The average crestal bone loss health and social care essay

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ABSTRACT

Purpose: This study was done for quantitative evaluation of crestal bone loss occurring around root form, threaded collar, two-piece, endosseous implants. Also, since the imaging modalities have seen a drastic change over the last decade. Newer imaging modalities such as CBCT have started to replace RVG for implant imaging. Aim: The aim of this study was to quantitatively compare crestal bone levels around root form, threaded collar, two-piece, endosseous implants (ADIN-SWELL) immediately after placement & nine months after placement using Digital radiography (RVG) & CBCT. Also, the efficacy of RVG for evaluation of crestal bone levels in comparison to CBCT was checked. Materials and Methods: Ten implants were placed in mandibular first molar region of ten partially edentulous patients. The crestal bone levels were evaluated by using RVG and CBCT. The crestal bone levels were measured at three time intervals for RVG i. e. immediately post implant placement, sixteen weeks post implant placement and twenty weeks post implant loading and at two time intervals for CBCT scan i. e. immediately post implant placement and twenty weeks post implant loading. The results were then statistically analyzed using 1- way ANOVA (for comparison among various implants for each point of time), 2- way ANOVA (Repeated measure analysis) (for comparison of change over a period of time in each implant) followed by post Hoc test. P value <0. 05 was considered significant. To verify the correlation between RVG and CBCT, Bland and Altman graph and ICC curve were used. Results: Average Crestal Bone Loss around Implants measured using RVG was 0. 61 ± 0. 13 mm and using CBCT was 0. 58 ± 0. 15 mm. The statistical difference was found to be non-significant (p <0. 05)

between the average crestal bone loss measured using the two imaging modalities. The Intra-class correlation coefficient between measurements made using RVG & CBCT was found to be significant (p <0. 05) with ICC value of 0. 944. Bland and Altman plot having a confidence interval of 95% shows that there is a high degree of agreement between the measurements made by the two imaging modalities. On using RVG as the projectional modality, a bone gain was observed in 4 of the 10 implants during the five months of functional loading. This gain was in the range of 0. 2 - 0. 5 mm on the mesial side and 0. 1 - 0. 5 mm on the distal side. Conclusions: The results of the study showed that the RVG and CBCT had a significant agreement between measurements of crestal bone loss made using the two imaging modalities and 40% of ADIN-SWELL two-piece, root form, threaded collar, endosseous implants showed an increase in crestal bone levels 5 months post loading of the implants.

INTRODUCTION

The present study made an attempt at evaluating the crestal bone adaptation to placement and loading of implant over aperiod of nine months. Measuring cumulative peri-implant crestal bone loss in radiographs is a means for researchers and clinicians to evaluate dental implant performance, i. e. success vs. failure. A classic widely quoted paper by Albrektsson1 established the success criteria that the marginal bone level change in the first year should be 0. 1–1. 5mm, and ongoing annual bone loss should be less than 0. 2mm. Adell2 reported a bone loss of 1. 2mm in the Branemark Systems for the first year in his 15-year study. However, with the advent of more textured implant surfaces, and modified implant designs,

e. g. crestal micro-threads or platform-switching, this older criterion no longer stands up to scrutiny. Indeed, many newer implant designs show stable bone levels regardless of time in function if optimal treatment has been provided from the outset. The six main factors listed in literature for crestal bone loss are surgical trauma, occlusal overload, peri-implantitis, microgap, biologic width and implant crest module. 3 However preservation of bone is a multi-factorial process, affected by other secondary factors such as bone volume, bone quality, soft tissue biotype, implant design, implant dimensions, abutment design, augmentation procedures, implant insertion depth, time of loading, frequency of prosthetic secondary component replacement, suturing technique and patient compliance. 4The explanation offered for crestal bone loss is mainly based upon the stress distribution around the fixtures. It has been demonstrated by photo-elastic and finite element analysis studies that stress is concentrated around the crestal region. 5 When there is excessive stress (pathologic overload) in a localized region (bone crest) due to prosthetic loading, crestal bone loss will occur. 6A successful dental implant requires that osseointegration be achieved and crestal bone height be maintained. It was proposed that bone-retention elements such as microthread and rough surface at the implant neck might help stabilize the marginal bone. 7 Various implant crest modules or neck collar designs are being studied and proposed to reduce crestal bone loss. Many of the implant systems have a polished collar design to aid in reducing plaque accumulation and to promote biologic seal around the implant collar. Such collar design may itself be contributory to crestal bone loss. Prosthetic loading of implant may aggravate the crestal bone loss, initially. However the amount of bone loss that would occur before prosthetic loading using rough surface, microthreaded crest module, two-stage implants, needs further evaluation.

