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Soft tissue contour changes at immediate implants: a randomized controlled clinical study

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Background: Alveolar crest undergoes substantial resorption after tooth extraction and bone resorption occurs irrespective of simultaneous implant installation, while socket preservation techniques seem to be effective in limiting the remodeling of the alveolus.

Aim: Aim of the present study was to evaluate whether the insertion of immediate single implants into fresh extraction sockets with the use of bone substitute and collagen membrane could preserve the tri-dimensional bone ridge volume, when compared to immediate implants inserted into fresh extraction sockets without any bone regeneration technique.

Methods: Fifty-two patients requiring single tooth extraction from second premolar to second premolar, and presenting intact bone walls of the alveolus, were selected for a total of 52 sites. The study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000. After tooth removal, 52 tapered implants (Nanotite Certain, Biomet/3i) were immediately inserted into the extraction sockets. 26 implants (test) were randomly allocated to fill the bone-to-implant gap with a bovine bone substitute (Bio-Oss) and protect with a collagen membrane (Bio-Gide), while 26 implants (control) were allocated to leave the bone-to-implant gap heal spontaneously. Prosthetic rehabilitation was scheduled 3 months after installation. A power calculation was performed. At baseline (T0) and 12 months after surgery (T12), dental casts from impressions were fabricated in order to outline the soft tissue contour at the implant sites. A reference sylicone stent outlined the most prominent points buccaly and lingually of the ridge. Ridge witdh (horizontal dimension) was measured at T0 and T12. Similarly, ridge height (vertical dimension) was assessed as the perpendicular distance between the midpoint of the implant site and the line connecting the most occlusal and buccal surfaces of the adjacent teeth. Data were analyzed using two-tailed paired *t*-test at T0 and T12. Intergroup comparisons was made using *t*-test for indipendent data.

Results: At T12 success rate was 100% and 96.43% for test and control sites respectively. Horizontal dimension reduction was 0.69 ± 0.68 mm (corresponding to 8.13%) in test sites and 1.92 ± 1.02 mm (21.62%) in control sites. The difference between the two groups was statistically significant ($P = 0.000$). Similarly, test sites showed significantly lower reduction in ridge height than the control sites (0.58 ± 0.77 vs. 1.69 ± 1.74 mm; $P = 0.004$).

Conclusions and clinical implications: Immediate implant installation concomitant with the use of a bone substitute to fill the bone-to-implant gap considerably limits the amount of horizontal and vertical soft tissue alteration when compared to implant installation alone, with fairly stable aesthetics outcomes at 12 months.

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Three-year soft and hard tissue outcomes of immediately placed implants

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Background: There is evidence that immediately placed implants result in short term bone changes, mainly in apical and bucco-lingual reduction of the buccal alveolar crest.

Aim: To evaluate the soft and hard tissue response around immediately placed implants in the maxilla after three years in function.

Methods: Adults in need of single tooth extraction within the region 15–25 were recruited at three centres. After tooth extraction, sites with intact socket walls were randomized to receive either conical or cylindrical implants (OsseoSpeed™, Astra Tech, AB). Implants were immediately placed after extraction and Permanent Crowns (PR) delivered after 22 weeks (loading). Patients were followed for 3 years from PR. Bone tissue adaptation was evaluated from radiographs taken at implant placement, PR and 1, 2 and 3 years after PR. Marginal Bone Level (MBL) was evaluated on radiographs as the distance from the top of the machined bevel surface (rim) to the most coronal implant-bone contact point. Soft tissue adaptation was evaluated at PR and 1, 2 and 3 years after PR. Gingival Zenith (GZ) was measured clinically as the distance from the soft tissue margin to the crown margin. Mesial and distal papillae were classified as defined by Jemt.

Results: Ninety-three patients were randomized to receive 48 conical and 45 cylindrical implants, respectively. 48 were males and 45 females, with a mean age of 51 ± 13 years (mean ± 1 SD) (range 19–80 years). 36% were smokers and 63% non- or ex-smokers. Only one implant was lost prior to loading. The majority of the implants were placed in the premolar region (58%) and 42% replaced incisors or canines. Mean MBL at PR was 0.67 ± 0.76, 0.61 ± 0.57 mm at PR + 1 years, 0.54 ± 0.54 mm at PR + 2 years and 0.51 ± 0.51 mm at PR + 3 years. Mean MBL gain from PR to three years was 0.17 ± 0.67 mm (range −1.4 to 2.6 mm). Mean GZ gain from PR to three years was 0.23 ± 1.2 mm (range −2 to 5 mm). At PR, 30% of the mesial and distal papillae were scored '>50%'

or 'Complete', at PR + 3 years this value increased to 79% and 72% for the mesial and distal papillae, respectively.

Conclusions and clinical implications: Soft and hard tissues were stable over the 3 year study period for immediately placed implants in the maxilla.

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Immediate placement and provisionalization of single-tooth implants involving a definitive individual abutment

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Background: The outcome of implant therapy involving immediate implant placement has been evaluated in recently published systematic reviews. Immediate implant installation can be combined with immediate provisionalization using a provisional or a definitive abutment. It was concluded that the knowledge about the treatment outcome of immediate placement and provisionalization of single-tooth implants is limited, why further studies are needed before final conclusions can be made.

Aim: To assess with a mean follow-up period of 33 months (median: 31 month, range: 11–89 month) the treatment outcome after immediate placement and provisionalization of single-tooth implants involving a definitive individual abutment and a provisional crown followed by later placement of a definitive crown.

Methods: Of the 55 patients with 55 single-tooth implants in the esthetic zone were consecutively treated in the study. The treatment involved tooth extraction, implant placement, placement of a definitive individual abutment, and a provisional crown in the same visit in private practice. The definitive crown was placed after a mean period of 7 months. The primary outcome measures included implant survival, definitive implant crown survival, and overall treatment survival. The secondary outcome measures included probing depth, bleeding on probing, peri-implant marginal bone level, marginal bone level of the neighbouring tooth surfaces, biological complications, and technical complications.

Results: Of the inserted implants 98% survived and of the definitive crowns mounted a survival of 100% was observed. Consequently, the overall treatment survival was 98%. The mean probing depth was 2.9 mm at implant level and 63% of the implants were characterized by no bleeding on probing. The mean peri-implant marginal bone level was 2.0 mm. A significant mean peri-implant marginal bone level gain of 0.5 mm was observed from implant placement to the follow-up (95% CI: 0.07–0.89 mm, $P = 0.022$). No significant changes of the marginal bone level at the neighbouring tooth surfaces were seen. Four episodes of peri-implant inflammation were identified in three patients, while 46 incidents of loosening of the provisional crown occurred in 33 patients. One abutment screw loosened before placement of the definitive crown. Finally, loosening of four definitive crowns occurred in four patients.

Conclusions and clinical implications: Immediate placement and provisionalization of single-tooth oral implants involving a definitive individual abutment and a provisional crown, followed by later placement of a definitive crown was characterized by high survival of the implant crowns and implants as well as healthy peri-implant tissues, after a mean follow-up period of 33 months. Loss of retention of the provisional crown occurred frequently.

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One-step vs. two-steps flapless placement of two-stage dental implants

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Background: Beside the advantages of flapless surgery, the influence of oral environment upon implants integration in one-step surgery is still incompletely studied.

Aim: Establishment of the influence of one-step flapless approach and gingival biotype upon crestal bone loss and implant stability.

Methods: Sixty-five partially edentulous patients (40.8 ± 0.39 years) had 167 two-stage dental implants inserted in posterior sides of the mandible by flapless method (Alpha-Bio; 3.3–5.0 mm diameter and 8–13 mm length). Eighty-five implants were inserted by two surgical steps (Control) and 83 implants – in one-step (Study, with immediate healing abutment connection). Each group was divided in two subgroups according to the gingival biotype: Study-A and Control-A-thin biotype (≤ 2 mm), Study-B and Control-B-thick biotype (>2 mm). Implant sides were divided into anterior and posterior ones. After a mean healing period of 3.0 ± 0.12 months, the second surgical step for implants in Control-Group was performed. Periotest values (at the end of the healing period) and crestal bone loss were evaluated (Autodesk Design Review – 2011). Statistical analysis was made by calculating mean values, standard errors, indices of Student's paired *t*-test and Pearson correlation test.

Results: After the healing period, crestal bone loss for anterior and posterior sides had the following values: Study – 0.8 ± 0.09 and 0.6 ± 0.12 mm, Study-A – 0.8 ± 0.09 and 0.6 ± 0.13 mm,

Study-B – 0.2 ± 0.18 and 0.4 ± 0.13 mm; Control – 0.3 ± 0.08 and 0.8 ± 0.09 mm, Control-A – 0.3 ± 0.08 and 0.4 ± 0.07 mm, Control-B – 0.4 ± 0.10 and 0.5 ± 0.10 mm. Mean Periotest Values were: Study-group −5.4 ± 0.14; Study-A −5.4 ± 0.14, Study-B −4.9 ± 0.54; Control −5.2 ± 0.13, Control-A −5.2 ± 0.14, Control-B −5.3 ± 0.06. Statistical significant difference of bone loss was noticed only in anterior sides of the following groups: Study and Control ($P < 0.001$), Study-A and Study-B ($P < 0.01$), Study-A and Control-A ($P < 0.01$). Mean Periotest values as well as bone loss in the other groups showed no statistical difference ($P > 0.05$). The correlation between gingival biotype and bone loss was: Study-rxy = −0.069 for posterior sides and rxy = −0.225 for anterior sides; Control-rxy = 0.113 and rxy = 0.106 respectively.

Conclusions and clinical implications: Thin gingival biotype lead to a bigger resorption around implants installed in one-step than those installed in two-steps or in sides with thick gingival tissue. The presence of greater bone-loss only in anterior sides can be explained by close or subcrestal position of the microgap due to ascending alveolar ridge. The lack of statistical difference between values of bone loss in other subgroups and the presence of a mature biological width in Study-Group demonstrates a good predictability of one-step approach. One-step placement and gingival biotype don't affect implant stability.

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The implant position influence upon crestal bone using one-step flapless surgery

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Background: Implant-abutment junction is one of the factors which may cause peri-implant bone loss. Due to particularities of flapless approach, it is necessary to establish optimal relation between the bone crest and implant-abutment junction.

Aim: To establish the influence of two-stage dental implant platform position upon crestal bone during healing period in case of one-step flapless placement.

