Original Article

Comparison of bone loss around submerged and non-submerged implants during osseointegration phase

ABSTRACT

Background: In Modern dentistry, the implant is the most popular and desirable management of tooth loss. Traditionally two stage (submerged) or one-stage (non-submerged) system has been added by many investigators. In the present study we evaluated the crestal bone loss during osseointegration phase among the three groups (i.e. submerged implants, non-submerged implants with anatomical healing abutment and non- submerged implants with esthetic healing abutment).

Material and Methods: 10 subjects with 30 implants, were enrolled in the study. Subjects were randomized in three groups i.e., group 1 submerged (n=10), group 2 non-submerged with anatomical healing abutment (*n*=10), group 3 non submerged with esthetic healing abutments (*n*=10). Intraoral periapical radiograph (IOPA), IMAGE J software and CBCT were used to evaluate the crestal bone loss around each implant at baseline, 1 and 3 months after implant placement.

Results: Crestal bone loss at the end of the 3months (osseointegration phase) was lowest in the submerged group (0.18+-0.06mm) followed by non-submerged esthetic group (0.21+-0.03mm) but it was statistically insignificant. Maximum amount of bone loss was observed in non-submerged anatomical abutment group (0.34+-0.03mm) which was highly significant.

Conclusion: It can be concluded that submerged implants technique is a better option in comparison to non-submerged implant technique in terms of radiographical performance during initial phases of osseointegration.

Keywords: Non-submerged anatomical healing abutments, non-submerged esthetic healing abutments, submerged implants

INTRODUCTION

In modern dentistry, the implant is most popular and desirable management of tooth loss. Implant dentistry is the field concerned with diagnosis, design, insertion of implant devices, and implant restorations. As it provides adequate function, comfort and aesthetic for the complete dentulous or partially edentulous patients. Leonard I. Linkow[1] was one of the first to insert titanium and other metal implants into the bone jaw.

Although the first discovery of Branemark was based on the process of osseointegration in which he presented his work on osseointegration 15 years back in Toronto. He proved that this process is the main point of interest when it comes to implanting a foreign object inside the jaw bone. His work was closely emphasized on which materials were susceptible for bone and which are not and have led to the most important discoveries in the world of dentistry. In most recent studies, the original concept of Branemark-1965[2] was based on using both the submerged

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and nonsubmerged approaches. The first human patient was treated in 1965 and since then dental implants have become one of the most significant advancements in dentistry. Traditionally two-stage system (i.e., submerged) or one-stage (nonsubmerged) has been added by many investigators.[3] Two techniques of implant placement described by Branemark[4] out of which the submerged healing aimed to heighten the process of remodeling and new bone formation following implant placement and usually preferred in cases of guided bone regeneration (GBR) and ridge augmentation procedures which protect the implants from unintended functional loading forces in preliminary healing period. This submerged technique composed of two surgical stages; in first stage the implant is placed inside the bone and after a preliminary phase of osseointegration, the (transmucosal) abutment is attached in a second stage, as it circumvents the overloading of the implants during initial osseointegration phase. This secures the healing period in serrations from the oral medium [Figure 1].[5] The procedure has been widely researched and documented and has shown good short-term[6] and long-term outcomes.[7]

The one-stage, or nonsubmerged, implant has a polished collar that extends through the oral mucosa and attaches to the prosthetic components at supragingival or slightly subgingival location.

Recent studies have shown that osseointegration can be achieved using a single-stage surgical procedure. In this, the transmucosal abutments are placed in a single procedure and the abutment remains exposed to the oral medium during the osseointegration period.[2]

The nonsubmerged technique shows various advantages; it only requires a single surgery, which makes it more cost-effective and reduces the number of patients visit, potential discomfort, and minimizes the changes in coronal direction of the mucogingival junction.[8,9]

Supragingival components (abutments) have two subtypes, one is esthetic healing abutment and other is anatomical healing abutment. Esthetic abutment has same height and taper as the anatomical abutment but its base is narrower than the implant platform. It also ensures the good emergence profile, particularly in the esthetic zone as well plays a role in preventing peri-implant disease by forming a barrier to efficiently protect underlying bone and prevent access for microorganisms [Figure 2].[10] Studies have shown that peri-implant crestal bone loss is main clinical criteria for implant success.[11] Loss of marginal bone is important as a reduction in bone level that exceeds physiological limits can lead to loss of the implant's bone anchorage.[2] Also finally, after implant placement it has been shown that crestal bone loss of approximately 1.5 mm within the first year after insertion followed by 0.2 mm annually in later year in successful implants.[12] Some study suggested that among stage one (nonsubmerged) and stage two (submerged), the later has more amount of crestal bone loss than former and also manifests that the bone quality-based dental implant design minimizes over all implant failure and crestal bone loss regardless of bone density.[13] Comparing the crestal bone level changes between two different implant designs, tissue level (TL) and bone level (BL), and concluded that tissue level implants presented greater bone loss in the mesial surface than bone level implant. Both designs presented stable and clinically acceptable bone crests.[14]