MATERIALS & METHODS

Patients and Implants

Subjects were selected from patients referred to the Department of Prosthodontics, Crown and Bridges, Maxillofacial Prosthodontics and Oral Implantology, I. T. S Center for Dental Studies and Research, Muradnagar, between October 2010 and October 2011. The implants used for the study were ADIN - SWELL, root-form, threaded collar, two-piece implants (3. 75/4. 2mm D X 11. 5/13mm L) CE certified, ISO 13485, US FDA approved. Patients were consecutively enrolled in the study according to predefined inclusion criteria as per Table I

Table I: Inclusion Criteria

Male patientsPartially edentulous sites in mandibular posterior regionAge range of 20 -50 yearsBuccolingual width not less than 7mmMesiodistal width not less than 7mmInter-occlusal distance not less than 8mmWell rounded ridge which does not require osteoplasty (evaluated clinically on palpation and radiologically by OPG)

Implant Treatment

A two-stage implant placement procedure was followed for placement of implants in the mandibular first molar region. For placement of implant in the centre of the edentulous span and in a standardized manner a surgical template was fabricated. Complete measures of asepsis were maintained during the surgery and all sterilization protocols were followed. Sequential osteotomy was performed (Drill sequence 2. 0, 2. 8, 3. 2/3. 65) under copious irrigation, depending on the implant size planned for the patient. During the procedure guide pins were used to check the angulations. Primary closure was achieved using Ethicon 3-0 (reverse cutting) suture. Single PFM crowns were placed after 16 weeks of submerged healing. After occlusal adjustments were made, passivity of the fit was ensured using a 30μ articulating paper on the prostheses to make passive contact in centric and no contact in eccentric. Dental floss was used to verify the contact points. All surgical and prosthetic procedures were performed by the same clinician.

Follow-up

Radiographic examinations were conducted at baseline (i. e. immediately post implant placement) and at 16 weeks post implant placement and 36 weeks post implant placement (20 weeks post loading). After implant placement, standardized digital IOPAs were taken sing Kodak 5100 RVG and intra oral x–ray system (Kodak Dental System, Carestream Health Inc, Rochester, NY, USA) at 1week, 16 weeks and 36 weeks post implant placement to assess proximal bone changes, incorporating paralleling technique. RVG was done at exposure parameters of 70kV and 7mA for 0. 160 seconds, standardization was done with Hawe X-ray sensor holder system (Kerr Hawe SA, Via Strecce, Bioggio /Switzerland). After obtaining the images, a computer software program (Kodak 6. 11. 7. 0 dental imaging software digital IOPA) was used to measure proximal bone levels on radiographs. The known length (11. 5 /13mm) of the implant was used for calibration of measurements. The measurement were made from the implant abutment junction to the first BIC (bone to implant contact) both mesial and distal to the implant. Radiographic measurements of marginal bone levels (mesial/distal) were made to the nearest 0. 1 mm. A small field of view (FOV) i. e. 5cm x 5 cm post-surgical CBCT scans of the mandibular first molar region were performed using Kodak 9300 CBCT unit (Kodak Dental System, Carestream Health Inc, Rochester, NY, USA) at 1 week and 36 week after surgery. The scans were done with exposure parameters of 84kVp and 5mA at 200 micron resolution, using a bite platform between the upper and lower arches for patient positioning. Images were reconstructed with a slice thickness of 0. 2mm. Multiplanar image reconstruction and reformation was performed, crestal bone levels were then checked on, buccal, lingual, mesial and distal surface of implants with interactive CBCT software (3DTM Cyber-Med Inc., Seoul, South Korea). Crestal bone levels were assessed from 3 digital IOPAs and 2 CBCT scans. Bone loss per surface (buccal, lingual, mesial and distal) was calculated as the difference between first, second and third set of readings. Bone loss was measured on the buccal, lingual, mesial and distal sides of the implants and the average value was used.

Statistical Analysis

The data obtained was entered into MS Excel spread sheet and analyzed, using SPSS statistical software version X. Descriptive statistics was calculated for each variable of both the groups, using Two-way ANOVA test. The values of the crestal bone loss in millimeters around each implants at four different positions at three time intervals was compared using Post Hoc Test [Multiple Comparison] following Bonferroni method having p <0. 05 as significant value. For comparison of the crestal bone loss among implants at particular time interval, descriptive statistics was calculated for each variable in the two groups, using One-way ANOVA. The values of the crestal bone loss around implants at particular time interval was compared using Post Hoc test [Multiple Comparison] following Bonferroni method having p <0. 5 as significant value.

