ORIGINAL RESEARCH

Comparative Study of the Crestal vs Subcrestal Placement of Dental Implants via Radiographic and Clinical Evaluation

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Abstract

Aim: The study aims at using the level/depth of implant placement (equicrestal or cretsal) as the key parameter in measuring the vertical crestal bone loss (CBL) mesially and distally, using periapical radiographs (IOPARs) taken at 1-, 3-, and 6-months interval, postprosthetic loading.

Materials and methods: Patients ($n = 40$; 18–65 years), with edentulous space anteriorly or posteriorly, were randomly divided into two groups, namely, group I (equicrestal) and group II (subcrestal) with 20 patients in each group. Implants were placed at an edentulous site (delayed implants), after obtaining cone-beam computed tomography (CBCT) scans. Prosthetic loading (following osseointegration) was done within 3 months of implant placement. The patients were followed up and IOPAR were taken to measure CBL at 1-, 3-, and 6-months interval, postloading. The CBL between the two groups was compared using IOPARs. The data obtained was compiled and unpaired Student's *t*-test was done for statistical analysis.

Results: After the statistical analysis of the data obtained during follow-up, CBL was measured radiographically. Mesial and distal vertical bone loss was charted and compared between the two groups. The mean bone loss on the mesial aspect for group I implants is 0.39 mm and for group II implants, it is 0.27 mm, 6 months postloading, determined radiographically.

Conclusion: Subcrestally placed implants are conducive to the overall oral rehabilitation, as it has been seen to preserve marginal peri-implant bone for longer durations than their equicrestally placed counterparts, within the limitations of the current study.

Clinical significance: The study prospectively relates the level of implant shoulder with respect to alveolar crestal bone, postloading. Following radiographic comparison between the two groups, significant clinical findings indicated that better esthetics and stability were seen in the subcrestally placed implants. This proves that implant placement level directly influences crestal bone levels; hence, indirectly affects esthetics and function.

Keywords: Crestal bone levels, Crestal bone loss, Dental implants, Equicrestal, Prosthetic loading, Radiographic evaluation, Subcrestal.

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Introduction

Endosseous root form dental implants are useful in preserving both esthetics and function in edentulous and partially edentulous patients. However, success of implant therapy depends on the amount of bone present in the edentulous space.[1] Preservation of crestal bone is crucial and must be prioritized from the onset of implant placement. Adequate amount of peri-implant bone contributes to esthetic success and implant stability. Crestal bone contributes to both esthetics and function. Resorption of crestal bone is seen as loss of interproximal papillary support and gingival recession, which gives way to peri-implantitis and compromises esthetics.[2] The surgical procedure, implant design, implant placement, period of loading, and various other factors determine the crestal bone preservation. However, the placement procedure itself and the implant to be placed, vary depending on patient factors; for example, bone density, that is, both quality and quantity of bone, occlusal forces, and amount of soft tissues.[2]

With respect to the depth of insertion, implants can be placed at various levels in the bone. These different levels of implant placement (i.e., relation of the implant shoulder with the available crestal bone) are as follows: Supracrestal (implant shoulder above the level of alveolar crest), crestal or equicrestal (implants placed at the level of alveolar crestal bone), and subcrestal (implant shoulder below the level of alveolar crestal bone).[2,3] One of the dire complications of implant therapy (peri-implantitis and perimucositis) leads to bone loss around the implant. The microgap [implant–abutment junction (IAJ)] level, also influences crestal bone levels.[2] Peri-implantitis and degree CBL is directly proportional. The presence of the microgap apical to crestal bone can accumulate a lot of inflammatory cells, leading to eventual resorption/remodeling of crestal bone.[2] Hence, the level of implant placement and thus, the level of IAJ are correlated. The CBL of 1–1.5 mm is generally seen within a year of implant placement, which subsequently reduces to a maximum of 0.2 mm annually.[4] Bone loss around the implant can be prevented by meticulously evaluating the periodontal biotype, bone density, amount of surgical trauma induced, formation of the biologic width, inter-implant distance, implant design, location of the implant-abutment interface, occlusal load or trauma, and stress concentration at the crestal bone level.[5,6]

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Available literature on implant placement depth as being the key factor in determining long-term implant success is still meagre and most data provided, is contingent on animal studies. Many of the animal studies done have shown increased bone loss with subcrestally placed implants.[1] Few studies are in favor of crestal placement while othersare in favor of subcrestal placement. The affirmation that one (either equicrestal or subcrestal) is better than the other, has not been explicitly specified in any given literature.[7] This study deals with restoration of edentulous sites on patients, by placing implants at different depths with respect to crestal bone. Therefore, the objective of this study is to evaluate the effect of different placement depths as a key factor in conserving marginal bone, postloading, thereby ensuring implant durability via radiographic evaluation using IOPARs.