Methods: Forty-two partially edentulous patients (39.5 ± 0.33 years) had 83 two-stage dental implants (Alpha-Bio; 3.3–5.0 mm diameter and 8–13 mm length) inserted in posterior sides of the mandible by one-step flapless method (with immediate connection of healing abutments). Implant sides were divided into anterior and posterior ones. In dependence of relation between the shoulder and cortical bone, each side was divided into *supracrestal-1* (31 anterior sides and 46-posterior), *at the bone crest-2* (25 anterior sides and 19-posterior) and *subcrestal-3* (27 anterior sides and 18-posterior) positions. After the healing period, Periotest values and radiographic indices (Autodesk Design Review 2011, at the beginning and the end of healing period) were evaluated. Statistical analysis was made by calculating mean values, standard errors, indices of Student's paired *t*-test and the analysis of variance (ANOVA).

Results: After a mean healing period of 3.1 ± 0.2 months, mean Periotest value was −5.4 ± 0.14. Crestal bone loss had the following values: for anterior sides (1, 2 and 3 subgroups) 0.37 ± 0.10; 0.72 ± 0.13; 0.77 ± 0.148; for posterior sides – 0.22 ± 0.17; 0.76 ± 0.20 and 1.25 ± 0.186 respectively. According to the Student's *t*-test, statistical difference was noted between the next subgroups: *anterior-1* and *anterior-2* ($P < 0.05$), *anterior-1* and *anterior-3* ($P < 0.001$), *anterior-2* and *anterior-3* ($P < 0.01$), *posterior-1* and *posterior-2* ($P < 0.05$), *posterior-1* and *posterior-3* ($P < 0.001$). Between *posterior-2* and *posterior-3* subgroups there were no statistical difference ($P > 0.05$). Bone apposition was noted only in anterior and posterior supracrestal subgroups (eight cases, and 10 cases respectively). According to the analysis of variance, the ANOVA F-test had the following values: anterior – 14,336 ($P < 0.001$), posterior – 6671 ($P < 0.01$).

Conclusions and clinical implications: The supracrestal positioning of two-stage dental implants using one-step flapless surgery lead to a smaller bone resorption than subcrestal or at the bone crest positions.

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Healing of buccal dehiscence defects at implants installed immediately into extraction sockets – an experimental study in dogs

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Background: Some recent systematic review (Lang et al. 2012; Botticelli et al. 2008; e.g. Botticelli et al. 2004; Sanz et al. 2010) have documented that implants installed into alveolar sockets immediately after tooth extraction yielded a similar survival rate as implants placed in healed alveolar bony ridges.

Aim: To evaluate the influence of implant positioning into extraction sockets on bone formation at buccal alveolar dehiscence defects.

Methods: In six Labrador dogs the pulp tissue of the mesial roots of $_4P_4$ was removed and the root canals were filled. Flaps were elevated bilaterally, the premolars hemi-sectioned and the distal roots removed. The implants were placed in contact with either the buccal (test site) or with the lingual (control site) bony wall of the extraction sockets. Triangular buccal bony dehiscence defects, 3 mm deep and 3.5 mm wide, were then prepared. No regenerative procedures were done. Healing abutments were affixed and a non-submerged healing was

allowed. After 4 months of healing, block sections of the implant sites were obtained for histological processing and peri-implant tissue assessment.

Results: After 4 months of healing, the bony crest and the coronal border of osseointegration were located 1.71 ± 1.20 and 2.50 ± 1.21 mm apically to the implant shoulder, respectively at the test sites. At the control sites, the corresponding values were 0.68 ± 0.63 and 1.69 ± 0.99 mm, respectively. The differences reached statistical significance ($P < 0.05$). Residual marginal bone defects were found both at the test and control sites. A statistically significant difference between test and control sites was only found at the lingual aspects (depth 2.09 ± 1.01 and 1.01 ± 0.48 mm, respectively). Similar heights of the buccal biological width were observed at both sites.

Conclusions and clinical implications: The placement of implants in a lingual position of the extraction sockets allowed a higher degree of bone formation at buccal alveolar dehiscence defects compared to a buccal positioning.

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Outcomes of flapless post-extractive implant with or without soft tissue augmentation: a 2-years randomized clinical trial

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Background: The esthetic outcome of an implant-supported restoration is first of all dependent on the soft tissue volume. Since the labial bone plate resorbs in every direction after tooth extraction, even when an implant is placed immediately, most patients end up with compromised esthetics

Aim: The purpose of this study is to evaluate the crestal ridge width and thickness changes after post-extractive implants, with and without placement of a soft tissue graft, after a healing period of 2 years.

Methods: In this randomized clinical trial, participants were randomly assigned to the test (treated with subepithelial connective tissue graft placed using the tunnel technique in the labial area: CTG-group) and control groups (treated without raising a flap: F-group) and were seen under investigation at baseline, crown insertion, 1-year follow-up, and 2-year follow-up. Clinical, radiological, and esthetic parameters were recorded to assess treatment outcomes.

Results: At the 2-years examination, all 47 implants were successfully integrated, demonstrating stability and healthy peri-implant soft tissues as documented by standard clinical parameters. The results showed a soft tissue remodeling of −10% in thickness and −18% in highness in the F-group, whereas in the CTG-group there was a gain of 35% in thickness and a slight reduction of −11% in highness. Considering thick biotypes, midfacial soft tissues remained stable over time in both groups. In thin biotypes CTG induced less midfacial (<1 mm) recession than flapless surgery ($P = 0.0027$). Significant midfacial recession (>1 mm) occurred following thin biotypes in F-group. Test group has reported a statistically relevant increase of esthetic result (mean PES = 8) respect to control group (mean PES = 6.65) ($P < 0.05$). Considering thick biotypes, CTG-group obtained good esthetic results (PES ≥ 7) in 90% whereas F-group in 66%. In thin biotypes, CT-group and F group had good esthetic results in 70% and 8% respectively. Insufficient PES score (PES < 6) were reported only in F-group in 33%.

Conclusions and clinical implications: This prospective study evaluates the concept of immediate implant placement and demonstrated successful tissue integration for all 47 implants. These results demonstrate the effectiveness of placing a soft tissue graft at the time of immediate implant placement in the esthetic zone; at the 2-year follow-up test group revealed a better esthetic outcomes and stable facial soft tissues respect to control group. This procedure can also obviate major resorption of soft tissue in thin biotypes. These encouraging results need to be confirmed with long-term follow-up examination.

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Ridge preservation with magnesium-enriched hydroxyapatite: histological evaluation at different time-points

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Background: Ridge preservation has shown to reduce alveolar crest resorption after tooth extraction. Magnesium-enriched hydroxyapatite, due to its chemical properties similar to natural bone, was demonstrated to be suitable for ridge preservation. However, lack of evidence still remains regarding the best timing for implant insertion after grafting. It has been proven that early vascularization and angiogenesis of the material leads to earlier osteogenesis and provides natural bone quality. Caveolin-1 is a protein found in the plasma membrane of vessels which participates in bone metabolism; thus, caveolin-1 antibody was considered an ideal marker for angiogenesis.

Aim: To histologically and immunohistologically analyze the early angiogenesis–osteogenesis interplay in post-extraction ridge preservation using Magnesium-enriched hydroxyapatite to better understand the correct timing for implant insertion.

Methods: A randomized controlled trial was conducted involving 10 post-extraction sites grafted with Magnesium-enriched hydroxyapatite. Sites were randomly divided in two balanced groups and bone specimens were collected 2 or 4 months post-surgery. Sections were stained with hematoxylin/eosin, Masson Goldner trichrome and tartrate-resistant acid phosphatase, respectively. Furthermore, indirect immunohistochemistry was performed using alkaline phosphatase, CD34 and caveolin-1 antibodies. Blind histological and histomorphometric evaluation was undertaken by two independent investiga-

tors. Mean values and standard deviations were calculated for each outcome variable. Data were compared using one way ANOVA test. $P < 0.05$ was considered statistically significant.

Results: Ten patients (six female and four male; mean age 53.5 ± 16.4 years) were recruited; no drop-out occurred. Histomorphometric analysis presented a 5.1 fold increase in regenerated bone between 2 (15.0 ± 3.5%) and 4 months (77.4 ± 8.6%) post-surgery ($P < 0.001$). At the same time, a non-significant reduction in graft material was observed from 21.7% to 11.6%, while the area of connective tissue/marrow spaces reduced significantly from 63.3% to 11% ($P = 0.003$). Caveolin-1 expression in vessel-like structures reduced significantly from 645 (±33) to 255 (±94) ($P = 0.008$). Changes in CD34 expression from 301 ± 95 to 88 ± 24 ($P = 0.046$) confirmed these findings.

Conclusions and clinical implications: Within the limits of the present study, histologically it may be concluded that blood vessel density developed in opposite to osteogenesis and that high vascularization after 2 months could provide a highly accelerated ossification. Thus, clinically, it may be concluded that magnesium-enriched hydroxyapatite is suitable for post-extraction bone crest preservation and ensures early angiogenesis and osteogenesis, suggesting that implant placement could be appropriate even after 2 months.

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Biomolecular and ct evidences of remodeling grafts fixed with cyanoacrylate

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Background: Recently, using tomographic and histological tools in an animal model our group reported that *N*-butyl-2-cyanoacrilate (NB-Cn) was more efficient in preserving volume of onlay bone grafts as compared with titanium fixation (TiS) (Oliveira Neto et al. *Clin Impl Dent Rel Res* 2010). This outcome may infer that NB-Cn's fixation in augmenting procedure will be advantageous at the time of implant installation. However, the molecular mechanisms governing bone remodeling with NB-Cn and TiS is still incipient.

Aim: To analyze mineralized tissue variation of calvarial bone grafting fixed in the mandible with NB-Cn or TiS; To evaluate gene expression of IL-6, IL-10, TNF-αand TRAP, by RT-PCR and to correlate with grafts remodeling process.

Methods: Eight rabbits were submitted to bilateral calvarial graft removal using 10 mm-trephine diameter. The grafts were fixed at both sides of the mandible either with NB-Cn or TiS. Four animals were sacrificed at 4 and 8 weeks, respectively. The μCT analysis was performed with a Skyscan 1172. Specimens were scanned rightafter animals sacrifice, at 4 ($n = 2$) and 8 days ($n = 2$). Pre-defined volumes of interest (VOIs) with dimensions of 4.0 × 2.5 mm were used. For each graft, four VOIs were established (two peripheral and two central). The percentage of mineralized tissue, trabecular thickness (Tb.Th), trabecular separation (Tb.Sp), degree of anisotropy (DA) and fractal dimension (FD) were used for comparisons. For biomolecular analysis, the other four animals were used. Gene expression of interleukin-6 (IL-6), interleukin-10 (IL-10), tumor necrosis factor-alpha (TNF-α) and tartrate-resistant acid phosphatase (TRAP) was assessed. Quantification by real-time PCR was performed. The paired *t*-Student test was applied for statistical analysis ($P \leq 0.05$).