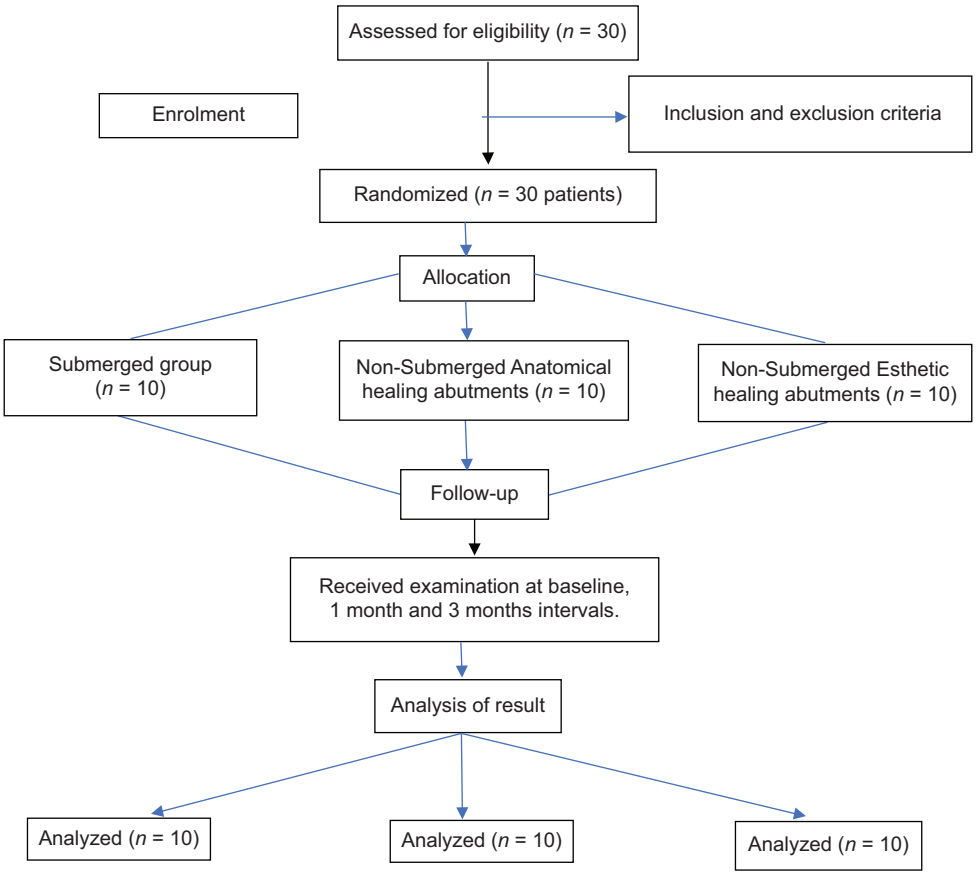
The aim of this randomized controlled clinical study was to evaluate crestal bone loss during osseointegration phase comparing submerged and nonsubmerged implants with healing abutments of different design.

MATERIAL AND METHODS

The present prospective randomized controlled trial has been conducted in Department of Periodontology, Faculty of Dental Sciences, with interdepartmental collaboration with the Department of Prosthodontics, Department of Oral Medicine and Radiology, and Department of Oral and Maxillofacial Surgery. Ethical clearance was obtained from KGMU institutional ethics committee, with Ref. no: 102nd ECM II B-Thesis/P14. A total number of 17 subjects were enrolled from the Outpatient Department (OPD) of Periodontology. The study was registered in clinical trial registry–India. Subjects were randomized by using computer-generated software into following three groups, group 1 submerged (n = 10), group 2 nonsubmerged with anatomical healing abutment (n = 10), and group 3 nonsubmerged with esthetic healing abutments (n = 10). Inclusion criteria were as follows: >18 years of age patient, periodontally healthy patient, single missing tooth in edentulous mandibular posterior area, minimum soft tissue thickness of 2 mm (Linkevicious *et al*. 2015),[15] and possibility of implant placement without the need for bone augmentation techniques. Exclusion criteria were as follows: subjects with systemic diseases affecting the healing process, smokers, pregnant or lactating women, and patient on steroid therapy. Patients were provided with full information and all subjects gave their informed consent for participating [Flow Chart 1].

