wall between the submerged and NS protocols in relation to immediate implant placement in this dog model.
A Comparative Study of Clinical Parameters in Submerged and Non-submerged Implants.

Torkzaban P\textsuperscript{1}, Arabi SR\textsuperscript{2}, Roshanaei G\textsuperscript{3}, Rostami M\textsuperscript{4}, Soheilifar S\textsuperscript{5}.


Abstract

AIM: The aim of this study was to evaluate and compare the radiographic bone loss and soft tissue parameters around one stage and two stage implants.

MATERIALS AND METHODS: Twenty four patients with submerged implants and twenty four patients with non-submerged implants at the time of loading were assessed in this prospective cohort study. The soft tissue assessment included probing depth (PD), papilla index (PI), mucosal thickness (MT) and keratinized tissue (KG); another parameter assessed was the radiographic distance between the shoulder of the implant and alveolar crest evaluated at baseline (loading time) and 3, 6 and 12 months after loading in both groups. Data were analysed using repeated measures analysis of variance (ANOVA) and multiple comparisons were done using LSD method.

RESULTS: The changes in the soft tissues including PD, KG, MT and PI had no significant differences in either group. The amount of bone loss 3 and 6 months after loading was significantly greater in one stage implants (0.93±0.45 mm at 3 months and 1.45±0.58 mm at 6 months, for one stage and 0.32±0.21 mm at 3 months and 0.74±0.43 mm at 6 months for two stage group). But the change of this index 12 months later was not significantly different between the two groups (1.87±0.76 mm for one stage and 1.65±0.59 mm for two stage group).

CONCLUSION: Based on the results of this study there is no difference in hard and soft tissue changes one year after loading of one or two stage implants.

Clinical and radiologic outcomes after submerged and transmucosal implant placement with two-piece implants in the anterior maxilla and mandible: 3-year results of a randomized controlled clinical trial.

Sanz M\textsuperscript{1}, Ivanoff CJ, Weingart D, Willfang J, Gahlert M, Cordaro L, Ganeles J, Bragger U, Jackowski J, Martin WC, Jung RE, Chen S, Hammerle C.


Abstract

PURPOSE: The aim of this investigation was to evaluate the 3-year outcomes regarding crestal bone level, clinical parameters, and patient satisfaction, following submerged and transmucosal implant placement for two-piece implants in the anterior maxilla and mandible.

MATERIALS AND METHODS: Patients requiring dental implants for single-tooth replacement in the anterior maxilla or mandible were enrolled in a randomized, controlled, multicenter clinical trial. The implants were randomized at placement to either submerged or transmucosal healing, with final restorations placed after 6 months. Radiographic and clinical parameters were recorded after 1, 2, and 3 years; a questionnaire was also used to assess patient satisfaction. A two-sided, unpaired T-test (significance level p ≤ .05) was used to statistically evaluate the differences between the two groups.
RESULTS: A total of 106 patients were included in the 3-year analysis. The mean change in crestal bone level from implant placement to 3 years was $0.68 \pm 0.98$ mm ($p < 0.001$) and $0.58 \pm 0.77$ mm ($p < 0.001$) in the submerged and transmucosal groups, respectively; the differences between the groups were not significant. Clinical parameters remained stable throughout the study, with no significant differences between the groups, and patient satisfaction was good or excellent for over 90% of subjects in both groups.

CONCLUSIONS: The results demonstrate excellent clinical and radiographic conditions after 3 years for implants supporting single-tooth restorations, regardless of whether a submerged or transmucosal surgical technique was used.

Clinical evaluation of submerged and non-submerged implants for posterior single-tooth replacements: a randomized split-mouth clinical trial.

Nemli SK¹, Güngör MB², Aydın C², Yılmaz H², Türkcan I³, Demirköprülü H⁴.


Abstract

The aim of this study was to evaluate clinical and radiographic results of submerged and non-submerged implants for posterior single-tooth replacements and to assess patient-based outcomes. Twenty patients were included in the study. A split-mouth design was used; implants inserted using a submerged technique were compared to those inserted with a non-submerged technique. Implants were restored with metal-ceramic crowns after 3 months. Reconstructions were examined at baseline, 6, 12, and 24 months. Standardized radiographs were made. Radiographic crestal bone level changes were calculated, as well as soft tissue parameters, including pocket probing depth, bleeding on probing, plaque index, and gingival index. Results were analyzed by two-way repeated measures of variance (ANOVA). To evaluate patient-based outcomes, patients were asked to complete a questionnaire at the 6-month follow-up; the Wilcoxon paired signed rank test was used to compare scores. The data of 18 patients were reviewed. During 24 months, non-submerged implants ($0.57 \pm 0.21$ mm) showed significantly lower bone loss than submerged implants ($0.68 \pm 0.22$ mm) ($P<0.01$). Patient satisfaction with non-submerged implants (median 87.5) was significantly higher than with submerged implants (median 81.5) ($P<0.01$). Non-submerged implants showed comparable clinical results to submerged implants and resulted in higher patient satisfaction due to decreased surgical intervention.
Clinical outcome of submerged vs. non-submerged implants placed in fresh extraction sockets.
Cordaro L¹, Torsello F, Roccuzzo M.