Results: Bone graft fixation with NB-Cn promoted superior volume and density preservation. The percentage of mineralized tissue at the center portion or border of the graft were very similar (NB-Cn = 50.6 ± 8.3% or 50.3 ± 10.6%, respectively), and superior than TiS group (32.5 ± 3.5% or 33.8 ± 6%, respectively). Genes from NB-Cn group were up-regulated in comparison with TiS group at initial phases of bone healing (4 days) and the profile reversed at the 8 days period. At day 8 the osteoclastogenesis-related genes were down-regulated in the NB-Cn group.

Conclusions and clinical implications: Onlay bone grafts fixed with screws increased remodeling process compared with NB-Cn. A higher amount of mineralized tissue was observed in NB-Cn group compared with TiS group. The evidences of improved volume and density maintenance observed in the NB-Cn group cast new perspectives in bone augmentation for implant therapy.

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Osteotome sinus floor elevation with or without grafting: a 3-year randomized controlled study

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Background: The osteotome sinus floor elevation (OSFE) technique has been proved to be a predictable procedure for successful implant placement in posterior maxillae with limited bone height under sinus. OSFE is considered to be minimal invasive and minimal traumatic while having a limitation with regard to the residual bone height. However, there is still controversy regarding the necessity of a grafting material in order to maintain the space for new bone formation.

Aim: The present study was to (1) evaluate the clinical and radiographic results of dental implant placed in posterior maxillae with limited residual bone height using osteotome sinus floor elevation, and to (2) compare the endo-sinus bone remodeling with and without simultaneous grafting.

Methods: Ninety-two implants in eighty patients with limited residual bone height (RBH < 8 mm) were included, and randomly assigned to osteotome sinus floor elevation (OSFE) with (Group 1) or without grafting (Group 2). The endo-sinus bone gain (ESBG) and peri-implant marginal bone loss (MBL) were assessed on periapical radiographs obtained using a paralleling technique at 6, 12, 24, 36 months following surgery. Implant survivals, biological/technical complications, peri-implant soft tissue parameters and patients' satisfaction were also assessed.

The patient was regarded as the statistical unit. Intra-group comparison were performed using Wilcoxon test. Inter-group comparison were performed with Chi-squared test for categorical variables and with Student *t*-test for continuous variables.

Results: Three implants in three patients were lost during the observation. The cumulative survival rates of the osteotome-installed implants after 3-years' follow-up were 98.8% for Group 1 and 97.5% for Group 2. No statistically significant difference was found in RBH between two groups (5.59 ± 2.72 mm for Group 1 and 5.74 ± 2.08 mm for Group 2). The ESBG was 6.61 ± 0.72 mm at 6 months of healing, but was reduced significantly to 3.92 ± 1.30 mm at 36 months in Group 1. Whereas the ESBG in Group 2 represented slow but steady growth from 2.69 ± 2.21 mm at 6 months to 4.04 ± 3.15 mm at 36 months, reaching the same level as Group 1 eventually. The MBL and soft tissue parameters showed no significant difference between two groups during observation.

Conclusions and clinical implications: OSFE and simultaneous implant installation with or without grafting both result in predictable ESBG with high implant survival rate during 3 years follow-up. Spontaneous bone formation can be observed after OSFE without grafting. While grafted area shrinkage was detected after OSFE with grafting. The application of simultaneous grafting has no significant advantage in terms of clinical success.

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Maxillary sinus augmentation for implant placement: clinical, histologic and histomorphometric study in 75 patients

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Background: Maxillary sinus augmentation (MSA) applied with various grafting materials enable placement of implant-supported prostheses even in cases with increased resorption of the posterior maxilla.

Aim: Objective of this study was to evaluate new bone formation after MSA using autologous bone (AB), demineralised freeze-dried bone allograft (DFDBA) and biphasic calcium sulfate (BCS).

Methods: Seventy-five patients (43 women, 32 men, mean age 62 years) with severe atrophy of the posterior maxilla, in need of bilateral MSA using lateral window approach, were recruited. A 2-stage protocol was conducted. Patients were randomly divided in three groups of 25 patients each. In each group the right sinus was grafted with AB (in total 75 sinuses, control group, CG), while the left sinus (experimental group, EG) was treated with: 1st group: DFDBA (25 sinuses), 2nd group: DFDBA + AB, in mixture 50/50 (25 sinuses), 3rd group: AB + BCS (25 sinuses). After a healing period of 6 months, bone cores biopsies were collected, at implant placement. Five-micron thick sections, stained with hematoxylin-eosin and Masson's trichrome, were used. A total of 150 biopsies were processed for histomorphometric evaluation of the mean percentage of bone, residual graft and connective tissue by area. A total of 386 implants were placed into grafted sites. After 4–6 months of healing, fixed prosthetic restorations were fabricated.

Results: Adequate bone volume was clinically observed in all cases. 382 implants were restored into function, while four implants failed to osseointegrate, with a survival rate at baseline of 98.96%. Histologic analysis revealed the presence of newly formed bone in all biopsies. Bone showed a lamellar well-organized structure, in direct contact with residual graft (RG) particles. Histomorphometric evaluation revealed an overall mean bone volume (MBV) of 51.6 ± 17.1%, 32.7 ± 13.5% of connective tissue (CT), and 15.7 ± 10.3% of RG material. The analysis revealed more bone in the left sinuses (EG) 69.1% vs. 61.9% in the right sinuses (CG) ($P < 0.05$). Both groups included both vital bone (EG:52.6%, CG:48.6%) and non-vital RG fragments (EG:16.5%, CG:13.3%). The MBV was higher in cases where combination of AB + DFDBA was used (54.2%) ($P < 0.05$). In cases where BCS was used, clinical and radiographic evidences of bone maturation were earlier, with nearly equal MBV (53.9%, $P > 0.05$). In detail, analysis of the samples showed an average of: a) 1st group: 51.6% MBV, 19.1% RG particles, and 29.3% CT, b) 2nd group: 54.2% MBV, 17.6% RG particles, and 28.2% CT, c) 3rd group: 53.9% MBV, 12.7% RG particles, and 35.4% CT, d) Control group: 48.6% MBV, 13.3% RG particles, and 38.1% CT.

Conclusions and clinical implications: The use of DFDBA + AB in 50/50 mixture and the addition of BCS to AB appear to promote bone formation. Both BCS and DFDBA are biocompatible and osteoconductive when used in maxillary sinus augmentation procedures. Implant success rate was 98.9% at baseline and implant survival rate reached 97.9% during follow-up period.

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Impact of citric acid etching on biocompatibility and osseous organisation of a natural bovine bone mineral

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Background: Within the last years it was shown that etching of biomaterials can improve hydrophilicity and cell proliferation which in turn may accelerate the osseointegration of implant materials.

Aim: The aim of the present study was to evaluate the influence of superficial acid etching of a xenogenous bone mineral on cell proliferation and bone regeneration.

Methods: A granular bone substitute material [BSM] (Bego Oss [BO], Bego Implant Systems, Bremen, Germany) was superficially etched using citric acid (Bego Oss Acid [BOA]). BO and BOA were allocated into 96 non-binding well plates and incubated with 1×10^{-4} human osteoblast-like cells (SaOs-2) per well under standardized conditions. After 2 h, 3 and 7 days a LDH-Assay (CytoTox 96®; Promega) was used for photometric evaluation of cell proliferation ($n = 8$). LDH values were transferred into cell amounts using a standard curve and analyzed for statistical difference. Additionally, cell morphology was investigated using scanning electron microscopy (SEM) ($n = 3$). In the *in-vivo* part, BO and BOA granules were used for lateral augmentation of the maxillae of four beagle dogs and covered with a collagen membrane (Bego Membrane, Bego). Healing periods were set at 3 and 8 weeks ($n = 2$, respectively).

Results: *In-vitro* evaluation revealed statistically significant higher cell proliferation after 3 and 7 days on BOA compared to BO ($P < 0.05$, Wilcoxon test). SEM observation presented flat and star-shaped SaOs-2-osteoblasts displaying high numbers of lamellopodia on both BO and BOA surfaces. *In vivo*, both BSM showed osteoconductive properties and osseous organisation after 8 weeks. However, the number of the *in-vivo* applications did not allow further statistical analysis.

Conclusions and clinical implications: Within the limits of the present study it was concluded that superficial etching of natural bone minerals using citric acid may support osteoblast-like cell proliferation. Further studies are necessary to specify the impact on bone regeneration.

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Impact of matrix density of collagen grafts on early tissue response and biodegradation. A histomorphometrical study in rats

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Background: Collagen is used as membrane material, for filling of smaller bone defects, preservation of extraction sockets and coverage of the Schneiderian membrane in sinus augmentation procedures. Its haemostyptic reactivity helps to avoid postoperative bleeding, whilst its chemotactic effect attracts cells involved in regeneration processes. A new aspect of collagen applications is soft tissue augmentation procedures, to overcome the donor site morbidity of connective tissue grafts. However, new requirements such as volume stability and integration instead of resorption are combined with this new indication.

Aim: The aim of the present study is to evaluate volume stability, resorption pattern and vascularization of porcine dermal collagen matrices of different densities.

Methods: Two collagen matrices of different densities: Jason fleece (JF) and Mucoderm (MD) (JF: lyophilized and MD: non-lyophilized porcine dermal collagen, Botiss Biomaterials, Berlin, Germany) were included in the study. Matrices were marked by a non-resorbable polycarbonate spacer and randomly allocated in (1) unconnected pouches subcutaneously on the back and (2) intra-orally in the molar region of 40 rats. Eight animals each were sacrificed after 1, 3, 7, 14 and 24 weeks. The following parameters were evaluated: biodegradation over time, vascularization, tissue integration, and foreign body reaction.

Results: While JF revealed early ingrowth of cells and blood vessels and fast resorption within the first 2–3 weeks, MD remained stable until the end of the study with negotiable loss of matrix width. Subsequent blood vessel ingrowth was visible from the superficial part to the center of the matrix. In contrast to JF, the surrounding connective tissue showed no presence of inflammatory cells and good tissue integration in both subcutaneous and intraoral applications.

Conclusions and clinical implications: Within the limits of the present study, it was concluded that collagen compactness and lyophilisation have an impact on the biodegradation process. Further studies are necessary to evaluate the long-term stability of MD and its clinical outcome in soft tissue augmentation procedures.