Surgical procedure

After achieving adequate local anesthesia with 2% lignocaine (epinephrine 1: 2,00,000), implants (Bioner



Flow Chart 1: Subjects Randomization into three Groups.

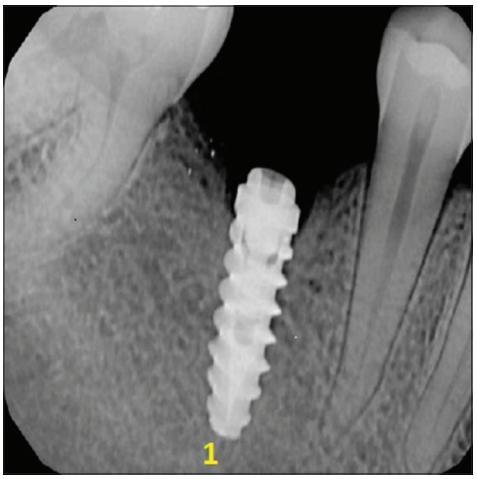


Figure 1: IOPA of submerged implant

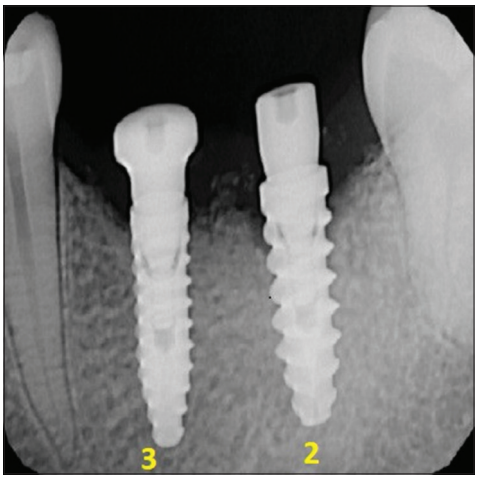


Figure 2: IOPA of nonsubmerged implant

Implant System, Barcelona, Spain) were placed as per the manufacturer's instructions. In Group 1 (submerged technique), the closure was done by primary intention with 3-0 silk sutures, while in Group 2 anatomical healing abutment (4.5 mm-DM-PCR45) and in Group 3 esthetic healing abutments (4.5-DM-PC45) were placed. Esthetic abutments have same height and taper (4.5 mm height and 120° taper) as anatomical abutment but its base is narrower than the implant platform as compared to anatomical abutment. Also, esthetic abutments provide better emergence profile, healthy peri-implant mucosa by preventing peri-implant disease by forming a barrier to efficiently protect underlying bone, and prevent access for microorganisms [Figure 3].