Materials and Methods

This study was conducted in the Department of Oral and Maxillofacial Surgery, Mathrusri Ramabai Ambedkar Dental College and Hospital, Bengaluru, Karnataka, India, for a duration of 18 months (from November 2019 to June 2021) after obtaining the approval of the institutional ethical committee (ethical approval number EC-542) and an informed consent form each patient.

Study design

For this single-blinded, prospective, comparative study, 40 patients ($n = 40$), who reported to the outpatient department, with single or multiple missing teeth in the posterior region of the maxilla or mandible were selected and randomly divided into two groups: Groups I and II, with 20 patients in each group. In each patient, 1–3 implants were placed at different depths, in each patient, depending on the span of edentulism and prosthesis needed for function. Following osseointegration in 3 months, the implants were prosthetically loaded and the cases were followed up in 1-, 3-, and 6-months postloading. The IOPARs were taken at each follow-up visit to calibrate the bone loss mesially and distally.

Inclusion Criteria

- Patients aged within 18–60 years.
- Patients with an edentulous space that could be restored with an implant (the period of edentulism varied with the different cases, ranging from 3 months to 5 years).
- Patients willing for follow-up.

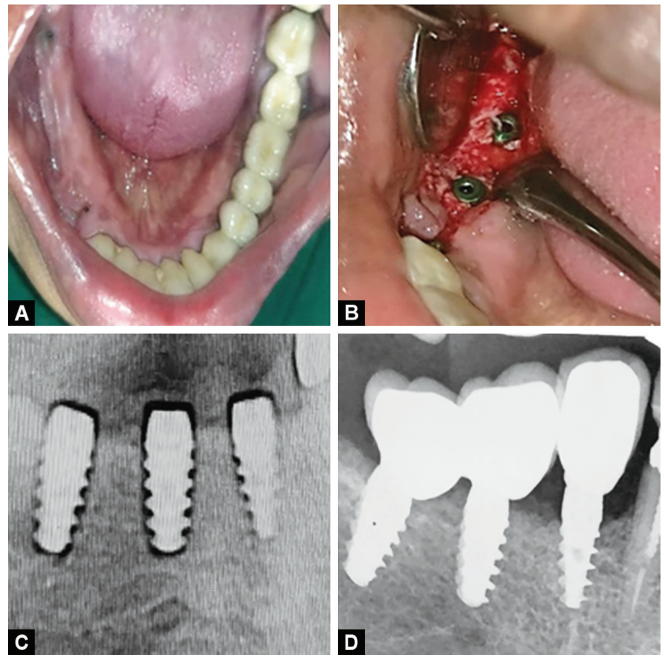
Exclusion Criteria

- Medically compromised patients.
- Chronic smokers.
- Tooth adjacent to edentulous space having a periapical pathology.