RESULTS

The test group comprised of 10 male patients in age group from 25-55years in which 10 single root form, threaded collar, two-piece, endosseous implants were placed in mandibular first molar region. All patients achieved an initial implant stability of more than 35 Ncm. No remarkable complications were experienced over the course of the study. No patient reported suffering from pain, and no mobility or prosthetic complications were detected. Statistically significant (p <0. 05) bone loss was observed on all surfaces (buccal, lingual, mesial and distal) from the time of implant placement to thirty six weeks post implant placement (twenty weeks post implant loading). Table 2 shows the changes in bone loss for each interval and on each side measured using the two imaging modalities. On using RVG as the imaging modality, statistically significant crestal bone loss 0. 72 ± 0. 15 mm on mesial side and 0. 51 ± 0. 14 mm on the distal side was observed from immediately post implant placement to twenty weeks post implant loading (a total of 36 weeks post implant placement). Further, using RVG as the imaging modality it was observed that the majority of the bone loss occurred during the healing phase prior to stage two surgery. A significant bone loss was observed on distal side 0. 53 ± 0. 18 mm from the time of implant placement to sixteen weeks post implant placement (prior to stage II). On using CBCT as the imaging modality, statistically significant crestal bone loss 0. 71 ± 0. 27 mm on buccal side, 0. 43 ± 0. 16 mm on lingual side, 0. 69 ± 0. 11 mm on mesial side and 0. 50 ± 0. 14 mm on the distal side was observed from immediately post implant placement to twenty weeks post implant loading (a total of 36 weeks post implant placement). These values of crestal bone loss, measured on mesial and distal sides are in accordance with the values of crestal bone loss that have been reported in literature. Average Crestal Bone Loss around Implants measured using RVG was 0. 61 ± 0. 13 mm and using CBCT was 0. 58 ± 0. 15 mm. The statistical difference was found to be non-significant (p <0. 05) between the average crestal bone loss measured using the two imaging modalities. The Intra-class correlation coefficient between measurements made using RVG & CBCT was found to be significant (p <0. 05) with ICC value of 0. 944. Bland and Altman plot having a confidence interval of 95% shows that there is a high degree of agreement between the measurements made by the two imaging modalities.

DISCUSSION

There are six main factors listed in literature for crestal bone loss are surgical trauma, occlusal overload, peri-implantitis, microgap, biologic width and implant crest module. 3 However preservation of bone is a multi-factorial process, affected by other secondary factors such as bone volume, bone quality, soft tissue biotype, implant design, implant dimensions, abutment design, augmentation procedures, implant insertion depth, time of loading, frequency of prosthetic secondary component replacement, suturing technique and patient compliance. 4One of the first studies to understand and quantify the early crestal bone loss was a 15-year retrospective study which evaluated implants placed in edentulous jaws. In this study Adell et al reported an average of 1. 2 mm marginal of bone loss from first thread during healing and the first year after loading. In contrast to the bone loss during the first year, there was an average of only 0. 1 mm bone lost annually thereafter. There are many imaging modalities currently available for pre-implant imaging, including intra oral peri apical radiography, conventional extra-oral radiography, tomography, computed tomography (CT), cone beam volumetric tomography (CBVT) and magnetic resonance imaging (MRI). 8Monsour et al8 stated that for evaluating crestal bone loss around implants, the long cone paralleling technique is one of the most predominantly used radiographic modality. The reasons for this are: reduced skin dose (0. 005–0. 015 mSv); less magnification; a true relationship between the bone height and adjacent teeth. RVG aids in capturing this image in computerized format and the software's further aid in quantifying these bone levels. The latest imaging modality available which has progressively refined the quantification of crestal bone loss 3 dimensionally with an enhanced accuracy and a significant dose reduction (0. 052–1. 025 mSv) is Cone Beam Computed Tomography (CBCT). During the stage I surgical placement procedure an attempt was to place all the implants equicrestally. However, since the topography of the bone at the site of placement was not planar, hence to achieve equicrestal plane on all the 4 sides (i. e. buccal, lingual, mesial and distal) was not possible. Osteoplasty was not done in any of the cases in this study. Goyal9 observed that if bone width is increased by osteoplasty, very valuable cortical crestal part of bone is lost and implant lies in underlying trabecular bone which is less dense and offers less bone to implant contact, thus less primary stability and an increased prosthetic space. In this study the implants selected i. e., Adin