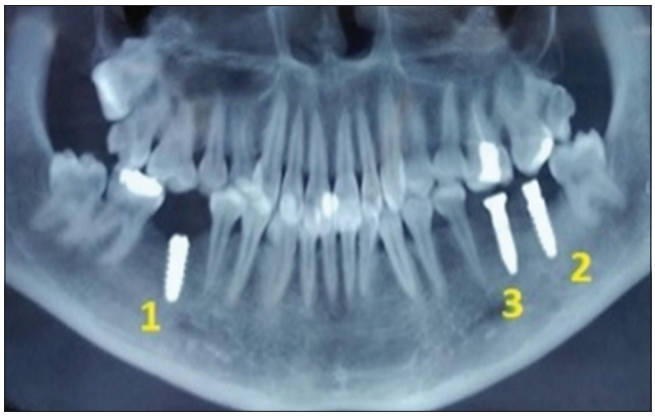


Figure 3: Postoperative OPG

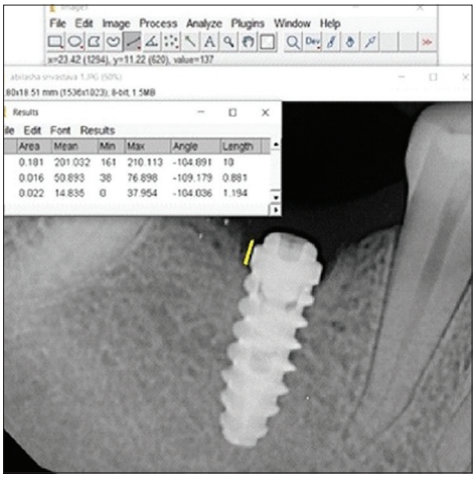


Figure 5: Submerged distal bone loss

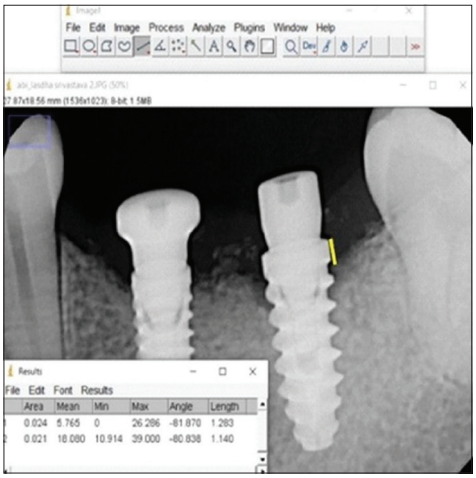


Figure 7: Nonsubmerged anatomical distal bone loss

Postoperative instructions were given to the patients, antibiotic: amoxicillin (500 mg thrice a day), anti-inflammatory (Acelofenec 100 mg twice daily) for 3 days, were prescribed postsurgically. Patients were instructed to rinse twice daily with a 0.12% chlorhexidine mouth rinse for 7 days. The sutures were removed after 1 week.

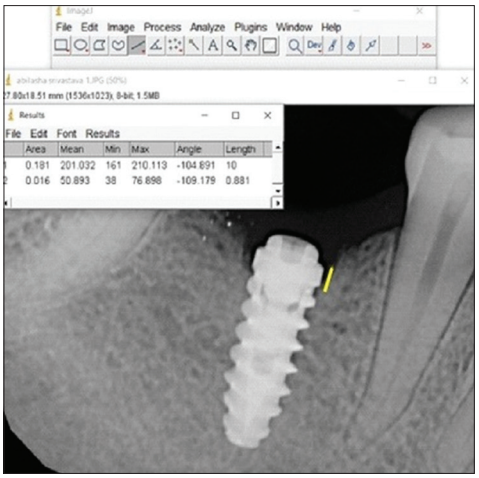


Figure 4: Submerged mesial bone loss

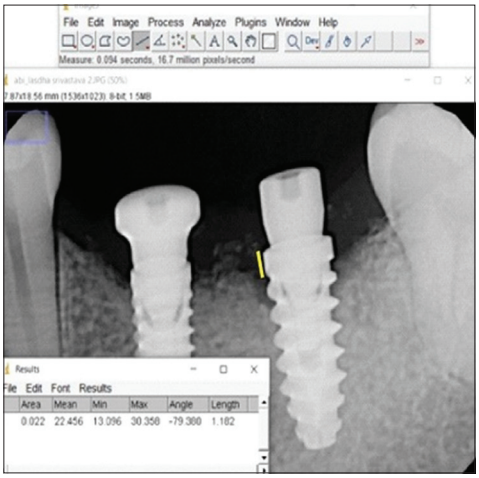


Figure 6: Nonsubmerged anatomical mesial bone loss

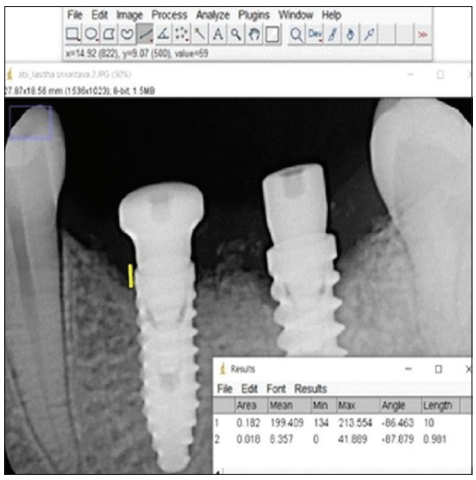


Figure 8: Nonsubmerged esthetic mesial bone loss

Radiographic evaluation

To evaluate the crestal bone loss, total three sets of intraoral periapical radiographs (60 Kv, 7 mA) and cone beam computed tomography (CBCT) (Carestream CS 9300,