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Implant induced post-traumatic inferior alveolar nerve neuropathy

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Background: Nerve injury is a recognised but preventable complication of dental implant placement. A number of inferior alveolar nerve injury (IANI) patients have been identified at a dedicated oral surgery nerve injury clinic at King's College Hospital.

Aim: To present data regarding demographics, pre-, intra- and postoperative management, resultant neurological deficit and quality of life measurements of these cases and discuss improvements to current practice.

Methods: Forty-four implant related IANI patients attending over the past 48 months, were retrospectively identified and reviewed. In the clinic, data were collected on a proforma regarding; preoperative information, the surgical event, timing of referral, perceived and qualitatively examined neurosensory deficit, functional deficit and effect on the quality of life and analysed using SPSS software.

Results: Sixty-nine percent of the patients were female, while 36% recalled giving preoperative written consent and 14% were specifically warned about nerve injury. Pre-operative radiographic assessment included periapical radiograph 47%, orthopantomogram 52% and cone beam CT 11%. Intra-operative events included bleeding (18%), pain (8%) and neural stimulation (27%). In 41% of the cases removal of the implant was undertaken. Of the 22%, removed within the

recommended 30 h post injury, 50% had complete resolution. 5% of the 78% who had implants removed after 30 h showed partial resolution. The majority of the patients were referred for a specialist opinion more than 6 months post injury and 7% were referred within 30 h. Two-dimensional radiography showed overlap of the implant bed or implant and the inferior alveolar canal for 39% with contact with the roof of the canal, 16% crossing the superior border of the canal and 25% crossing the inferior border of the canal. All the patients presented with demonstrable neuropathy. 27% of the patients complained of paraesthesia while neuropathic pain was present for 45% of them, having psychological morbidity with impact on social life and work. Functional difficulties included speaking, drinking, kissing. Post injury management included tricyclic antidepressants, cognitive behavioural therapy, sessions with liaison psychiatrist and anaesthetic patches.

Conclusions and clinical implications: Referrals regarding implant related IANI and neuropathy have increased over the last years. Appropriate preoperative assessment, treatment planning and awareness of instrumentation intra-operatively, is of paramount importance in order to avoid the potentially debilitating implications. Early specialist referral, removal of the offending implant and medical or behavioural therapy, where indicated is also encouraged. It is anticipated that practitioners will have an increased awareness of neuropathic pain as a consequence of inferior alveolar nerve injury.

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Dimensional alterations of extraction site after different socket preservation techniques – a volumetric study

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Background: Socket preservation after tooth extraction has been proven to be successful in limiting the post-operative resorption of the alveolar ridge. Conclusively most of the studies report that the ridge dimension was preserved to a certain extent. Preservation of the buccal bone plate and complete ridge stabilization has never been shown.

Aim: The aim of the following randomized controlled clinical study l was to evaluate the contour changes after different socket preservation techniques in the horizontal dimension.

Methods: Thirty patients needing tooth extraction were included. The patients were randomly assigned to one of the following treatments: Tx1: extraction socket filled with xenogenic bone substitute (mp3-OsteoBiol) and covered with a soft tissue punch harvested from the palate. Tx 2: a soft tissue punch from the palate was sutured to cover the socket. Tx 3: extraction socket filled with xenogenic bone substitute Tx 4: extraction socket with the blood clot only Impressions were obtained at baseline and 4 months after surgery. Cast models were optically scanned; digitally superimposed and horizontal measurements of the contour alterations between time points were performed using digital imaging analysis.

Results: All groups displayed contour shrinkage at the buccal aspect. Four months following extraction the mean horizontal loss was -0.79 ± 0.19 mm for Tx1 group and was -0.85 ± 0.20 mm for Tx2 group. The Tx3 group demonstrated corresponding horizontal dimensions of -1.45 ± 0.25 mm. The value of Tx4 group was -2.26 ± 0.45 mm. When the results from the horizontal dimension were tested with the analysis of variance (ANOVA), a statistically significant difference between the groups Tx1 or Tx2 and the control Tx4 could be assessed. A significant positive influence of the soft tissue punch graft on the maintenance of the ridge width was recorded ($P < 0.001$).

Conclusions and clinical implications: Within the limits of this study, it appears that covering the orifice of the extraction socket with a free gingival tissue graft, irrespective of the incorporation of a xenogenic bone substitute into the extraction socket, sems to have the potential to limit the buccal soft tissue contour changes after tooth extraction.

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Sinus elevation with and without grafting: a 3-year prospective study

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Background: Rehabilitation of the atrophied posterior maxilla can be simplified by using implants ≤ 10 mm and osteotome sinus floor elevation (OSFE) technique. Peri-implant bone formation after sinus augmentation without grafting has been now well documented (Bruschi et al. 1998, Winter et al. 2003, Lundgren et al. 2004, Nedir et al. 2006, 2009, Lai et al. 2008, 2010, Pjetursson et al. 2009) but a comparison between implants randomly placed with and without grafting is still lacking.

Aim: To evaluate the efficacy of an OSFE procedure in extremely atrophic maxillae (residual bone height [RBH] $\leq$ 4 mm) with short tapered chemically-modified hydrophilic surfaced implants. To compare bone levels around randomly placed implants in grafted and non-grafted sinuses, after 1 and 3 years.

Methods: Twelve patients requiring 1–2 implants per sinus with a mean maxillary RBH of 2.4 ± 0.9 mm were enrolled. Through randomization, implants (TE® SLActive; Straumann, AG, 8 mm) were placed without grafting ($N = 17$, test) and with grafting (Bio-Oss®; Geistlich Pharma, AG; $N = 20$, con-

trol). Healing time was 10 weeks before functional loading with single crowns. After 1 and 3 years, endo-sinus bone gain and crestal bone loss (CBL) were measured on standardized peri-apical radiographs.

Results: Before loading, two control implants failed (RBH 1.4 and 1.2 mm). Early adverse events occurred when implants were placed in merged corticals. One osseointegrated test implant was removed after 3 years (RBH 2.8 mm) because of peri-implantitis. The overall success rate was then 91.9%. All implants gained endo-sinus bone. Bone gain was 3.9 ± 1.0 mm (test) and 5.0 ± 1.3 mm (control) after 1 year ($P = 0.006$); it reached respectively 4.1 ± 1.0 and 5.1 ± 1.2 mm after 3 years ($P = 0.012$). CBL was respectively 0.5 ± 1.0 and 0.6 ± 1.1 mm after 3 years; the difference in CBL between test and control groups was not statistically significant ($P > 0.05$). Mean endo-sinus bone gain and CBL did not statistically increase between 1 and 3 years ($P > 0.05$).

Conclusions and clinical implications: This study shows that grafting is not needed to reach 4.1 mm of bone gain in maxillary RBH $\leq$4 mm after 3 year. However, more bone is obtained when grafting material is inserted. Bone gain observed after 1-year is preserved and does not shrink over the 3-year mid-term. The OSFE procedure with immediate implant placement, while technically sensitive, might be considered as a predictable, efficient and less invasive alternative care of the atrophic maxilla.

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Infection rates after sinus floor elevation with and without the use of bone collectors

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Background: The collection of bone debris during preparation of sinus floor augmentations is a commonly used technique to avoid autologous bone transplants and therefore to reduce donor site morbidity. There is evidence in the literature that the collected bone debris has a higher risk of bacterial contamination and therefore might lead to a higher infection rate after sinus floor elevation.

Aim: The aim of this retrospective study was to analyse whether the use of collected bone debris has an impact on the infection rates after sinus floor augmentation.

Methods: A retrospective analysis of 343 sinus floor elevations in 249 patients was carried out. Sinus floor elevations were performed by the lateral approach. A bone collector was used in 136 cases. In the control group, no bone collector was used. Statistical analysis was carried out with the programme 'R'. Fisher's exact test and Chi-square test were calculated to analyse which parameters influence the infection rate. The parameters that were taken into consideration were the usage of a bone collector, bone substitute material, perforation of the schneiderian membrane, gender, nicotine abuse, diabetes mellitus and haemorrhagic disorders.

Results: Localized infection occurred in 7% (25 of 343) of the sinus floor elevations. In 40% of the cases a bone collector was used, in this group the infection rate was 12%. In the control group the infection rate was 4% and significantly lower than in the bone collector group ($P = 0.004769$ Fisher's exact test, $P = 0.005155$ Pearson's chi-square-test). No statistical significant effects could be shown for the use of bone substitute material, perforation of the schneiderian membrane, gender, nicotine abuse, diabetes or haemorrhagic disorders.

Conclusions and clinical implications: According to the literature, intraoperatively collected bone debris has a high risk of bacterial contamination. This is supported by the findings of our study. To reduce the amount of bacteria a full mouth disinfection with chemical agents such as chlorhexidine and a strict preparation protocol should be used when a bone collector is applied.

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Radiographic 2-years follow up after complex augmentation by deduced triggering of stem cells based on a bionic approach

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Background: Osteogenic induction is regarded as an indispensable step for complex augmentations. Intraoperative stem cell settlement as an *in-situ* regenerative (bionic) approach leads to higher clinical bone quality. For *in-situ* regeneration, integration of intraoperative concentrated stem cells and bioactive growth factors in complex augmentations may promote tissue regeneration by deduced triggering.

Aim: A controlled prospective clinical trial in humans should give evidence if deduced stem cell triggering in preimplantological complex augmentations can provide less bone resorption and an improved implant outcome.

Methods: Thirty Patients undergoing complex augmentations by harvesting large bone grafts from the iliac crest were treated by stem cell harvest and intraoperative concentration. Patients were randomized in a control group with conventional augmentation, for an open sterile bench technique or a closed sterile chair-site system (each group: $n = 10$) [Ethic Approval A167/10]. Radiographic augmentation and periimplant bone height results were compared to controls in this follow up study.

Results: The clinical routine of harvesting bone grafts for complex augmentations may supplemented by intraoperative stem cell harvest, -concentration and-settlement of stem cells and growth factors without additional donor site morbidity.

The harvested cells are detectable with typical surface characteristics of quiescent mesenchymal stem cells (FACS-analysis, proof of cell surface positivity for CD-105,-29,-90,-73 and negative results for CD-45,-14,-34,-19, 7-AAD und HLA-DR). Histological examination of bone biopsies and radiographics showed, that augmented bone have a higher histological quality of bone and a 15 percent less post-transplantational loss by bone resorption ($P = 0.011$) compared to controls. In the follow up period the periimplant bone loss by bone resorption was lower ($P = 0.014$) in both intervention groups compared to control group.

