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Effect of High insertion torque during placement of dental Implant on marginal bone in mandible

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Introduction

Presently, the most common procedure in oral surgery after wisdom tooth extraction are dental implants.[1] With the increasing number of dental implant placements, more and more post-operative complications also occur. Predictable success of dental implants has been reported because of enhanced implant surface modifications and improved understanding of osseointegration.[2]

Osseointegration has been defined as a direct and functional connection between the bone and an artificial implant.

Various factors influence the long-term prognosis of dental implants and can affect Osseointeg ration, such as surgical technique, host bed, implant surface, implant design, material bio compatibility, and loading conditions. Also Bone quality and quantity can influence the success of these procedures.[3] Height and density are two important parameters for a successful result in implantology.

Bone compaction and the Osseo densification technique positively affect the primary implant stability values in cancellous bone, which permits a high insertion torque.[4] Insertion torque is the force required for the implant to lock in the bone structure, expressed in newton centi meters (Ncm). The optimal torque value depends on the manufacturer's recommendations, but it is usually between 30 and 40 Ncm, and the higher the insertion torque, the greater the tension in the region.[5]

The crestal area receives the majority of occlusal forces that affect the surrounding tissue of an implant.[6] Interface and thus allow stress transfer to the sur rounding tissue if stress does not exceed localized yield strength of the cortical bone. Mechanical stress below a certain threshold result in apposition of peri-implant bone, whereas bone loss is observed beyond this threshold.[7,8,9] Higher insertion torque values are related to higher primary stability; however, excessive Osseo com pression can cause marginal bone loss. This may be associated with peri-implant bone injury and difficulties in vascularization, contributing to osteocyte necrosis, and resulting in microfractures in the cortical bone, extensive bone remodelling and minimal bone formation.[2]

Criteria for the evaluation of implant success are generally based on clinical and radiologic aspects such as probing depths, implant mobility, and peri-implant bone changes.[10,11] Peri-implant bone level alterations are considered as a significant indicator of implant health showing the majority of bone loss within the first year of implant placement.[2,11]

The marginal bone loss (MBL) of implants is one criterion used to determine the success rate of rehabilitation. A reduction in MBL can reduce other complications, such as soft tissue recession, peri-implantitis, fractures and implant loss. Historically, MBL from 1.2 mm to 2.0 mm is reported during the first year of function, with a further loss of 0.1 mm every year, with the greatest bone loss occurring during the first three months of occlusal loading.

Detection of factors impairing dental implant success is the main goal of recent research in implant dentistry. Information on the influence of insertion torque and marginal bone loss is one of the important aspects in success of dental Implants. Therefore, the aim of the present study was to evaluate the impact of insertion torque and marginal bone loss associated over a period of one year.

Material and methods

In this prospective study, a total of 60 implants were placed in 42 patients in the mandible. Inclusion criteria involved: (1) single tooth or multiple missing teeth, (2) teeth extracted for at least 6 months, (3) sufficient bone volume in height and width to allow for implant placement; (4) no active cavities, residual roots, peri apical or periodontal infection sand (5) without any augmentation procedure. Patients were excluded from the study if any medical or psychiatric contraindication to implant surgery and smoking was present.

For all individuals, a complete clinical examination was performed, and blood (including vitamin D) and imaging exams were requested. Peri apical, panoramic radio graphs were requested, according to the needs of the case, to guide the surgeon in their selection of the size and diameter of the dental implant. Dentium Super line dental implants were used. The implants were installed after administering a local anesthesia, following the manufacturers recommend dations.

In D2 bone under drilling using half-length of final drill. The surgeries were performed by single surgeon with at least 5 years of experience, assisted by two nursing assistants. Another surgeon was responsible for data tabulation. All implants were installed at the bone or infra bone level. The healing process was carried out under a closed mucoperiosteal flap, unloaded in two-stage implants. Reopening and installation of healing abutments occurred at three months after implant placement. Post operative analgesic, anti-inflammatory, chloro Hexi diene mouthwash and antibiotic medications were prescribed. The antibiotics used was Amoxycillin 875 plus clauvalinic acid 125 twice a day for 5 days). One week after surgery, patients were recalled for suture removal and control.

Two-dimensional X-ray images were taken immediately after surgery (00M), 3 months, 6 month and one year later. The radiographs were taken in the standardized way. MBL around the implant was calculated as the difference between the MBL of T0 and T1. The measurements were performed by a calibrated evaluator and blinded for predictor variables related to the implant or patient. The clinical monitoring included the assessment of bleeding on probing (4-point measurement) and peri-implant pocket depths (mesial, buccal, distal, and lingual). Peri-implant bone level changes were evaluated at the mesial and distal aspect of each implant by periapical radiographs after implant placement as well as after 3, 6, and 12 months.

Statistical analysis

A Student's t test was used for comparison of two independent groups of variables with a normal distribution and Mann-Whitney U test was used for comparison of two independent groups of variables with a non-normal distribution. ANOVA test was used for comparison of three and more independent groups of variables with normal distribution and Kruskal Wallis test was used for non-normal distribution. Chi-square test was used to assess relation between categorical variables. Pearson correlation was used to assess relation between numerical variables. Descriptive statistic para meters were presented as frequency, percentage (%), and mean ± standard deviation (mean ± SD). Statistical analysis was performed with SPSS 22.0 ($P < 0.05$).