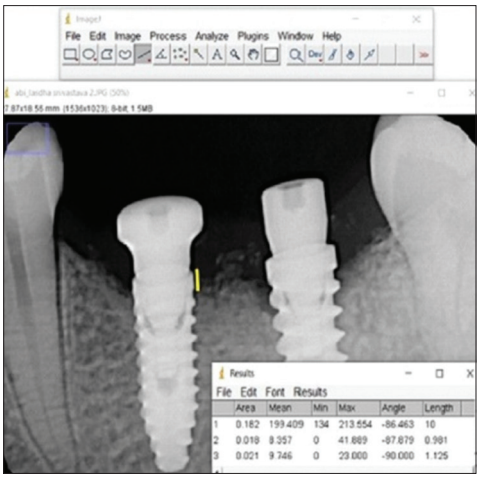


Figure 9: Nonsubmerged esthetic distal bone loss

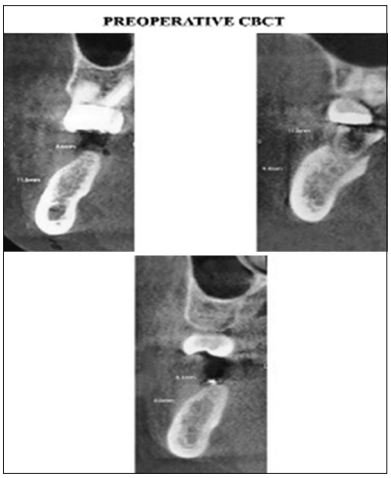


Figure 10: Preoperative CBCT

Trophy Dicom Version 6.4.0.4) were taken on the day of implant placement (baseline) and 1 month and 3 months after implant placement. Mesial, distal, and total crestal bone loss were measured using digital image analysis IMAGE J software (National Institute of Health, Federal Government, USA) [Figures 4-11].

Statistical analysis

Sample size was calculated on the basis of variation in crestal bone loss in submerged and nonsubmerged implant groups using the formula:

$$n = \frac{(Z_\alpha + Z_\beta)^2(\sigma_1^2 + \sigma_2^2)}{d^2}$$

Where $\sigma_1 = 0.14$, $\sigma_2 = 0.12$ the standard deviations of crestal bone loss in two groups (as per the "Mariano *et al*" 2016).[12]

d = mean difference of submerged and nonsubmerged implant groups (= 0.22); the minimum mean difference consider to be clinically significant.

type I error α = 5% corresponding to 95% confidence level.

type II error β = 10% for detecting results with 90% power of study.

So, the required sample size,

n = 10 each group.

RESULT

A total of 17 subjects with 30 implants were enrolled in the study to evaluate and compare the crestal bone loss around the 3 groups during osseointegration phase. However, only 16 subjects (7 males + 9 females) with age range between 18 and 50 years were recruited for the analysis as 1 subject with 2 implants failed to turn up for the follow-up. The subjects were asked to come after 1 month and 3 months for evaluation of various radiological parameters. Radiographic analysis was done by using intraoral periapical radiograph (IOPA) and CBCT.

Crestal bone loss

Crestal bone loss were measured at baseline, 1 month, and 3 months in all the groups by using IOPA and CBCT.

At baseline, there were no crestal bone loss recorded for all the three groups. After 1 month, the mean crestal bone loss in Group 1 was 0.03 ± 0.01 mm, Group 2 was 0.23 ± 0.04 mm, and Group 3 was 0.10 ± 0.02 mm. After 3 months, the mean crestal bone loss in Group 1 was 0.12 ± 0.03 mm, Group 2 was 0.42 ± 00.06 mm, and in Group 3 was 0.20 ± 00.03 mm. The mean crestal bone loss was increased in all the three groups and it was found to be significantly higher in Group 2 (nonsubmerged with anatomical abutment) in all assessed periods [Table 1].

On comparing Group 1 and Group 2, the mean bone loss was found to be significantly higher in Group 2 after 1 month and 3 months. In Group 1 and Group 3, the mean bone loss was higher in group 3 in both the periods but it was significant in 1 month. In Group 2 and Group 3, the bone loss were significantly higher in Group 2 during all assessed periods [Table 2].

By using CBCT, measurement of crestal bone loss between 3 groups were done. At baseline, there was no crestal bone loss recorded for all the three groups. After 1 month, the mean crestal bone loss of Group 1 was 0.11 ± 0.02 mm, Group 2 was 0.23 ± 0.04 mm, and in Group 3 was 0.15 ± 0.03 mm.

Table 1: Intergroup comparison of crestal bone loss using IOPA and IMAGE-J software

Bone Loss	SUBMERGED (Group 1)		NON SUBMERGED -Anatomical Abutment (Group 2)		NON SUBMERGED -Esthetic Abutment (Group 3)		ANOVA - 1 way	
	Mean	SD	Mean	SD	Mean	SD	*F*	*P*
Baseline	0.00	0.00	0.00	0.00	0.00	0.00	-	-
1 month	0.03	0.01	0.23	0.04	0.10	0.02	133.18	<0.001
3 months	0.12	0.03	0.42	0.06	0.20	0.03	129.36	<0.001
Repeated Measure ANOVA	*F*=188.31, *P*<0.001		*F*=372.04, *P*<0.001		*F*=298.93, *P*<0.001			