Conclusions and clinical implications: The proof of less resorption in the post-transplantation-, implantation phase and follow up may allow harvesting minor sized bone grafts to reduce donor site morbidity by applying stem cell concentration and settlement techniques in complex augmentations supported by bioactive deduced triggering factors. For the future, the comprehension of mechanisms of deduced triggering of stem cells may allow a reduction of autologous bone part maintaining high success in implant outcome for selected indications.

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Clinical comparison between screwretained and removable prostheses on maxilla implants

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Background: Different treatments are available for the anchorage of the prostheses on implants in the edentulous jaw. The selection of the type of prosthesis may have an impact on subject's life quality.

Aim: To analyze prosthetic outcome, observe and compare the success of implants, mechanical and biological complications of removable prostheses attached by telescopic crowns and fixed screwretained prostheses on implants in the edentulous maxilla during the first months in function. To find out which restorative solution the patient preferred for keeping.

Methods: This is a randomized, prospective, parallel-group, open, comparative, monocenter, cross over study on 22 patients. Six ANKYLOS® C/X implants (DENTSPLY Friadent) were placed in the edentulous maxilla of each subject (132 implants). In 10 subjects internal sinus lift was performed. Four months after submerged healing, abutment operation was performed and the patients achieved randomized the first titanium acrylic prostheses after 5 months, either a removable prosthesis with the SynCone®-system (a prefabricated telescopic crown system on abutments with a full supported cast titanium frame) or a fixed screwretained prostheses (with a milled titanium framework on abutments, DENTSPLY CAD/CAM). After 3 months of wearing the first prosthetic solution the subjects received their old denture for a wash out period of 1 month. Subsequently the subjects had the other prosthetic solution for 3 months. Finally, the patient decided which prosthetic solution that was preferred for keeping. Non-parametric statistical method was used in the analysis of choice of prosthetic restoration (binomial test).

Results: Out of 22 included patients 20 patients have completed the study so far (one patient wearing the second construction; one patient excluded due to illness). Fifteen patients preferred the fixed screwretained prostheses for keeping and five subjects the removable prostheses ($P = 0.041$). The reasons to choose either construction were mainly: (Fixed: Feels safer, more secure, and two patient were not satisfied with removable construction; Removable: Easier to clean, to talk with and esthetics). One implant became loose before loading. Few diminutive mechanical ($n = 4$ SynCone®) and biological complications ($n = 0$) were reported during the first 3 months in function.

Conclusions and clinical implications: Most of the patients preferred the fixed screw retained prostheses. However, most patients were satisfied with both constructions. Few complications were reported during the first 3 months of follow-up. It is always important to present the different treatment alternatives for the patients before treatment starts due to different interindividual preferences of prosthetic restorations.

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Factors influencing removal of the cement excess in implant-supported restorations: a prospective clinical study

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Background: There is a lack of information about the factors influencing the removal of the cement after cementation of the implant-supported restorations. It has been proven *in vitro* and clinically that location of the cementation margin is associated with undetected cement remnants. However, the data about other clinical factors related to remaining cement is still missing.

Aim: To perform clinical evaluation of the dependence between undetected cement after cementation and (1) position of the implant in dental arch (anterior, premolar or molar); (2) undercut (horizontal distance between inner peri-implant sulcus margin and outer emergence profile of restoration).

Methods: Fifty three patients were treated with 53 single implant supported cement-retained metal ceramic restorations. Location: molars 33 cases (62.3%), premolars 16 (30.2%) and anteriors 4 (7.5%). Undercut was measured in four locations (distance from gingival margin to adjacent tooth mesially and distally or distance from inner gingival margin to the outer margin of the soft tissues buccaly and lingually): 93 cases (43.9%) 1 mm, 81 (38.2%) 2 mm, 38 (17.9%) 3 mm. Restorations were fabricated with occlusal openings (temporarily

closed with composite during cementation) and cemented with resin reinforced glass ionomer. After cleaning, a radiograph was taken to evaluate if all cement had been removed. Then the composite was eliminated to gain the access to the abutment screw and cemented restoration-abutment unit was unscrewed. All quadrants of the specimens were photographed in a special device with standardized distance and analyzed with Adobe Photoshop. Total area of the restoration and the area of cement remnants were measured in pixels in each quadrant and proportion calculated. The same was done with the perpendicularly taken pictures of the implant intraorally. The level of significance was set to 0.05.

Results: Remnants were found in nearly all the cases. Location and proportion of the pixels on the crown (molars 0.153 ± 0.026, premolars 0.153 ± 0.033, anteriors 0.114 ± 0.056) and proportion of the pixels intraorally (molars 0.235 ± 0.043, premolars 0.252 ± 0.047, anteriors 0.135 ± 0.068). Undercut and proportion of the pixels on the crown (1 mm 0.031 ± 0.004, 2 mm 0.041 ± 0.004, 3 mm 0.048 ± 0.013) and proportion of the pixels intraorally (1 mm 0.041 ± 0.008, 2 mm 0.074 ± 0.010, 3 mm 0.072 ± 0.018). Pixels relation increased statistically significantly when undercut was greater (on the crown $P = 0.025$ and intraorally $P = 0.004$). Statistically significant difference was found between 1 and 2 mm.

Conclusions and clinical implications: It has been shown that undercut of restoration has influence on amount of cement residue. The greater undercut of the crown is present, the more cement is left undetected. The tooth type did not have influence on amount of cement remnants. Therefore, clinicians should be very careful when using standard abutments for cement retained-implant supported restorations and select individual abutments, which do not possess the undercut.

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Combined alumina-zirconia implant-supported single tooth restorations in anterior areas: a 5 year clinical results

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Background: All-ceramic materials were introduced to obtain an optimal esthetic integration in anterior area. zirconia abutments and alumina crown exhibited excellent esthetic performance, although there is insufficient long term data on clinical service in implant supported restoration.

Aim: The aim of the present study was to evaluate the 5 years mechanical, and biological stability of alumina-crown and zirconia-abutment combined materials when used as implant supported single tooth restorations in anterior regions.

Methods: 50 consecutive patients receiving a total of 67 Branemark Mk III TiUnite implants (Nobel Biocare, Gothenburg, Sweden). All implants were immediately loaded. After 6 months, 67 individualized Zirconia abutments (Procera; Nobel Biocare) were connected and 67 Alumina crowns (Procera; thickness 0.4 mm –canines and incisors; 0.6 mm – for premolars), veneered with ceramic, were cemented. Follow-up visits were scheduled at 1 and 12 months and at 3, 4 and 5 years following crown insertion. Clinical evaluation included assessment of modified Plaque Index (mPII) and Gingival Index (GI), marginal bone level changes assessed by intra-oral radiographs, stability of the soft tissues evaluated by perpendicular digital photographs (Gingivomorphometry). Any biological and mechanical complications were also recorded.

Results: Sixty restorations in 45 patients were examined at 5 years time-point. Five patients were lost to follow up. Mean observation period was 62.2 months (range: 58–64). No abutment fractures were observed, resulting in a 5 years cumulative prosthetic survival rate of 100%. No abutment–screw loosening occurred. Minimal incisal chipping was reported for two crowns at the 3 year timepoint. Regarding evaluation of the soft tissue stability, at 5 years timepoint, 56 (90.3%) restorations showed no recession, 5 (8%) exhibited a recession <1 mm, and 1 (1.6%) a recession more than 1 mm. Concerning modified Plaque Index and Gingival Index no statistically significant difference ($P > 0.05$) between implant–supported restorations and neighboring teeth was found at any time during the follow up. When compared with baseline (prosthetic delivery) the mean marginal bone loss was 1.5 mm (SD 0.6) at 5 year follow-up examination.

Conclusions and clinical implications: Within the limitations of the present study these findings document that single-tooth implant- supported all-ceramic restorations is a reliable option in terms of strength, aesthetics and biologic integration when used in incisor and premolar regions.

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Clinical evaluation of implant supported zirconia restorations with transverse fastening screws: 30 months clinical results

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Background: An increased interest in implant supported all-ceramic reconstructions during recent years can be attributed to the ongoing search for new esthetic, biocompatible, and durable materials as an alternative to conventional porcelain-fused-to-metal fixed dental prostheses. The fabrication by traditional casting procedure is technique-sensitive and demanding. By utilizing CAD/CAM technology disadvantage of traditional manufacturing processes could be overcome.

Aim: The aim of the this study was to evaluate the clinical performance of single and multi-unit implant supported all-ceramic fixed dental prostheses with transverse fastening screw made by a CAD/CAM procedure.

Methods: Thirty-one patients received at least 1 zirconia (Y-TZP) fixed dental prostheses manufactured according to the Procera CAD/CAM technique with transverse (lingual or palatal) screw fastened to a CAD/CAM titanium substructure or abutments supported by Branemark MkIII TiUnite (Nobel Biocare, Gothenburg, Sweden) implants. Veneering ceramic was

applied in all restorations. The following clinical and technical parameters were assessed: framework fracture, fracture of veneering ceramic, screw loosening or fracture, and cumulative survival rate (CSR).

Results: Nineteen patients received a single tooth restoration, sixteen patient received 2–4 unit fixed dental prostheses, and one patient a full arch restoration. A total of 77 units were evaluated after a mean observation period of 30.4 months (28–35 months). After the observation period, all restorations were in use, and all patients were fully satisfied with their treatment. None of the reconstructions had fractured. Superficial chip-off fractures of the veneering porcelain were, however, observed in two patients (2.6% of units). All could be polished and no restoration were in need of replacement. Screw loosening was observed in two restorations. All could be re-tightened. No screw fractures were observed. The cumulative survival rate was 100% after a mean 30.4 months observation period.

Conclusions and clinical implications: Preliminary results from this study suggest that implant-supported zirconia fixed dental prostheses with transverse fastening screws seem to be a predictable procedure. Hovewer, long-term follow-up studies involving larger numbers of patients are needed, before the material and technique can be recommended for general use.

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Submerged vs. transmucosal placement of bone level implants: 3-year results of a multicenter RCT

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Background: In implant dentistry, the choice of procedures is of importance relating to the surgical management of the soft tissues for optimal hard and soft tissue conditions at the implant.

Aim: To test whether or not transmucosal healing at two-piece implants is as successful as submerged placement regarding crestal bone levels at 3 years of implant loading.