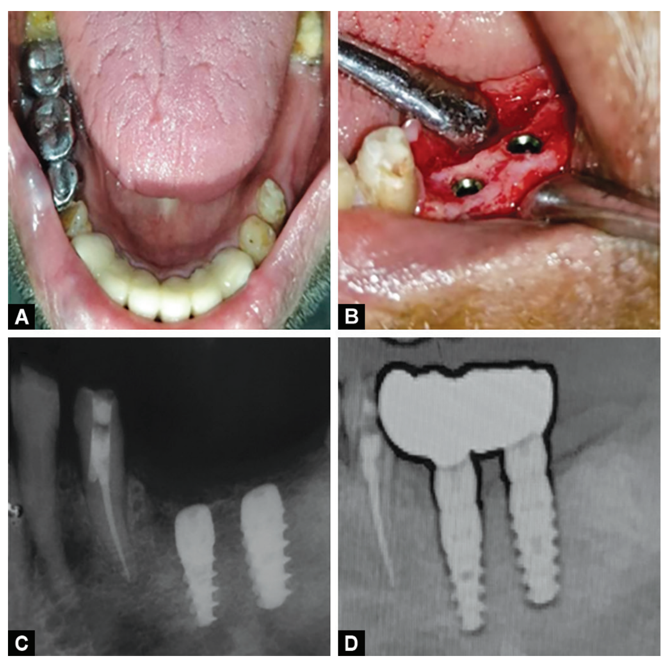
The procedure and follow-up periods were explained to the patient and the patient was given to read, fully comprehend, and sign an informed consent form. A thorough case history, and upper and lower alginate impressions were taken for the purpose of fabricating a surgical stent. A preoperative radiograph (orthopantomogram (OPG)/IOPAR) and CBCT scans were taken and assessed for bone morphology, crestal bone levels, and method/position of placement. The edentulous site/sites (Figs 1A and 2A) were examined clinically and via the radiographs. Preoperative casts were poured for record maintenance. The imperative preoperative blood investigations were advised, analgesics, and antibiotics were prescribed (amoxicillin + clavulanic acid 625 mg, diclofenac sodium 50 mg) per-oral and started prior to the procedure.

Design of Implant

(JD Implant. Evolution®) was selected. The average length of the implants placed was 4.3 mm × 10 mm. All implants used had built-in platform switching, self-cutting capacity in both directions, and were tapered dental implants with straight abutments.



Figs 1A to D: Clinical and radiographic image showing equicrestal level of implant placement (A) Edentulous site on the right mandible; (B) Equicrestal level of implant placement; (C) Immediate postoperative IOPAR; (D) IOPAR 6 months postloading



Figs 2A to D: Clinical and radiographic image showing subcrestal level of implant placement (A) Edentulous site on the left mandible; (B) Subcrestal level of implant placement; (C) Immediate postoperative IOPAR; (D) IOPAR 6-months postloading

Surgical Technique

For group I patients, the implants were placed at a crestal level (Fig. 1B) and for group II patients, they were placed at a subcrestal level (Fig. 2B). Also, 1–3 implants were placed for the patients, depending on the span of edentulism and quantity of bone present. All surgeries were performed under local anesthesia (2% lignocaine HCl and 1:200,000 adrenaline). Following the implant placement, the mucoperiosteal flap was repositioned carefully for maximal tissue adaptation and suturing was done. Postoperative instructions were explained and an OPG/IOPAR was taken to check for the placement position. A second visit, 3 months after the implant placement, was scheduled wherein a punch excision was made at the implant site and an extension healing abutment/gingival former was attached, which remained in situ for a minimum time period of 10–12 days.

A healing period of 3 months was given prior to loading the implants. Once osseointegrated, the implant was prosthetically loaded at the third month, when the healing caps were removed and crowns were cemented onto the abutments. The IOPARs were taken again to assess the bone levels after loading at the first month, third month, and sixth month.

Radiographic Technique

The crestal and subcrestal bone levels were measured and compared using IOPA radiographs at these time intervals (i.e., first, third, and sixth month after crown placement). To measure the marginal bone loss, the method used by Ghahroudi et al. was utilized.[8] Two points were marked; one point marked the uppermost point at the crest of the alveolar bone (point A), adjacent to the implant and the other point (point B), is the lowermost point at the depth of bone loss. A line was traced from the first point A at the crest of alveolar bone, perpendicular to the implant axis. A vertical line was then created that ran parallel to the implant surface, connecting a point in the line drawn from point A to point B. This point of interaction was named point C. The distance between point B and C, for each implant was measured using a ruler. The distance measured gave an indication of the CBL in millimetres.[8]

Crestal bone loss was calculated at mesial and distal sides of the implant and the most observed loss occurring in mesial or distal sides was considered as final implant bone loss with the help of IOPARs.[8]

Statistical Analysis

The data acquired was then compared using an unpaired Student's *t*-test for statistical analysis using GraphPad Prism 5.0.