Abstract

AIM: The aim of this study was to compare the clinical outcome of submerged vs. non-submerged tapered implants placed into fresh extraction sockets.

MATERIALS AND METHODS: A prospective, controlled, multicenter, randomized, clinical trial has been performed in two centers in Rome and Torino (Italy). Thirty healthy patients were recruited according to the following inclusion criteria: need for an immediate post extraction implant, ages between 18 and 70, horizontal defect depth <2 mm, smokers <10 cigarettes/day and absence of any circumstance or condition that could represent contraindications to implant surgery. The patients were randomly allocated to submerged or non-submerged treatment groups immediately after flap elevation and tooth extraction. Submerged implants were exposed 8 weeks after the first surgery; all implants were loaded with provisional restorations 12 weeks after the first surgery and with definitive restoration 12 weeks thereafter. Clinical and radiographic parameters were evaluated at baseline, at implant loading and at the 1-year follow-up visit.

RESULTS: The results showed statistically significant differences between the two groups in the mean value of keratinized tissue (KT) height after surgery that was significantly reduced for submerged implants when compared with transmucosal implants (mean reduction of KT at year follow-up: T group 0.2 mm, S group 1.3 mm; P=0.007).

CONCLUSION: Similar outcomes were found for submerged and non-submerged implants placed in fresh extraction sockets with a horizontal peri-implant defect smaller than 2 mm, except for a reduction of KT in the submerged group. Either with a submerged or a non-submerged procedure, 1 mm of mean soft tissue recession is seen after 1 year when compared with the pre-extraction situation.
12 weeks thereafter. Clinical and radiographic parameters were evaluated at baseline, at implant loading and at the 1-year follow-up visit.

**RESULTS:** The results showed statistically significant differences between the two groups in the mean value of keratinized tissue (KT) height after surgery that was significantly reduced for submerged implants when compared with transmucosal implants (mean reduction of KT at year follow-up: T group 0.2 mm, S group 1.3 mm; P=0.007).

**CONCLUSION:** Similar outcomes were found for submerged and non-submerged implants placed in fresh extraction sockets with a horizontal peri-implant defect smaller than 2 mm, except for a reduction of KT in the submerged group. Either with a submerged or a non-submerged procedure, 1 mm of mean soft tissue recession is seen after 1 year when compared with the pre-extraction situation.

---

**Clinical analysis of the soft tissue integration of non-submerged (ITI) and submerged (3i) implants: a prospective-controlled cohort study.**

Garcia RV, Kraehenmann MA, Bezerra FJ, Mendes CM, Rapp GE.


**Abstract**

AIM: The aim of this study was to compare the soft tissue integration of submerged and non-submerged implants by means of periodontal parameter assessments and analysis.

MATERIAL AND METHODS: Thirty-one patients, who received 42 non-submerged implants (ITI) and 48 submerged implants (3i), participated in the study. There was no significant difference (P>0.05) between both groups considering gender; educational level; handedness; toothbrushing frequency; the number of auxiliary devices used; and smoking habits. The parameters assessed were gingival index (GI), plaque index (PII), retention index (RI), pocket probing depth (PPD) and keratinized mucosa index.

RESULTS: At evaluation, 66.67% of all sites showed a GI of 0; 72.22% a PI of 0, and 93.33% the absence of calculus. The average PPD was 2.56 mm in the non-submerged and 2.70 mm in the submerged group. With regard to the width of keratinized mucosa, 100% of the ITI implants showed a band of keratinized gingiva around the implant, whereas 14.58% in the 3i group showed a complete absence of keratinized mucosa. The intra-examiner reproducibility was 90.96% for all parameters and the Kendall tau-b analysis showed a powerless correlation between the chosen parameters for both studied groups.

CONCLUSIONS: The study material showed no major differences between submerged and non-submerged dental implants regarding GI, PII, RI and PPD, except the width of keratinized mucosa. Regarding the presence of keratinized mucosa, there is a need for further longitudinal studies to elucidate a possible benefit of one implant system over the other.
Effects of surface hydrophilicity and microtopography on early stages of soft and hard tissue integration at non-submerged titanium implants: an immunohistochemical study in dogs.