Methods: Adults requiring implants in the anterior maxilla or mandible in regions 21–25, 11–15, 31–35 or 41–45 (WHO) were recruited for this randomized, controlled multi-center clinical trial of 5-year duration. Randomization was performed at implantation allowing for either submerged or transmucosal healing. Two-piece implants were placed according to manufacturer's instructions with sufficient primary stability (Straumann Bone Level SLActive implants, 4.1 × 8/10/12/14 mm). Final reconstructions were placed 6 months after implantation. Radiographic interproximal crestal bone levels and peri-implant soft tissue parameters were measured at implant placement (baseline), 6, 12, 24 and 36 months. A two-sided *t*-test (80% power, significance level $P = 0.05$) was performed on bone level changes at 6, 12, 24 and 36 months.

Results: Of the 106 subjects were included in the 36-month analysis (submerged (S): 50.9%, transmucosal (TM): 49.1%). From implant placement (baseline), to 6, 12, 24, 36 months, changes in crestal bone level measured −0.31, −0.50, −0.49 and −0.68 mm for the S and −0.30, −0.54, −0.55, −0.58 mm for the TM groups (all $P < 0.001$). The mean differences of change in bone levels between the two groups were not statistically significant at either time point indicating equivalence of both procedures. Full soft tissue coverage was observed in 98% of the subjects in both groups after 3 years. Over the whole study period, only one implant was lost in the transmucosal group after 6 months post-implantation yielding very high implant survival rates of 100% for S and 98% for TM groups. Implant success rates were 100% for S and 98% for TM groups. At 3 years post-loading patient satisfaction was rated good to excellent in >99.3% of all subjects in the categories comfort, taste and fit.

Conclusions and clinical implications: Transmucosal healing of two-piece implants is as successful as the submerged healing mode with respect to crestal bone levels and tissue integration during the first 42 months after implant placement. Very high patient satisfaction, implant survival and success rates are achievable.

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One-piece ceramic oral implants: three-year results on single tooth replacement from a prospective cohort investigation

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Background: Zirconia oral implants are used clinically. Sound scientific data is sparse.

Aim: The objective of this prospective investigation was to evaluate the outcome of a one-piece zirconia oral implant when used for single tooth replacement.

Methods: Sixty-five subjects were included in this study. The implants were immediately temporized after insertion. A total of 66 implants were inserted. Two single tooth implants were inserted in one patient. For this report, all subjects were followed-up for a minimum of 3 years after implant placement. For evaluation of the periimplant bone standardized radiographs were taken at implant insertion, prosthesis insertion, at the 1- and 3-year follow-up to evaluate periimplant bone remodeling. For implant survival, a Life Table Analysis was computed. Furthermore, a frequency analysis of bone loss was generated. A univariate analysis of the influence of different parameters such as implant position, bone quality and quantity, flap design and insertion torque on marginal bone loss from implant insertion to 36 months was performed. Soft tissue parameters were evaluated at prosthesis insertion and at the 3-year follow-up.

Results: After 3 years, six implants out of the 66 failed in six patients, giving a survival rate after 3 years of 90.8%. Furthermore, two patients had to be withdrawn from the investigation. For one patient the forms were missing. The mean marginal bone loss from implant insertion to the 3-year follow-up was to 1.45 mm. Three years after implant placement, 35% of the implants have lost at least 2 mm of periimplant bone, and 22% more than 3 mm of periimplant bone. In the univariate analysis no effect of a single parameter on marginal bone loss from insertion to the 3-year follow up could be found. Probing depth and Clinical Attachment Level increased for the implant sites and were significantly higher than around the neighbor teeth. Bleeding Scores increased at implant sites and were significantly higher than at tooth sites. Plaque Scores slightly decreased over time and were not different to tooth sites.

Conclusions and clinical implications: The cumulative survival rate of the presented one-piece ceramic implant after 3 years in function is inferior to the reported survival rate of two-piece oral implants when immediately restored. The frequency of increased radiographic bone loss (>2 mm) after 3 year was higher around the one-piece zirconia implants compared to conventional two-piece titanium implants. This investigation was supported by a grant from Nobel Biocare, Gothenburg, Sweden (grant # T-114). The zirconia implants were provided by Nobel Biocare.

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Zirconia and titanium implant abutments for single-tooth implant prostheses in posterior regions: A five-year prospective study

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Background: At present, dental implants and abutments are usually fabricated out of commercially pure titanium; the well-documented bio-compatibility and mechanical properties of such a material are reported in literature. Standardized titanium abutments represent the 'gold standard' for implant reconstructions due to the good stability of metal. In addition, the pre-fabricated components simplify the technical procedures. However, from an esthetic point of view, titanium may cause an unnatural appearance to the soft tissue. Tooth-colored abutments would provide better translucency of the implant restoration for an optimal muco-gingival esthetics. Abutments made of densely sintered yttrium-stabilized zirconia have been introduced to support implant-supported single tooth crowns; this ceramic reaches a flexural strength and fracture toughness almost twice as high as alumina. Several comparative clinical studies, however, are needed to support the assumption that zirconia may be suitable also for implant abutments.

Aim: The aim of the present prospective was to verify, in a medium-term follow-up, whether or not zirconia abutments show similar survival outcome as titanium abutments in posterior areas.

Methods: Eighty-five patients with a single gap posterior edentulism were treated with 85 implants supporting 47 titanium and 38 zirconia abutments, respectively. Each patient showed a single-unit edentulism and a healthy contra-lateral natural tooth as control. A two-stages surgical protocol was used. All-ceramic (38) and metal-ceramic (47) single crowns were fabricated. Each patient was followed for 5 years after the definitive prosthesis installation. Clinical and radiographical parameters were assessed at the yearly follow-up visit. Moreover, prosthetic complications were recorded. Statistical analysis was used to compare any difference in biological and radiographical parameters between implant sites and the natural contra-lateral teeth (Wilcoxon signed ranked test). Descriptive statistics were used to analyze the changes over time of clinical and radiographical parametersfrom baseline to the last follow-up. Depending on the clinical situation, either zirconia or titanium were used as abutment material. No randomization was performed for the abutment selection.

Results: Four patients were classified as 'drop-out'. Eighty-one implants supporting 44 titanium and 37 zirconia abutments completed the 5-years follow-up examination. No implant, reconstruction, and abutment failure were recorded: therefore, the prosthetic survival after 5 years of function was 100% for all the abutments and restorations. No significant differences in biological and radiographical indexes were found between Ti and Zr abutments when compared each other and with the natural teeth after 5 years. No significant marginal bone loss (MBL) was found between the baseline and the last follow-up, both for Zr and Ti abutments.

Conclusions and clinical implications: The medium-term survival of Zirconia abutments in posterior regions was comparable with that of titanium abutments. Long-term evaluations are needed to confirm this finding.

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Do cement remnants always lead to peri-implant disease? A retrospective case analysis

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Background: The use of cement-retained implant restorations involves a possibility of leaving residual cement in peri-implant tissues. To date it is not clear why in certain cases residual cement may lead to peri-implant disease and in others it does not. It is possible, that at least few factors, such as history of periodontitis and cement excess, may be required for the development of delayed peri-implant disease.

Aim: The purpose of this study was to determine the relationship between patients with history of periodontitis and development of cement-related peri-implant disease.

Methods: Seventy-seven patients with 129 implants for this retrospective analysis were selected from completed implant cases that had experienced mechanical or biological complications between years 2006 and 2011 in private practise. Implants with extracoronal residual cement and implants without cement remnants were analysed. The selected cases were further divided into two groups – periodontally compromised (1) and periodontally healthy (2). The selection into these groups was made on the basis of treatment history and orthopantomograph. As a control group, a set of 238 screw-retained implant restorations, delivered to 66 patients during the same period of time was examined. The incidence of peri-implant disease among implants in all groups was calculated.

Results: Peri-implant disease was evident in 62 out of 73 implants with cement remnants (85%). All implants in group 1 developed peri-implantitis – four early and 35 delayed disease cases. In the periodontally healthy group, 20 out of 31 implants were diagnosed with peri-mucositis, 3 implants had early peri-implantitis and 11 implants with cement remnants did not develop biological complications. In the groupof implants without cement remnants peri-implant disease was diagnosed in 17 out of 56 cases (30%). In contrast only two occurrences of peri-implant disease were registered in the control group of screw-retained restorations (1.08%).

Conclusions and clinical implications: Implants with cement remnants in periodontally compromised patients may be more likely to develop peri-implantitis. Screw-retained implant restorations should be considered in periodontally susceptible patients.

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Cell functions of human osteoblasts on UV-bioactivated roughened implant surfaces

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Background: Recent studies reported on significant effects of UV-induced bioactivation of implant surfaces on osteoblast cells. However, cells other than of human origin or cells not representing oral implant targets were frequently employed.

Aim: Therefore, the present study aimed at investigating distinct cell functions of primary human alveolar bone osteoblasts on UV-bioactivated roughened titanium- and zirconia-based implant surfaces in comparison to non-activated controls.

Methods: Disks of commercially available roughened titanium (TiUnite, NobelBiocare, Gothenburg, Sweden) and two zirconia-based implant surfaces (Zit-Z, Ziterion, Uffenheim, Germany; Zircapore; Metoxit, Thayngen, Switzerland) were treated with 345 J/cm² UV-C and 17 J/cm² UV-A light. Surface morphology and topography of the implant materials were analyzed using scanning electron microscopy (SEM) and interferometry. The chemical composition and wettability of the implant surfaces were examined by X-ray photoelectron spectroscopy (XPS) and contact angle measurement. Morphogenesis and cell attachment of human osteoblasts were examined by SEM, indirect immunofluorescence (IIF) of vinculin and DNA quantification. Cell proliferation was determined by alamarBlue metabolic assay. The gene expression of the osteogenic biomarkers collagen type I (COL-I), alkaline phosphatase (ALP) and osteocalcin (OC) was analyzed using real-time RT-PCR. Experiments for DNA quantification, cell proliferation and gene expression were performed in triplicate in three independent experiments, and were statistically compared using the Student's *t*-test (level of significance: $P < 0.05$).

Results: Surface characterization revealed different surface topographies of the examined implant materials. In terms of height deviation and surface enlargement TiUnite demonstrated the largest height deviation (S_a = 1.09 μm) and surface enlargement (S_{dr} = 67.3%), while Zit-Z demonstrated the smallest (S_a = 0.58 μm; S_{dr} = 19.4%). UV light treatment significantly changed material surface chemistry characteristics resulting in reduced surface carbon (reduction from 39% to 7%) and elevated surface oxygen (increase from 59% to 90%). Also, surface wettability was increased on all UV-treated materials. UV-induced bioactivation generally did not improve cell functions, including primary adhesion, morphogenesis, proliferation and gene expression of osteogenic biomarkers COL-I, ALP and OC ($P > 0.05$). However, it was observed that surface topogra-

phy influenced cell functions. While rougher surfaces (TiUnite, Zircapore) favored primary cell adhesion, proliferation appeared to be improved on smoother zirconia surface (Zit-Z).