Results

Figures 3 and 4 show the comparative data (in mm) of CBL mesially and distally at first, third, and sixth months postloading, respectively. The mean bone loss on the mesial aspect for group I implants is 0.39 mm and for group II implants, it is 0.27 mm; 6 months postloading, determined radiographically. Performing the unpaired Student's *t*-test on the data presented, a *p*-value below 0.013 was obtained for the bone loss levels on the mesial aspect, in an interval of 3 months postloading and a *p*-value below 0.023 for 6 months postloading, which prove to be highly statistically significant (Table 1).

Also, a *p*-value below 0.001 was obtained for bone loss levels on the distal aspect, in an interval of 3 months postloading and a *p*-value below 0.001 for 6 months postloading, which prove to be highly statistically significant (Table 2).

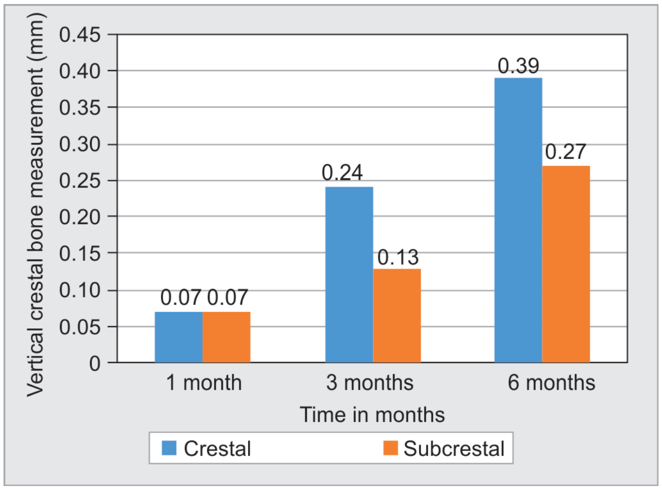


Fig. 3: Comparison of vertical crestal bone measurement mesial (mm) for crestal and subcrestal implants

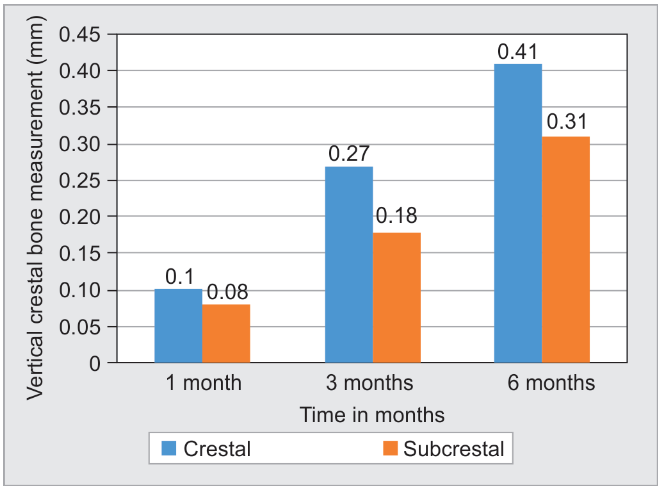


Fig. 4: Comparison of vertical crestal bone measurement distal (mm) for crestal and subcrestal implants

Table 1: Comparison of vertical crestal bone measurement between crestal and subcrestal implants: mesial (mm)

Vertical crestal bone measurement mesial (mm)	*Crestal implants*	*Subcrestal implants*	*p-value*†
1 month	0.07	0.07	0.642
3 months	0.24	0.13	<0.013**
6 months	0.39	0.27	<0.023**

Significant when $p \leq 0.05$; **$p < 0.001$ highly significant; †Student's *t*-test

Table 2: Comparison of vertical crestal bone measurement between crestal and subcrestal implants: distal (mm)

Vertical crestal bone measurement distal (mm)	*Crestal implants*	*Subcrestal implants*	*p-value*†
1 month	0.1	0.08	0.552
3 months	0.27	0.18	<0.001**
6 months	0.41	0.31	<0.001**

Significant when $p \leq 0.05$; **Highly significant when $p < 0.001$; †Student's *t*-test

All implants (crestal and subcretsal) showed satisfactory primary and secondary stability and osseointegration on clinical and radiographic evaluation (Figs 1C and D; 2C and D). One implant (placed crestally) showed soft tissue loss, evident on clinical examination. None of the implants (of the 40) showed any sign of peri-implantitis or loss of stability on clinical evaluation on a 6 months follow-up period, postloading.

