

A 1-YEAR COMPARATIVE STUDY OF MARGINAL BONE CHANGE IN 2 SYSTEMS OF BONE-LEVEL, TAPERED IMPLANTS

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ABSTRACT

Among the tapered, bone-level implants available, Straumann Bone Level Tapered (BLT)[®] implant system (Straumann[®], Switzerland) and Helix GM[®] implant system (Neodent[®], Brazil) are widely used. However, to our knowledge, there is no evidence that compares marginal bone loss between these two systems. Therefore, this study focused on the difference of the marginal bone loss in radiographic findings between these two implant systems after 1 year of implant placement. Patients with Straumann Bone Level Tapered (BLT)[®] and Helix GM[®] implants were recruited. The intraoral periapical radiographs at baseline (T0), 6 months (T1), and 1 year (T2) after implant placement were evaluated and measured changes in marginal bone level. Between-group differences in marginal bone change at 1 year were not statistically significant. However, both groups showed statistically significant within-group changes at 6 months and 1 year. The mean marginal bone levels were 0.719 ± 0.736 and 0.54 ± 0.772 in Straumann Bone Level Tapered (BLT)[®], and 0.90 ± 0.596 and 0.95 ± 0.465 in Helix GM[®] group, at 6 months and 1 year, respectively. It could be concluded by the study that there was no difference in changes of marginal bone level between the two implant systems after 1 year of placement. Hence, differences in mean marginal bone level at 6 months and 1 year were observed in in both groups, though not clinically significant.

Keywords: Bone-Level Implant, Marginal Bone Loss, Peri-Implant Marginal Bone

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INTRODUCTION

Tooth loss is a frequent chief complaint for presentation to dental clinics. Contemporary treatment options include fixed restorations, removable dentures, and dental implants. Implants are now widely used for the rehabilitation of edentulous sites.

Patients commonly express concern about implant longevity. There are various criteria that were developed to categorize the conditions of the dental implants as successful, surviving, or failing. Marginal bone loss (MBL) is seen in the criteria developed by Albrektsson et al. in assessing dental implant success. (Albrektsson et al., 1986) Marginal bone loss is also incorporated into the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference as a parameter to classify dental implant health. (Misch et al., 2008)

Regarding the dental implants, there are many types and designs available. Both tissue-level and bone-level implants play important roles in restoring patient's dentition. The primary distinction is the vertical position of the implant platform relative to the soft tissue or alveolar bone. A systematic review by Cosola et al. reported no statistically significant difference in term of success and survival rates between the two types, and reported no statistically significant differences in marginal bone levels over follow-up periods of 1 to 5 years. (Cosola et al., 2020)

The implant designs—diameter, length, geometry, thread configuration, thread pitch, thread depth, and surface topography—affect the mechanical and biological interactions between the implant and peri-implant bone and can influence marginal bone levels. These characters may be suitable for different types of cases and clinical planning. Two widely used bone-level implant systems are Straumann Bone Level Tapered (BLT)[®] (Straumann[®], Switzerland) and Helix GM[®] (Neodent[®], Brazil). Although, they are both bone-level, there are slight distinctions when consider the designs.

To our knowledge, there is no known study that compares the marginal bone loss among these two implants systems. Therefore, the objective of the research is to study the difference of the marginal bone loss in radiographic findings between these two implant systems 1 year after implant placement.

LITERATURE REVIEW

Endosseous implants, which have a screw-shaped design that functions as an artificial tooth root, are the most commonly used today and can support fixed or removable restorations. Dental implants are generally classified as either bone-level or tissue-level. A systematic review by Cosola et al. reported no significant differences in success, survival, or marginal bone levels between these designs over 1–5 years. (Cosola et al., 2020) To further classify these implants, they may differ in geometry, thread designs, surface topography, and biomaterials. (Gaviria et al., 2014)