Conclusions and clinical implications: The results indicated that distinct cell functions in primary human alveolar osteoblasts were rather modulated by surface topography than by UV-induced bioactivation of titanium- and zirconia-based implant materials.

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Human blood plasma protein adsorption on amine functionalized titanium surface

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Background: The surface functionalization of titanium by incorporating specific chemical groups may lead to a selective adsorption of blood plasma proteins, resulting in acquired pellicles with different proteome profiles.

Aim: This study evaluated the influence of amine functionalization on the titanium surface free energy and its effect on protein adsorption from human blood plasma.

Methods: Commercially pure titanium grade IV discs (12.7 × 2 mm; Ra = 1.3 ± 0.1 μm) were submitted to amine-functionalization by immersion in 10% (3-aminopropyl)triethoxysilane (APTES) in boiling toluene for 4 h under reflux. The control group received no additional treatment. The surface chemical composition was determined by X-ray photoelectron spectroscopy (XPS) and the surface free energy was determined with a goniometer by the acid-base method using formamide, bromonaphthalene and purified water as probing liquids ($n = 6$). The polar component, dispersive component and total energy were computed automatically by the software. After the treatments, 24 discs of each group were individually incubated in 2 ml of human blood plasma for 3 h at 37°C. After the removal of non-absorbed proteins, the discs were vortexed for 30 s and sonicated (7 W, 5 min, 4°C) to extract the protein pellicle. The total protein was quantified using the Bradford techniques by a blind examiner at three independent experiments ($n = 8$). Data were subjected to student t-test ($\alpha = 0.05$). Next, 15 μg of the recovered proteins from each group were subjected to identification by a Q-TOF mass spectrometer coupled to a nanospray ESI interface. The identification was performed by Mascot Server against the International Protein Index (IPI) database.

Results: The diffract grams of XPS analysis showed a higher content of nitrogen N1s in the amine-functionalized group; however, no difference was found between groups regarding surface energy ($P > 0.05$). The total amount of proteins recovered from the pellicle was higher ($P < 0.05$) in amine functionalized (214.76 ± 4.45 μg) in comparison to the control group (179.05 ± 5.29 μg). However, the proteome of the acquired pellicle was not influenced by the surface chemical composition.

Conclusions and clinical implications: It is possible to conclude that amine functionalization increases the quantity of adsorbed proteins from the blood plasma, despite no changes on surface energy. However, the amine groups present on surface were not able to adsorb specific proteins from human blood.

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Platform switching vs. platform match: interim results from a prospective randomized-controlled multicenter study

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Background: Platform switching concept is based on the discrepancy between smaller diameter prosthetic abutments related to implant platform diameter and clinically seems promising to preserve crestal bone height and soft tissue levels increasing quality outcomes in treatments with dental implants and patient satisfaction. However, it is well-known the lack of well-designed prospective randomized clinical trials evaluating the efficacy of platform switching vs. platform match placed in partially edentulous mandibles.

Aim: The purpose of this five-year prospective randomized multicenter study was to assess the differences in bone level changes and success rates between CAMLOG® SCREW-LINE implant supporting single crowns in the posterior mandible restored either with standard abutments or abutments with platform switching (FDI positions 37–34 and/or 44–47). This paper presents interim results obtained up to 2 years.

Methods: Patients $\geq$18 years old missing two or more adjacent teeth in the posterior mandible and with a natural tooth mesially to the most proximal implant site were enrolled in this study. Free end situation was allowed and opposing dentition must be natural teeth or implant supported fixed restorations. Following implant placement (i.e. before placing the healing cap) patients were randomized either in the group of abutment for standard restoration or in the group for platform switching. Forty-three patients (seven of them split-mouth) with 91 implants followed-up to 1 year, and twenty-three patients (three of them split-mouth) with 56 implants followed-up to 2 years post-loading were included in this interim report. The distance from implant shoulder to first crestal bone contact, at mesial and distal side, was measured with standardized radiographs and statistical evaluation of significant changes in crestal bone levels between the two abutment types over time was performed with an equivalence test of means using a two-sided test on data from a parallel-group design.

Results: In the Platform Switching group a mean bone gain of 0.11 mm was recorded between the time of prosthesis placement and 12-months post-loading and 0.18 mm after 24-months post-loading while a bone loss of 0.20 and 0.26 mm, respectively, for one and two-years after loading, in the Standard group was measured. There is a significant difference ($P < 0.05$) between the two groups on the means of mesial and distal values averaged at 1 and 2-years post-loading.

Conclusions and clinical implications: At two-years, implants restored with platform switching abutments preserve the crestal bone more predictable than the implants restored with standard abutments.

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Abstract withdrawn

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Radiographic evaluation of marginal bone levels and prognosis of platform-switched implants: a 5-year prospective study

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Background: It is widely accepted that a marginal bone loss in the order of 1.5 mm during the first year of service, that is, during the first year after initiation of prosthetic loading, and an annual bone loss thereafter not exceeding 0.2 mm, is a natural feature and consistent with successful treatment.

Aim: The aim of the present prospective study on single tooth and partial fixed prostheses was to assess hard peri-implant tissue alterations from the time of implant placement.

Methods: One hundred patients (57 males and 43 females, mean age 54.8 years) were treated consecutively from March 2003 to September 2011 with implant supported fixed partial dentures (FPD's) or single tooth fixed prostheses (ST's) and included in the study. No patients received more than one implant-supported prosthesis. Sixty-six patients included in the study were rehabilitated with 66 single tooth (ST) implant-supported prostheses. Moreover, 34 patients were treated with 34 fixed partial prostheses (FPD) supported by 104 implants, respectively. Each patient was followed for 5 years after the definitive prosthesis installation. A total of 170 implants supported 100 prostheses. Clinical and radiographical parameters were assessed at the yearly follow-up visit. Moreover, prosthetic complications were recorded. Any difference in radiographical parameters between implants supporting different prostheses (ST vs. FPD) was compared. Marginal bone resorption (MBL) was evaluated and used as a parameter to define implant success. The MBL value was calculated by transposing patients X-ray images on a PC and then using a specific digital measurement software. Throughout the monitoring period, examinations were taken once every 12 months. Statistical analyses (Fisher's exact test) investigated the relationship between peri-implant bone resorption and the parameters considered in this study: length and type (mesial or distal) and opposite dentition to cantilever prostheses. A multilevel regression model was built to analyze factors influencing marginal bone loss (MBL) with three levels: subject as the highest, and then implant and site.

Results: After an average observation of 5.2 years no implants were lost, and the implant survival rates were 100% both for FPD and ST prostheses, respectively. In addition, the prosthetic survival rates were 97.1% and 100%, respectively for FPD and ST prostheses. The mean MBL value around implants supporting ST prostheses (0.20 mm) was lower than that of FPD prostheses (0.58 mm), but not not statistically different ($P > 0.05$).

Conclusions and clinical implications: The authors concluded that stable peri-implant bone levels can be achieved in a medium to long follow-up. So that, new and more strict success criteria related to the bone changes around implants could be considered instead of the ones traditionally observed in the literature.

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Use of ITI SLA short implants (6 mm) in single-tooth replacement: a prospective, controlled, randomized multicenter clinical study

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Background: The presence of anatomic constraints, such as maxillary sinus or alveolar nerve, often limits the use of long implants. Moreover, finite element modeling analyses have shown that occlusal forces are primarily distributed to the crestal bone rather than throughout the entire implant surface.

Aim: To compare 5-year follow-up clinical and radiographic outcomes and survival rate of short (6 mm) vs. long (10 mm) implants supporting a fixed single crown placed in the posterior sites, in partially edentulous patients.

Methods: Sixty implants with a moderately rough surface, 30 test (6 mm long, 4.1 mm in diameter) and 30 control (10 mm long, 4.1 mm in diameter), were placed in posterior sites in 49 patients. Implants were loaded after 6 weeks of healing. Implant survival rate and marginal bone loss were evaluated yearly. After 6 weeks of healing the implants were restored with a single fixed prosthesis made with gold palladium alloy and porcelain. The clinical crown/implant ratio was also calculated.

Results: Eleven out of 30 test implants were placed in the maxilla and 19 in the mandible; 16 out of 30 control implants were installed in the maxilla and 14 in the mandible. Two test implants were lost before loading. Two test and one control implants were lost during the 5-year follow-up. The total suc-

cess rate was 86.8% and 96.7% for the test and control sites, respectively. Small differences in bone levels were found between the time of prosthesis delivering and the 5-year follow-up, both at the test and control sites.

Conclusions and clinical implications: Short implants (6 mm) with a moderately rough surface loaded after 6 weeks of healing yielded a lower survival rate compared to the test implants (10 mm). Marginal bone levels remain stable during 5 years of loading both at 6 and 10 mm long implants.

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Microbiology of 2 implant systems, placed following a split mouth randomised protocol, at 12th year of loading

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Background: It has been suggested that differences in the microbiota might occur as the result of various implant characteristics. However, several other studies could not relate the presence of particular microorganisms to a particular implant system.

Aim: To compare the subgingival microbiota around two differently designed implant systems that were in function for more than 12 years in a randomised, split-mouth, study design and to compare the outcome with natural dentition.

Methods: Thirteen partial edentulous patients received at least 2 TiO blast Astra Tech®and 2 Brånemark®implants, 12 years ago, following a split mouth design. This allowed a comparison of 34 Astra Tech (Impl A) with 32 Brånemark (Impl B) implants. At the last follow-up visit periodontal parameters (probing depth, bleeding on probing and plaque) were recorded and intra-oral radiographs were taken to calculate bone loss. Subgingival plaque samples were collected for culture, qPCR and checkerboard DNA-DNA hybridization analysis. These data were related to implant design and bone loss.

Results: After 12 years of function, no implant has failed. Mean bone loss between loading and year 12 was 0.7 mm (range: -0.8 ± 5.8) (Impl A), and 0.4 mm (range: -1.1 ± 4.1) (Impl B). No significant microbiological differences (qualitative and quantitative) could be observed between both implant types. Compared to teeth, subgingival plaque samples from implants did not reach the concentration in pathogens as of the teeth, even after 12 years of function.

Conclusions and clinical implications: These data show that both implant systems (with difference in macro-design and surface characteristics), in patients with a good oral hygiene and a stable periodontal condition, can maintain a successful treatment outcome without significant subgingival microbiological difference after 12 years of loading. The presence of periodontopathogens did not necessarily result in bone loss.