Hence, from this study, it was inferred that subcrestal position of the implant shoulder was more conducive to preservation of crestal bone levels after prosthetic loading.

Discussion

This study succinctly substantiates that different implant placement depths, relative to the crestal bone, is a significant parameter in gauging the long-term success of the implant. The most notable finding has been the crestal bone levels around subcrestally placed implants after functional loading. In the current study, highly statistically significant results have been elicited in relation to crestal bone levels (p <0.001), for group B implants, indicating the reliability of placing implants subcrestally for both implant stability and soft-tissue coverage. As seen from Figures 3 and 4, the crestal cortical bone levels (mesially and distally) for both groups after a 6-month interval, postloading, is more for the subcrestal implants. A 0.41-mm of CBL was noted after radiographic measurements in group I patients, while 0.31 mm was seen in the subcrestal counterparts of group II, 6 months postloading. One of the implants placed at an equicrestal level had soft tissue loss which did not hamper the treatment outcome. These results are consistent with previously done studies, wherein a unanimous opinion was held that subcrestally placed implants had better capacity for crestal bone preservation. A study done by Degidi et al. in 2011, is in agreement with the current data, as it histologically proved that the subcrestal position of implants resulted in bone located above the implant shoulder.[2]

Peri-implant bone loss has been recognized for decades to be an important aspect of long-term implant success and in maintaining aesthetics.[1] The quantity and quality of the bone surrounding an implant affect implant osseointegration and influence the shape and contour of the overlying soft tissues that are important for the esthetic outcome of treatment,[9] and it has been reported that if an implant with a rough surface is exposed to the oral cavity, a greater amount of plaque, leading to perimucositis and peri-implantitis, may be present. The previous studies done on animals and humans have observed that statistically significant peri-implantitis occurred at 3 years of loading around implants with roughened, exposed surfaces than when compared to turned implants.[10] Keeping the outcomes of these studies in mind, one may arguably state that equicrestal levels of implant placement may lead to exposed implant surfaces after CBL postloading. According to Albrektsson et al. in 1986, 0.1–0.2 mm per year of CBL after loading can be considered as normal and successful.[4] There are certain advantages to placing an implant subcrestally. It minimizes the risk of implant exposure, and enables bone stability or bone growth over the implant shoulder.[1]

As the coronal part of the alveolar bone is narrower than the apical part, bone augmentation procedures/grafting can be avoided in certain scenarios when the implant is subcrestally placed.[1] A certain level of marginal bone loss is acceptable in the first year of implant placement and the bone loss diminishes following that.[1] Factors associated with marginal bone loss include surgically induced trauma, the formation of the biologic width, bacterial infiltration at the IAJ[11] and frequent removal and reconnection of prosthetic components.[1] The implants used in the current study had an in-built platform switching design (the abutment diameter was smaller than diameter of implant platform). Platform-switched abutments are so designed to reduce the microgap; hence, it has been seen to cause slower/lesser CBL. The harmful effects of a larger microgap, for example microbial incursion are curbed with platform-switching.[11] In the study conducted by Veis et al. in 2010, platform-switched concept did not have much significant benefits when comparing all parameters, but for the subcrestal location of the microgap, it resulted in lesser CBL. Crestal placement of the IAJ showed higher marginal bone resorption in both straight and platform-switched abutments.[11]

However, there has been evidence to the contrary seen in a study done by Pellicer–Chover et al. in 2016, wherein he states that within the limits of his study, subcrestal implants result in greater bone loss, as the microgap IAJ lies below the peri-implant bone crest, which induces the localized chronic inflammation. The results of the study (which included 23 implants among which 10 were placed crestally and 13 were placed subcrestally); however, the values were not statistically significant ($p = 0.131$).[10] Natalia Palacios–Garzón et al. in their systematic review and meta-analysis on 2018, compiled data on several studies, out of which there were no statistically significant differences in bone loss between equicrestal and subcrestal implant levels in 10 studies.[7] The review also found a greater bone loss in implants placed at the subcrestal level in three studies and three other studies found evidence against it, showing better bone preservation of the bone in the subcrestal implants.[7] Majority of the studies considered in the review showed a uniform sample with bone loss occurring in both equicrestal and subcrestal implants and the differences are not statistically significant.[7]

The clinical success of an implant is dependent on the primary stability achieved during placement. Primary stability is in turn dependent on the peri-implant bone levels at the osteotomy site and other factors such as absence of an infection, implant designs, etc. The study was undertaken to justify that not only the implant design (platform switching or apical blades), but the different levels of implant placement was a factor to be acknowledged when it came to preserving crestal bone levels.