Swell have a Pure Titanium Surface (PTS)10 that has been developed by ADIN based on research for a debris free surface that increases implant bone contact for maximum osseointegration. Unlike conventional surface treatment methods such as blasting with Aluminum Oxide or etching with chemicals, PTS(TM) uses Calcium Phosphate, a biocompatible Resorbable Blast Media (RBM) and achieves the roughness that is needed for optimal osseointegration as well as higher purity level. Le Guehennec et al11 in their study found that osteoconductive calcium phosphate coatings promote bone healing and apposition, leading to the rapid biological fixation of implants. In our study, a crestal bone loss of 0. 53 ± 0. 18 mm was observed on distal side of implants from immediately post implant placement to sixteen weeks post implant placement using RVG as the imaging modality. This bone loss which is occurring prior to stage II can be attributed to the surgical trauma that occurred during implant placement and the elevation of full thickness periosteal flap. In the present study, out of the ten implants placed, six implants were placed supra-crestally within a range of 0. 10-1. 20 mm. 50% of these implants showed a bone gain after five months of prosthetic loading. This bone gain was in the range of 0. 2-0. 5mm on the mesial side and 0. 1-0. 5mm on the distal side. This bone gain was also observed in one of the implant that was placed equicrestal, it showed a bone gain of 0. 5mm on the mesial side and 0. 6mm on the distal side after five months of prosthetic loading. Such findings have been previously reported in literature by various authors Henry et al12, Blanes et al13, Brunski14, Ganelez et al15, Schwarz16, Wowern et al17; although very few authors have elucidated the possible reason that could be attributed to this occurrence. In more modern engineering terms, bone is presumed to have a control system (eg. Frost's

Mechanostat, 1987) that acts to maintain a constant environment in the bone cells when external bone conditions change. Another aspect that has come into light in our study is that out of the implants placed supracrestally 50% of the implants showed bone gain. Hermann et al18stated that even the smallest sized microgap (<10ums) can lead to a significant crestal bone loss in two piece implant configuration. It may seem possible that a supracrestal placement has shifted this microgap coronal to the alveolar crest. This in turn has shifted the inflammatory mediators away from the crest and helps prevent bone loss. Upon reviewing the literature the phenomenon of crestal bone gain around dental implants is supported by several longitudinal clinical studies. However, till date no study has been able to explain that why this phenomenon is seen in some cases whereas bone loss is seen in others. On reviewing the work done by authors such as Henry et al11, Blanes et al12, Brunski13, Ganelez et al14, Schwarz15, Wowern et al16 on crestal bone changes, it can be said that this bone changes may be host dependent. The bone density of each individual varies and this variation is present even at different regions in oral cavity. Thus the same forces acting in the oral cavity in similar fixtures with same gingival biotype, surgical technique, loading protocol and occlusal material may become stimulatory at some sites and an overload in others. The present study complements reviewed literature regarding crestal bone loss and it can be postulated that in future, positive bone formation may be seen at the alveolar crest region, which is an area of high stress concentration. Thus what is required is a change in perspective about how to view this dynamic bone adjacent to the fixture (dental implant). A lot of answers still remain hidden after conducting this study but the study definitely opens a plethora of possibilities of retrospective analysis of implants showing bone gain.

SUMMARY & CONCLUSION

This study has thrown light on changes in crestal bone levels around implants over a period of nine months. The concept of using microthreaded implants for reduction in crestal bone changes has been addressed in this study. Also, some light has been shed on the factors effecting crestal bone loss which has yielded key variables that need consideration to reduce the bone loss in this critical area of high stress concentration. The following conclusions are drawn from this study: The design of the root form, threaded collar, two-piece, endosseous dental implant (ADIN -SWELL) used in the study was found to be favourable as the crestal bone changes observed over 9 months of implant placement, are in the range of 0. 1mm - 1. 10 mm on the mesial side and . 01mm - 1. 30mm on the distal side which similar to the measurements already documented in the literature. CBCT is an efficient method for evaluation of changes in crestal bone levels occurring circumferentially around implants on buccal, lingual, mesial and distal sides. For evaluating crestal bone loss using RVG as the imaging modality, the long cone paralleling technique is one of the most predominantly used technique. A crestal bone loss of 0. 72 ± 0. 15 mm and 0. 51 ± 0. 14 mm were found from immediately post implant placement to twenty weeks post implant loading (36 weeks post implant placement) on mesial and distal sides of the implants respectively. A bone gain in the range of 0. 2 - 0. 5 mm on the mesial side and 0. 1 - 0. 5 mm on the distal side were observed in 40% of the 10 implants when evaluation was done using RVG. An agreement was found in measurements made by two imaging modalities RVG and CBCT, on evaluating crestal bone changes around implants. A statistically significant Intra-class Correlation Coefficient (ICC) value of 0. 944 was observed. A single implant replacing a missing first mandibular molar, restored with porcelain fused to metal crown, with an occlusal scheme of passive centric and no eccentric contact is a favourable treatment option, as all the 10 implants showed a crestal bone loss well within the values already documented in the literature.