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Clinical evaluation of an alumina-toughened oral implant: 3-year follow-up – soft and hard tissue response

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Background: Alumina-toughened zirconia (ATZ) for use as oral implant material was not evaluated so far.

Aim: The objective of this prospective 5-year cohort investigation was to evaluate the survival/success rate, the bone remodelling and the soft tissue response of a one-piece ATZ oral implant after 3-years.

Methods: The investigation was approved by the ethics committee of the University Clinics Freiburg, Germany. Twenty patients were – after having signed an informed consent – included and each patient received one ATZ implant (Ziraldent, Metoxit, Thayngen, Switzerland) for single tooth reconstruction. The implants were immediately temporized after insertion and permanently restored after 4–8 months. For the evaluation of bone remodelling, standardized radiographs were taken at implant placement, at 1 year and at 3 years. For the evaluation of the periimplant soft tissue probing depth, gingival recession, clinical attachment level, bleeding index and plaque index were recorded at prosthetic delivery, at the 1-, 2- and 3-year follow up.

Results: Of the 20 patients, 17 were seen at the 3-year follow up. Two patients lost their implants due to non-integration after 3 and 4 weeks post implantation (implant survival rate of 90% at the 3-year follow up). Due to severe medical problems, one patient could not attend the 3-year follow up and dropped out of the investigation. The average marginal bone loss from implant placement to the 1-year follow-up amounted to 0.72 mm (SD 0.73 mm; $n = 17$) and from implant placement to the 3-year follow-up to 0.43 mm (SD 0.75; $n = 17$). The plaque index around implants and neighbouring teeth was on a low level over the 3 year observation period. The probing depth increased over time for implant and tooth sites, the implant sites always showing significantly higher values than tooth sites. The gingival recession decreased at implant sites over the study period and remained stable at tooth sites.

Conclusions and clinical implications: Due to the low number of included patients, the two implant losses weigh high. In this context, it has to be mentioned that the lost implants were the first to be placed. After those losses, no further losses occurred. The marginal bone loss after 3 years is comparable to the results obtain from studies of two -piece implants when immediately loaded. The soft tissue response around the implants is favourable and comparable to other implant systems. This positive result justifies an investigation including a larger population to evaluate the system. This investigation was supported by Metoxit AG, Thayngen, Switzerland

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New method and software prototype for automatized measuring of crestal bone levels around implants

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Background: Precise assessment of marginal bone levels is critical for the correct determination of success of clinical implant studies. Digital radiographic images are currently the most popular method for qualitative and semi-quantitative evaluation of the proximal bone level changes around implants or teeth; however quantitative analysis of bone loss or gain is not always accessible to the clinician due to image projection errors.

Aim: This study aimed at the elaboration of a new automatized method for detecting implant edges and crestal bone line on digital X-ray images based on the suitable combination of pre-processing and image segmentation techniques. This procedure allows the computation of the accurate distance between the implant shoulder and the crestal bone (proximal bone loss determination). For the exploitation of the segmentation method and user interface, we developed a software system prototype named DISIAT (Dental Image System for Implants Analysis and Tracking). The method was validated by statistical determination of the differences between the automatized measurements obtained by DISIAT and manual measurements done by experts on the same periapical digital radiographs.

Methods: Forty standardized digital radiographs of implants in the molar and pre-molar mandibular region, during a follow-up period of one-year, were analyzed using the DISIAT application. The method uses pre-processing tools such as noise suppression filters, histogram thresholding and mathematical morphologyfor bone line and implant contour determination. Active shape models were introduced in the program to segment both mesial and distal sites of the implant and to determine the model. Bone line segmentation was similarly obtained from training models of these radiographs. Measurements of mesial and distal bone levels were obtained with the appropriate feature extraction techniques. These results were compared with the matching reading from a group of experts and statistically analyzed with the paired-samples *t*-test (PASW® Statistics 18; IBM, USA)

Results: Fifty-six measurements were considered for comparison. No significant differences were found between the manual measurements performed by the experts and the measurements obtained by the DISIAT prototype ($P = 0.276$). The mean difference was -0.04863 ± 0.33088.

Conclusions and clinical implications: Automatizedimage segmentation with determination of implant boundaries and crestal bone line is a promising technique for simple bone level measurement around dental implants. The new proposed method/prototype has proven to be a robust tool, as no significant differences were found between the manual measurements and those produced with the DISIAT application. More, the mean difference between the measurements was 0.04863, inferior to the 0.15 acceptable threshold for error among experts evaluations.

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A quantitative *in vitro* study of the abutment micromovement in conical dental implants using synchrotron-based radiography

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Background: The implant-abutment connection of a conical two-piece dental implant depicts a complex micro-mechanical behavior: a micro-gap is evident at the implant-abutment interface with and without load. Its width varies when external mechanical load is applied. High resolution synchrotron-based radiography in combination with hard X-ray phase contrast to image this gap and estimate its size is deployed.

Aim: Visualization and quantification of micro-gap formation and micro-movement of the abutment *in vitro* under mechanical loads in two-piece conical dental implants. The influence of fatigue loading on the stability of the implant-abutment connection is also evaluated.

Methods: Within this study four commercially available implants with different internal conical implant-abutment connections are fatigue loaded according to DIN ISO 14801:2003 and their abutment movement under load application in various angles is visualized with hard synchrotron X-rays. The quantification of the micro-gap formation is performed using a previously published method (phase contrast).

Results: The results show that between virgin implants and fatigue loaded implants the size of the micro-gap and therewith the ability of micromovement increases. The cone angle of the connection influences the stability of the abutment in dependency of the angle of force application. Cyclic loading at medium force (120 N) induces plastic deformation of the titanium implant.

Conclusions and clinical implications: This underlines, that regardless of their cone angle and cone length conical implant-abutment connections allow micromovement of the abutment and fatigue enhances the ability of micromovement.

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Nanocoating with pectins – a novel surface for osseointegrated titanium implants

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Background: Titanium implants with microstructured surfaces have been used with success for bone anchoring of dental and orthopedic prosthesis. However, in cases where bone volume at the implant site is reduced or where bone metabolism is affected, improvement of bone healing and osseointegration is needed. Nanoscale modification of polystyrene surface with pectins, polysaccharides of botanical origin have been preliminary tasted *in vitro* and showed improvement of osseointegration by affecting surface properties and biological activities.

Aim: The aim of this project, was to evaluate the influence of nanocoating with pectins on titanium surface and their influence on surface properties, osteoblast attachment, cell viability and mineralization.

Methods: Pectic nanocoatings on titanium discs (diameter 13 mm) were represented by Rhamnogalacturonan-I (RG-I) extracted from the destarched potato pulp and enzymatic modified. The arabinan and galactan side chains were removed with α-L-arabinofuranosidase, Endo-arabinanase and β-galactosidase and Endo-1,4-β-galactanase. Modified structure of potato RG-Is was analysed with Multimode AFM on Mica. The RG-Is were covalently coated on aminated titanium discs (aminated Ti). The discs were evaluated by scanning electron microscope, contact angle measurements, atomic force microscope, and X-ray photoelectron spectroscopy. For viability and mineralization assays human osteoblast-like SaOS-2 cells were cultured for 10 days on aminated Ti discs coated with RG-Is. The viability assay used 10% tetrazolium salt and in the mineralization assay cells were stained with 40 mM Alizarin Red-S. Untreated (Ti) and aminated Ti discs were used as controls. The micrographs of SaOS2 were performed by confocal laser scanning microscopy. The results were analysed using ANOVA tests and Bonferroni corrections for multiple comparisons using SPSS 11.5 software.

Results: The enzyme treatment resulted in a reduction of the respective side chains. Enzymatically modification affected the RG-Is structure and surface properties. The viability assay showed that the greatest amount of cells were on the Ti control, while on RG-I coated surfaces the highest amount of cells were detected on Ti surfaces with potato dearabinanated and degalactanated pectins. The mineralization assay showed a significant increase in matrix deposition for cells cultured on titanium discs coated with potato unmodified compared with Ti control. The cell viability was significantly decreased when the titanium surface were coated with potato unmodified RG-I compared to Ti control, but this coating significant increased the ability of the cells to mineralize the extracellular matrix compared to cells in the Ti control group.

Conclusions and clinical implications: These results make RG-I a novel candidate for nanocoatings of dental implants with promising improvement of osseointegration.

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How to establish a suitable surface roughness for zirconia implant abutments under laboratory conditions?

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Background: Current implant suprastrucures involve computer-aided design (CAD)/computer aided manufacturing (CAM)-derived zirconium abutments. Since these abutments are custom-made the question arises how and to what extent the surface of these abutments should be polished. A surface roughness of Ra = 0.2 μm is reported to be ideal for dental surfaces in the oral cavity and especially for implant abutments.

Aim: The aim of this study was to assess and compare four different standardized polishing protocols of dental zirconia using a standard handpiece and abrasives. A further objective was to identify a standardized protocol to obtain a surface roughness of Ra = 0.2 μm on dental zirconia.

Methods: A total of 40 rectangular specimens madefrom yttrium-stabilizedzirconiawere produced and finished with four different polishing protocols (P1-P4) in groups of 10, using a standard laboratory handpiece and abrasives. P1: grain size 100 μm, P2:P1+ grain size 40 μm, P3:P2+ grain size 6 μm, P4: P3+ high-gloss polishing. To develop a reproducible, standardized polishing protocol the samples were grinded using an automatic device. Roughness measurement using an optical profiler and scanning electron microscopy was performed for each specimen. The alpha-error was set at 0.05.

Results: Surface modification with protocol P1 (Ra 0.29 ± 0.38 μm) showed significantly higher Ra-values than P2 (Ra 0.22 ± 0.38 μm) ($P = 0.005$), P3 (Ra 0.17 ± 0.37 μm) ($P = 0.000$) and P4 (Ra 0.07 ± 0.06 μm) ($P = 0.01$). P2 tended to produce rougher surfaces than P3 ($P = 0.118$), whereas P4 showed significantly lower Ra-values than all other groups ($P < 0.05$, ANOVA, respectively). Comparison of the Ra-value of the four protocols revealed statistically significant differences to the ideal roughness of Ra = 0.2 μm for P1 ($P = 0.00$), P3

($P = 0.043$) and P4 ($P = 0.00$), but not for P2 ($P = 0.17$) (Student 's t-test, respectively).

Conclusions and clinical implications: It was concluded that the ideal surface roughness of Ra = 0.2 μm can be achieved by preparation of zirconia surfaces following the P2 protocol. High-gloss polishing results in a surface roughness significantly lower than this value.