Table 2: Comparison of crestal bone loss between the groups IOPA

Crestal bone loss	Group vs Group		Mean Diff.	SE	*P*
1 month	Submerged	Non submerged -Anatomical Abutment	-0.20	0.01	< 0.001
	Submerged	Non submerged -Esthetic Abutment	-0.07	0.01	< 0.001
	Non submerged -Anatomical	Non submerged -Esthetic Abutment	0.13	0.01	< 0.001
3 month	Submerged	Non submerged -Anatomical Abutment	-0.30	0.02	< 0.001
	Submerged	Non submerged -Esthetic Abutment	-0.08	0.02	0.002
	Non submerged -Anatomical	Non submerged -Esthetic Abutment	0.23	0.02	< 0.001

Table 3: Intergroup comparison of crestal bone loss using CBCT

Crestal bone loss	SUBMERGED		NON SUBMERGED -Anatomical Abutment		NON SUBMERGED -Esthetic Abutment		ANOVA - 1 way	
	Mean	SD	Mean	SD	Mean	SD	*F*	*P*
Baseline	0.00	0.00	0.00	0.00	0.00	0.00	-	-
1 month	0.11	0.02	0.23	0.04	0.15	0.03	35.81	< 0.001
3 months	0.18	0.06	0.34	0.03	0.21	0.03	42.42	< 0.001
Repeated Measure ANOVA	*F*=92.85, *P*<0.001		*F*=408.18, *P*<0.001		*F*=261.46, *P*<0.001			

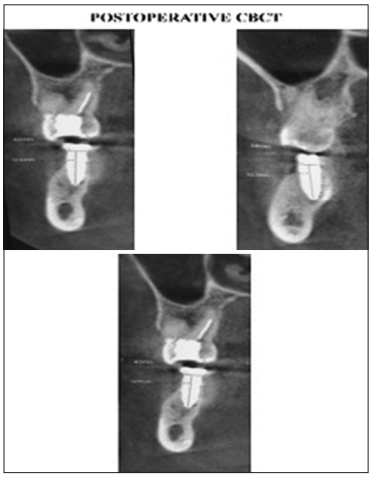


Figure 11: Postoperative CBCT

After 3 months, the mean crestal bone loss in Group 1 was 0.18 ± 0.06 mm, Group 2 was 0.34 ± 0.03 mm, and in Group 3 was 0.21 ± 0.03 mm. The mean crestal bone loss were increased in all the 3 groups and it was found to be significantly higher in Group 2 in all assessed periods [Table 3].

On comparing Group 1 and Group 2, the mean bone loss was found to be significantly higher in Group 2 at 1 month and 3 months; In Group 1 and Group 3, the mean bone loss was higher in Group 3 in both the periods but it was found to be slightly significant in 1 month and showed insignificant difference in 3 months. In Group 2 and Group 3, the bone loss was significantly higher in Group 2 during 1 and 3 months postoperatively [Table 4].

DISCUSSION

The present study is a randomized controlled prospective study used for the clinical evaluation of submerged and nonsubmerged dental implants replacing missing teeth in the mandibular posterior region. The aim of the study was to evaluate the crestal bone loss during osseointegration period by using intraoral periapical radiographs, CBCT, and IMAGEJ software, comparing submerged and nonsubmerged implants with healing abutments of different design (anatomic and esthetic). Apart from this, we also evaluated the clinical parameters gingival index, plaque index, pocket probing depth around implant at baseline, and after 3 months of follow-up.

Total number of patients enrolled in the study were 17 of which 7 were males and 10 were females. The number

Table 4: Comparison of crestal bone loss between the groups using CBCT

Crestal bone loss	Group vs Group		Mean Diff.	SE	*P*
1 month	Submerged	Non submerged -Anatomical Abutment	-0.12	0.01	< 0.001
	Submerged	Non submerged -Esthetic Abutment	-0.04	0.01	0.037
	Non submerged -anatomical	Non submerged -Esthetic Abutment	0.08	0.01	< 0.001
3 months	Submerged	Non submerged -Anatomical Abutment	-0.16	0.02	< 0.001
	Submerged	Non submerged -Esthetic Abutment	-0.03	0.02	0.334
	Non submerged -anatomical	Non submerged -Esthetic Abutment	0.13	0.02	< 0.001