Schwarz F, Ferrari D, Herten M, Mihatovic I, Wieland M, Sager M, Becker J.


Abstract

BACKGROUND: The aim of the present study was to investigate the effects of surface hydrophilicity and microtopography on soft and hard tissue integration at non-submerged titanium implants.

METHODS: Implantation of conventional sand-blasted large grit and acid-etched (SLA) and chemically modified SLA (modSLA) titanium implants with differently structured transmucosal surfaces (SLA implants: machined [M-SLA] or SLA [SLA-SLA]; modSLA implants: mod acid-etched [modA] [modA-modSLA] or modSLA [modSLA-modSLA]) was performed bilaterally in the upper and lower jaws of 15 beagle dogs. The animals were sacrificed after 1, 4, 7, 14, or 28 days. Tissue reactions were assessed histomorphometrically and immunohistochemically using monoclonal antibodies to transglutaminase II (angiogenesis) and osteocalcin.

RESULTS: Although the junctional epithelium commonly was separated from M-SLA and SLA-SLA implants by a gap, the epithelial cells appeared to be in close contact with modA-modSLA surfaces after 14 days of healing. Moreover, modA-modSLA and modSLA-modSLA groups showed a well-vascularized subepithelial connective tissue exhibiting collagen fibers that started to extend and attach partially perpendicular to the implant surface. The highest and statistically significant mean bone-to-implant contact areas were observed in the modA-modSLA and modSLA-modSLA groups at days 7, 14, and 28.

CONCLUSION: Within the limits of this study, it may be concluded that soft and hard tissue integration was influenced mainly by surface hydrophilicity rather than by microtopography.
Submerged or non-submerged healing of endosseous implants to be used in the rehabilitation of partially dentate patients.
Cecchinato D, Olsson C, Lindhe J.

Abstract

OBJECTIVE: To evaluate bone-level alterations that occurred at implants of the Astra Tech(R) System that were placed in the load carrying, posterior parts of the dentition using either a submerged (two-stage) or a non-submerged (one-stage) installation protocol.

MATERIAL AND METHODS: Eighty-four patients that required 115 fixed partial dentures (FPDs or cases) entered the prospective study. All subjects were assigned one patient and > or =one case numbers. For the randomization of cases, a custom-made program based on balanced random permuted blocks was utilized. The cases were assigned to two treatment groups, namely one-stage installation procedure, non-submerged technique (group A) and two-stage installation procedure, submerged technique (group B). Several subjects contributed with cases to both groups A and B. Periodontal, endodontal and open caries lesions were treated prior to implant installation. All patients received careful oral hygiene instruction and training in self-performed plaque control measures. The surgical technique used for fixture installation followed the outline described in the manual for the Astra Tech System. The FPDs were placed 3 months (mandible) and 6 months (maxilla) following implant installation. Immediately following FPD placement, a baseline examination was performed that included assessment of plaque, soft-tissue inflammation and bone level. Clinicians who were otherwise not involved in the study performed the radiographic measurements. Clinical and radiographical examinations were repeated once a year after the baseline examination.

DATA ANALYSIS: The primary outcome variable was the change in the bone level at the implants from the time of placement of the bridge (FPD) to the 1- and 2-year reexaminations. Fisher's permutation test was used to test if differences existed between groups A and B, and between patients (men/women, smokers/non-smokers, age), sites (maxilla/mandible) and implants (length, diameter). Pitman's test was used to study correlations between bone shape and quality data and different radiographic bone-level data.

RESULTS: It was demonstrated that tissue healing following implant installation appeared to be independent of the surgical protocol, i.e. whether the marginal portions of the implants during surgery were fully or only partly submerged under the ridge mucosa. Thus, (i) in both treatment groups the number of implants that failed to osseointegrate (early failures) was small (<2%); (ii) at the end of the recommended periods of bone healing prior to loading, - in both groups, maxilla=6 months and mandible=3 months - the level of the marginal bone was close to the coronal rim of the fixture; group A: 1.54+/-.92 mm, group B: 1.31+/-.77 mm. The current study also demonstrated that irrespective of surgical protocol (two-stage, one-stage), implants supporting the FPDs exhibited only small amount of radiographic bone loss during the first year of function (group A: 0.02+/-.038 mm, group B: 0.17+/-.064 mm). Moreover, during the second year of function, the amount of additional bone loss that occurred in the two treatment groups was close to zero.

CONCLUSION: Perimplant bone-level change during function seemed to be unrelated to whether initial soft- and hard-tissue healing following implant installation had occurred under submerged or non-submerged conditions.