The major designs of implants are either cylindrical or tapered. Superior feature of the tapered implants over the cylindrical implants is that higher primary stability can be achieved due to the intimate contact between the implant fixture and the osteotomy wall. Nonetheless, excessive compression can cause local necrosis and impair woven bone formation during early healing process. On the other hand, cylindrical implants with parallel walls tend to dissipate occlusal load better and may reduce localized stress concentrations. (Nandini et al., 2022) Another feature that distinguishes variety of dental implants available in the market is the thread designs. The thread configuration varies from V-shape, square shape, buttress, and reverse buttress depending on the face angle and the thickness. It has an influence on how an occlusal load is directed toward the bone interface. Square threads tend to direct forces parallel to long axis, whereas V-shaped and reverse-buttress profiles introduce greater shear components. (Misch, 2008) Larger thread pitch and depth increase cutting aggressiveness and insertion torque, which can enhance primary stability but also raise the risk of angular deviation

during placement (Lee et al., 2015) Hence, surface topography is modified to promote osseointegration, ranging from smooth machined finishes to roughened surfaces produced by physical and chemical treatments; sandblasted-acid-etched (SLA) surfaces combine macro- and micro-roughness and were found to stimulate osteogenic activity (Garg et al., 2012) Straumann® BLT implant system is a bone-level implant with tapered design. It is self-cutting with thread pitch of 0.8 mm and thread depth of 0.3 mm. The surface topography available is either SLA® or SLActive®, which has an increased hydrophilicity. (AG, 2023) The Helix GM® system is also a bone-level implant with tapered shape with slight differences in fixture designs. The geometry of Helix GM® differs as it is fully tapered and the thread shapes consist of both trapezoid and V-shaped threads, which are claimed to permit higher primary stability to be achieved. Its surfaces are offered as Neoporos® and Acqua®. The latter one is known to increase fixture surface hydrophilicity. (Neodent®, 2020)

Implant success and survival rate can be evaluated using many sets of criteria. Well-known criteria established in an International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference suggest several clinical and radiographic parameters that an implant should meet to be classified as successful. An implant is classified as being in the “optimum health” or “success” category when four clinical conditions are met: absence of pain or tenderness on function, absence of mobility, radiographic bone loss of less than 2 mm from placement, and no history of exudate. (Misch, 2008)

Periapical radiographs are a routine and accessible tool for evaluating implant condition, allowing detection of bone pathology and monitoring disease progression over time. A marginal bone loss (MBL) is a change in alveolar bone that occurs in apical direction after an implant placement when compared with the initial bone level. Renvert et al. defined 3 conditions of an implant placed in the oral cavity as peri-implant health, peri-implant mucositis, and peri-implantitis. Whereas peri-implant health and peri-implant mucositis are healthy condition and inflammation found in the soft tissue respectively, peri-implantitis is a more extensive condition which also involves either progressive bone loss or radiographic evidence of ≥ 3 mm bone loss. (Renvert et al., 2018) Marginal bone loss is multifactorial and remarkable in the first year after implant placement and prosthetic loading. Contributing factors are grouped into three categories: biological, biomaterial, and technical factors. (Arai et al., 2024)

RESEARCH HYPOTHESIS

H0: There is no statistically significant difference between marginal bone loss in the periapical radiographs between Straumann Bone Level Taper (BLT)® and Helix GM® implants, which are both bone-level tapered designs, within 1 year of placement.

H1: There is a statistically significant difference between marginal bone loss in the periapical radiographs between Straumann Bone Level Taper (BLT)® and Helix GM® implants, which are both bone-level tapered designs, within 1 year of placement.