This study prospectively relates the level of implant shoulder with respect to alveolar crestal bone, postloading. Following the radiographic comparison between the two groups, significant clinical findings indicated that better esthetics and stability were seen in the subcrestally placed implants. This proves that implant placement level directly influences crestal bone levels, hence indirectly affects esthetics and function.

Limitations

The current study has certain drawbacks. First, all bone loss measurements were done on IOPA radiographs, which are two-dimensional. A 3D radiograph could serve as a better, more accurate tool for the same and could give an overall picture of the actual bone loss in all dimensions. Second, a larger sample size would result in stronger, and more dependable results.

Conclusion

On reviewing the available literature on the objective of the study, evaluation of the data presented, and subsequent analysis of results, it can be inferred that subcrestally placed implants are conducive to the overall oral rehabilitation, as it has been seen to preserve marginal peri-implant bone for longer durations than their equicrestally placed counterparts. Also, risk of soft tissue exposure and therefore, subsequent peri-mucositis is obviated. Within the limitations of the current study and taking the variables into account, the overall performance of subcrestal implants was more consistent as far as preserving crestal bone levels, postloading was concerned. However, more research, with different sample sizes and follow-up periods are recommended.

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References

1. Romanos GE, Aydin E, Gaertner K, et al. Long-term results after subcrestal or crestal placement of delayed loaded implants. Clinical implant dentistry and related research 2015;17(1):133–141. DOI: 10.1111/cid.12084.
2. Degidi M, Perrotti V, Shibli JA, et al. Equicrestal and subcrestal dental implants: A histologic and histomorphometric evaluation of nine retrieved human implants. J Periodontol 2011;82(5):708–715.
3. Nagarajan B, Murthy V, Livingstone D, et al. Evaluation of crestal bone loss around implants placed at equicrestal and subcrestal levels before loading: a prospective clinical study. J Clin Diag Res 2015;9(12):ZC47. DOI: 10.7860/JCDR/2015/13911.7000.
4. Albrektsson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1(1):11–25.
5. Sotto–Maior BS, Lima CD, Senna PM, et al. Biomechanical evaluation of subcrestal dental implants with different bone anchorages. Braz Oral Res 2014;28(1):1–7. DOI: 10.1590/1807-3107bor-2014.vol28.0023.
6. Gualini F, Salina S, Rigotti F, et al. Subcrestal placement of dental implants with an internal conical connection of 0.5 mm versus 1.5 mm: Outcome of a multicentre randomised controlled trial 1 year after loading. Eur J Oral Implantol 2017;10(1):73–82. PMID: 28327696.
7. Palacios–Garzón N, Velasco–Ortega E, López–López J. Bone loss in implants placed at subcrestal and crestal level: A systematic review and meta-analysis. Materials 2019;5;12(1):154. DOI: 10.3390/ma12010154.
8. Ghahroudi AR, Talaeepour AR, Mesgarzadeh A, et al. Radiographic vertical bone loss evaluation around dental implants following one year of functional loading. J Dent (Tehran) 2010;7(2):89–97. PMCID: PMC3184744.
9. Maier FM. Initial crestal bone loss after implant placement with flapped or flapless surgery: A prospective cohort study. Int J Oral and Maxillofac Implants 2016;31(4):876–883. DOI: 10.11607/jomi.4283.
10. Pellicer–Chover H, Peñarrocha–Diago M, Peñarrocha–Oltra D, et al. Impact of crestal and subcrestal implant placement in peri-implant bone: A prospective comparative study. Med Oral Patol Oral Cirugia Bucal 2016;21(1):e103–e110. DOI: 10.4317/medoral.20747.
11. Veis A, Parissis N, Tsirlis A, et al. Evaluation of peri-implant marginal bone loss using modified abutment connections at various crestal level placements. Int J Periodontics Restorative Dent 2010;30(6):609–617. PMID: 20967307.