of participants received submerged implants, anatomical abutments, and esthetic abutments were 10 in each group. The present study focused the crestal bone loss and evaluated the bone loss around implant abutments using different radiological techniques which included IOPA and CBCT techniques and by using IMAGE J software (a dedicated software used for measuring crestal bone loss around implants). First, the evaluation of crestal bone loss was done through CBCT technique. Crestal bone loss (CBCT) around implants at baseline was taken as 0.00 for all the 3 groups. This baseline value represents comparability between all the 3 types of groups. On evaluation of the crestal bone loss around the submerged implants, a mean crestal bone loss of 0.11 mm was observed after 1 month of implant placement. Similarly, the crestal bone loss around the nonsubmerged anatomical healing abutments was found to be 0.23 mm and around nonsubmerged esthetic healing abutments was found to be 0.15 mm from these values, it was very much evident that submerged implant showed lesser bone loss in comparison to the other two implant abutments. Submerged implant ranked first when evaluated for crestal bone loss at 1-month interval. Nonsubmerged anatomical healing abutments were found to have the highest bone resorption around implants at 1-month follow-up. The difference in crestal bone loss compared between these 3 groups showed a highly significant result, claiming the submerged implant are superior to the nonsubmerged esthetic healing abutments, which in turn are superior to the nonsubmerged anatomical healing abutments with a *P* value of <.001. Comparing group versus groups crestal bone loss values among given 3 groups at 1-month follow-up, it was found that when a comparison between the submerged implant and nonsubmerged anatomical healing abutments were done; the mean difference of crestal bone loss was found to be -0.12 mm. A comparison between submerged implant and nonsubmerged esthetic healing abutments gave a mean difference of -0.04 mm. A comparison between nonsubmerged anatomical healing abutments and nonsubmerged esthetic healing abutments gave a mean difference of 0.08 ± 0.01. The mean difference between submerged implant and nonsubmerged anatomical healing abutment was highly significant. Submerged implant showed a lesser crestal bone loss as compared to nonsubmerged esthetic healing abutments but this difference was not significant. Bone loss around nonsubmerged esthetic healing abutments was significantly lesser as compared to nonsubmerged anatomic healing abutments at 1-month follow-up.

Mean crestal bone loss in submerged group was 0.18 mm, while in group 2 and group 3 were 0.34 mm and 0.21 mm, respectively, after 3 months of follow-up. While comparing the crestal bone loss between submerged implant and nonsubmerged with anatomical healing abutments, the bone loss was found to be significantly higher in anatomical healing abutments. On comparison between submerged implant and nonsubmerged implant with esthetic healing abutments, the crestal bone loss was found to be insignificant after 3 months. Bone loss around nonsubmerged esthetic healing abutments was lesser than the nonsubmerged anatomical healing abutments and showed a significant difference at the end of study period.

Evaluation of the crestal bone loss using IMAGE J software was also done along with the evaluation carried out through CBCT as discussed earlier. Mean crestal bone loss using IMAGE J software in submerged group was 0.12 mm, while in group 2 and group 3 were 0.42 mm and 0.20 mm, respectively, after 3 months of follow-up. Comparing the crestal bone loss between submerged implant and nonsubmerged anatomical healing abutments, the bone loss was found to be significantly higher in anatomical healing abutments. On comparison between submerged implant and nonsubmerged implant with esthetic abutments, the crestal bone loss was found to be insignificant after 3 months. Bone loss around nonsubmerged esthetic healing abutments was lesser than the nonsubmerged anatomical healing abutments and showed a significant difference at the end of study period.

Certain studies go well with the results obtained in the present study, for example, Tomas Linkevicius *et al.* (2015),[15] said that implants with a thick soft tissue coverage around shows lesser bone loss in comparison to implants having thin soft tissue coverage; this signifies the role of soft tissue coverage and indicating the submerged implant abutment as a better option in comparison to nonsubmerged implant abutment. Mariano Sanchez Siles (2016)[12] in his study also

represented a similar view point and advocated submerged implant over nonsubmerged implant abutments (i.e., nonsubmerged esthetic healing abutment and nonsubmerged anatomical healing abutment) as a better option to avoid initial crestal bone loss around the implants. Similarly, other studies like one by Warrer *et al* (1991),[16] Becktor *et al* (2007),[4] Branemark PI *et al* (1977),[17] Albrektsson *et al* (1988),[18] Vansteenberghe D (1989)[19] Adell R *et al* (1990),[20] Zarb GA *et al* (1990),[21] Weber *et al* (1992)[22] were in synchronization with the present study showing superior results of submerged implant as comparison to nonsubmerged implant abutments in restricting crestal bone loss around implants. Studies conducted by Teughels W *et al.* (2006)[23] and Subramani K *et al*. (2009)[24] indicated that some transmucosal implants favour biofilm formation and microbial adherence on to the implant because of rough surface and increased surface energy over the implant body. Chreanovic BR *et al*. (2013)[25] stressed upon the risk of fracture of implants in case of immediate loading implants and did not advocate the use of nonsubmerged healing abutment. Herman *et al*. (2001)[26] also rejected the nonsubmerged implant through his study in which a significant amount of crestal bone loss was observed in a two-piece configuration common in nonsubmerged implant abutment. Hence, all these studies are in agreement with the present study indicating submerged implant to be a better option in comparison to nonsubmerged implant abutments when it comes to crestal bone loss.