Results

A total of 60 implants were placed in edentulous jaws of 42 patients (26 females and 16 males) with a mean age of 62.4 years at time of implant placement (range: 40–85 years). No sex and gender predilection was observed in both the group in relation to marginal bone loss. 45% patients (n = 27) had single implant, 20% patients (n= 12) had 2 implant, 5% patients (n = 3) had implant placed Implant lengths of 7mm, 8mm, 10 mm and 12 mm were used in 3% (n = 2), 18.33%(n = 11), 40% (n = 24) and 21.66% (n = 13) and a diameter of 4, 4.5, and 5 mm in 23.33% (n = 14), 48.33% (n = 29), and 28.33% (n = 17) of cases, respectively. Insertion torque of more than 70 Ncm was achieved in 54 cases. During the observation period, one implant (insertion torque >70 Ncm) was lost after uncovering and another after 5 months of loading period. The resulting 1-year implant survival rate was 96.66%. Mean probing depths after 6 and 12 months were 2.8 ± 1.2 and 1.5 ± 1 mm, respectively, and were not influenced by insertion torque. Bleeding on probing was seen in 31.66% (n =19) and 20% (n=12) after 6 months and 1 year of the implant sites.

The statistical evaluation revealed that the amount of marginal bone loss in >70 Ncm group was between 0 and 2.2 mm after 3 months of observation; the average MBL was 0.35±0.98 mm; 0 and 1.8 mm after 6 months of observation; the average MBL was 0.3 ±0.88 mm; 0 and 2 mm after 1 year of observation; the average MBL was 0.28±0.88 mm. The marginal bone loss <70 Ncm was between 0 and 1.8 mm after 3 months of observation; the average MBL was 0.22±0.94 mm; 0 and 1.4 mm after 6 months of observation; the average MBL was 0.3 ±0.90 mm; 0 and 1.6 mm after 1 year of observation; the average MBL was 0.28±0.94 mm. the marginal bone loss in high torque group is more but no statistical significant difference was observed between the two groups.

Table 1: Gender of patients

Male	Female
16 (23 implants)	26 (37 implants)

Table 2: insertion torque

	<70 Ncm	>70
No. of implant	10% (n=6)	90 (n=54)

Table 3: Marginal bone loss

	3 months	6 month	1 year
<70Ncm	0.35±0.98 mm	0.3 ±0.88 mm	0.28±0.88 mm
>70 Ncm	0.22±0.94 mm	0.3 ±0.90 mm	0.28±0.92 mm

Discussion

In the present study, though there was more marginal bone loss associated with >70Ncm group, no significant influence of insertion torque value on peri-implant bone level was observed. These results, however, are in contrast to generally accepted engineering principles of the relationship between stress and strain relationship.[8] The amount of strain is dependent on both the applied mechanical stress as well as the properties of the surrounding bone.[8] Thus, it is reasonable to assume that higher insertion torques may result in peri-implant bone loss due to excessive osseocompression[12] but it may not lead to statistical significant variation in marginal bone loss. Similar results were observed in an experimental implant design study where excessive strains at the crestal area may have contributed to peri implant bone loss due to static load.[13] In the present study, however, no significant influence of insertion torque on peri-implant bone loss was found. Different interpretations may be hypothesized: (1) compressive torque forces did not exceed the critical threshold in this anatomical region and (2) the surrounding tissue was not exposed to excessive dynamic load.[2] Static load was reported to induce structural adaptation of the peri-implant bone with absence of bone loss[14,15,16,17]; dynamic load, by contrast, is seen to have detrimental effects on peri-implant bone behavior.[18] Implant insertion torque analysis is a valuable method for estimation of primary implant stability at surgery.[2,19,20,21] Higher torque values were assumed favourable to obtain osseointegration, otherwise, implants were prone to failure because of decreased resistance of micromotions.[2,9,22] Recently, an in vitro study showed that high insertion torque values in dense cortical bone did not induce implant failure but increased primary stability.[23] It was assumed that higher bone density reduced the strain in the marginal bone when subjected to loading and thus reducing peri-implant bone loss in the adaptation phase.[8] This is in line with the present study, as higher bone density of the mandible may have prohibited bone loss.

Some studies have shown that high torque values do not affect the osseointegration of the implants, including being able to improve the bone healing process by the micro-fractures generated in the bone tissue.[23] These studies had a wide range of IT (>25–176 Ncm), and there was no consensus on what was considered a high insertion torque value.[23,24,25,26]

However, Geometric deformation of the anti-rotational system can compromise its function after a torque magnitude of 36 Ncm.[27] Finally, the clinician must be aware of the force limits supported by the implants if he wants to install the implants with high torque values, as the different models can present deformations in the fitting system of the prosthetic abutments and precision problems. As described by Kourtis and Collaborators, the inaccuracy of fit in the implant-abutment interface can increase the degree of rotational freedom and the risk for long-term success of the restoration.[28]

High insertion torques above 50 Ncm can generate high compressive stresses to the peri-implant tissues causing blood supply deficiency and bone necrosis during the osseointegration phase and early implant failure usually within the first month after placement.[29] A high insertion torque may occur during implant placement in high density bone tissue.[30,31] This observation has been demonstrated in a study that evaluated the relationship between bone density and the maximum insertion torque supported by the bone tissue, using computer Tomography images and Hounsfield scale, and found a significant correlation between bone density, insertion torque and primary stability.[31] However, the effect of all the above can lead to major marginal bone loss or loss of dental implant over a long period of time is contested.

Conclusion

Our study found that Marginal bone loss occurs more prominently in patient with implant inserted with high torque but no statistical significant difference was noted in comparison to implant inserted at nominal torque.

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