In some studies, for example, Luca Cordaroetal (2009)[27] and Ericsson I *et al*. (1994),[28] the crestal bone loss around submerged and nonsubmerged implants were somewhat comparable to each other without any appreciable advantage of any particular implant abutment over the other.

Contradicting to these findings, few researchers observed nonsubmerged implant abutment to have a better results in terms of crestal bone loss as compared to submerged implant. In one such study, Berberi *et al*. (2014)[29] supported the placement of healing abutment at the moment of implant placement in fresh extraction socket to reduce the marginal bone loss.[23] A similar finding was reported by Koutouzis *et al*. (2013)[30] in which a minimal marginal bone loss was reported around an implant receiving final abutment at the time of implant placement. ITI system; Schroeder *et al*. (1976),[31] Babbush *et al*. (1986),[32] and Buser *et al.* (1988)[33] pointed toward a superior osseointegration and proper bone anchorage phenomenon using one step procedure. Romeo E *et al*. (2004)[34] and Ferrigno N *et al.* (2002)[35] showed a better osseointegration in nonsubmerged implant abutment. Schroeder (1976)[31] also advocated the use of nonsubmerged implant abutment with a better soft tissue profile with transgingival portion of implant. On the other side, Hermann *et al*. (2002)[26] proved that there was no significant amount of radiographic bone loss noticed over 6 months, around one piece implants (nonsubmerged implants).

In the present study between two subgroups of nonsubmerged implant abutments, it was found that nonsubmerged implant with esthetic healing abutments are significantly better than the nonsubmerged implants with anatomical healing abutments. Regarding this, some authors gave their consent. Akkocaoglu *et al*. (2005)[36] and Lang *et al.* (2007)[37] preferred nonsubmerged esthetic healing abutments for primary stability, which also reduces the distance between the implants and extraction socket walls. Other than this, Goktas *et al*. (2011)[38] were also found some additional character of nonsubmerged esthetic healing abutment and advocated that formation of connective tissue fibres around esthetic healing abutment provides greater resistance to biomechanical forces during mastication. Berglundh and Lindhe (1996)[39] also favours the concept of connective tissue formation and noticed that there will be less inflammatory infiltrate due to presence of healthy peri-implant connective tissue apically, which shows less amount of crestal bone loss. Similarly, Rompen E *et al*. (2006)[40] and Chenroudi B *et al*. (1992)[41] speculate that less peri-implant bone resorption takes place if there is more amount of connective tissue formation takes place which help in enhancing the shorter junctional epithelium. Mazzotti C *et al*. (2013)[42] also recommended that conical shape of esthetic healing abutments results in more amount of soft tissue thickness as compared to divergent anatomical healing abutments.

Another contradictory study on animals advocated by Patricia J *et al.* (2014)[43] that anatomical healing abutments behave as a protective device for both hard and soft tissues and also showed that they are more effective than the concave healing abutments, after the 12 weeks of follow-up. Similarly, Janvier Mareque Bueno *et al*. (2014)[44] also concluded that use of anatomic healing abutments in comparison to concave straight abutments reduces the bone resorption to a greater extent.

Our study is in accordance with Mariano Sanchez-Siles *et al*. (2016)[12] where they evaluated peri-implant crestal bone loss and concluded that bone resorption during osteointegration period using the nonsubmerged technique varied significantly depending on the morphology of the healing abutments.

The present study therefore emphasizes that submerged implant technique is a better option in comparison to a nonsubmerged technique.

CONCLUSION

The present study was done to compare the bone loss around submerged and nonsubmerged implants (i.e., nonsubmerged anatomical and nonsubmerged esthetic healing abutments) during osseointegration phase in mandibular edentulous area of periodontally healthy patients. On comparing both the groups submerged and nonsubmerged (anatomical and esthetic) healing abutments, it was noticed that submerged group showed lesser amount of bone loss followed by nonsubmerged esthetic healing abutments and then nonsubmerged anatomical healing abutments. Therefore, it can be concluded that submerged implants technique is a better option in comparison to nonsubmerged implant technique (with esthetic/anatomical healing abutments) in terms of clinical performance and crestal bone loss measured in the initial phases of osseointegration.

Declaration of patient consent

Informed consent was taken from all the participants for his/her/their images and other clinical information to be reported in the journal before enrollment into the study. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity.

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Conflicts of interest

There are no conflicts of interest.

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