CONCEPTUAL FRAMEWORK

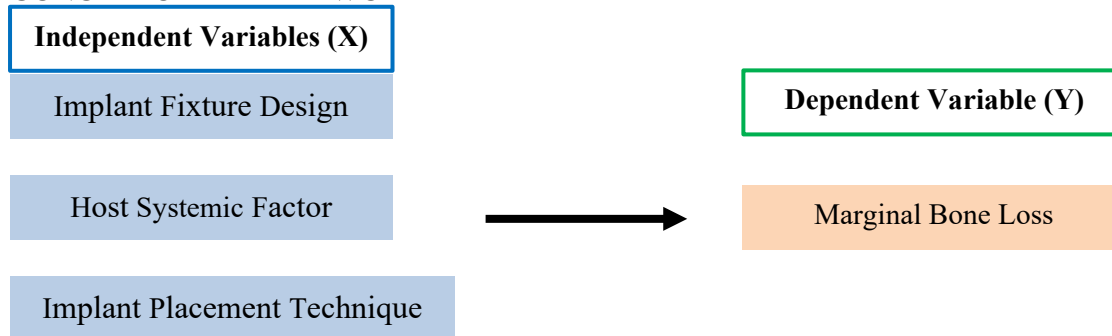


Figure 1 Conceptual Framework

METHODS

This research is a quantitative study which compares the marginal bone loss in two different systems of bone-level, tapered implants within 1 year of implant placement. Data were collected from patients who received implant placement at the Department of Oral and Maxillofacial Surgery, Chulalongkorn University, Thailand, and followed by crown placement at the Department of Prosthodontics, Chulalongkorn University, Thailand. Radiographic data were obtained from patients who had single implant supported unit using either Straumann Bone Level Tapered (BLT)[®] (Straumann[®], Switzerland) or Helix GM[®] implant system (Neodent[®], Brazil) from May 2022 to April 2025. Demographic data of the patients were recorded. Radiographs were collected at 3 timepoints: at baseline (T0) which was immediately after implant placement or at 2-week follow-up visit, at 6-month follow-up visit (T1), and at 1-year follow-up visit (T2).

Periapical radiographs were analyzed in the Infinitt[®] software (Infinitt Healthcare[®], Seoul, South Korea) and marginal bone level of each radiograph was measured. A reference line was drawn connecting the mesial and distal aspect of an implant. One perpendicular line on each side of the implant was drawn from the reference line to the first bone-to-implant contact. The distance was recorded as marginal bone level. The charge would be added to indicate direction with the positive charge indicating the bone level above the implant platform and negative charge indicating the bone level underneath it. Since radiographic jig was not used when radiographs were taken, the known implant length was used to calibrate the actual bone level. Then, the changes in marginal bone level were calculated by subtracting the values at T0 from T1 and T2. Changes in marginal bone were reported such that positive change denoted bone gain and negative change denoted bone loss.

Statistical analysis was done using IBM SPSS Statistics version 29.0.2.0 (SPSS Inc., Chicago, Illinois, USA). Normal distribution of the data was tested using Shapiro-Wilk test and the result showed that they were not normally distributed ($p > 0.05$). Nonparametric statistical test was utilized in this case. Mann-Whitney test was used to test the marginal bone change of the two types of implants ($p < 0.05$) while Wilcoxon signed ranks test was used to test the marginal bone change in each implant at different time periods ($p < 0.05$).

RESULTS

Thirty-five patients, receiving 37 implants, were included in this study. The patients were 13 males and 22 females with a mean age of 53.54 ± 3.33 years old (range 24-82). Twenty-two implants were Straumann Bone Level Taper (BLT)[®] and 15 were Helix GM[®], for a total of 37 implants. Of the 37 implants, 21 were placed in the maxilla and 16 in the mandible. Five implants were placed in the anterior area, canine to canine, and 32 implants were placed in the posterior region. The implants were placed fully in the bone without the need of any augmentation procedures. All the surgeries were performed successfully with no complications. Among the 37 cases, 5 implants were submerged and 32 implants were connected with healing abutments. The implant diameters used were 3.3, 3.75, 4.1, 4.3, 4.8, 5.0 mm. The implant lengths used were 8, 10, and 13 mm.

Mean changes in marginal bone of the two implant systems in six months and one year are shown in Table 1(a) and Table 1(b). The mean changes in six months and one year of Straumann Bone Level Taper (BLT)[®] were -0.42 ± 0.117 (95% CI: $-0.660, -0.172$) and -0.60 ± 0.168 (95% CI: $-0.947, -0.247$) while the changes observed in Helix GM[®] were -0.62 ± 0.176 (95% CI: $-0.994, -0.239$) and -0.57 ± 0.150 (95% CI: $-0.903, -0.250$). The negative values of changes in bone level suggested that there was a marginal bone loss. However, when analyzed using Mann-Whitney U test, no statistically significant difference was found between two groups at $p < 0.05$ at 6 months and 1 year ($p = 0.506$ and $p = 0.926$ respectively).

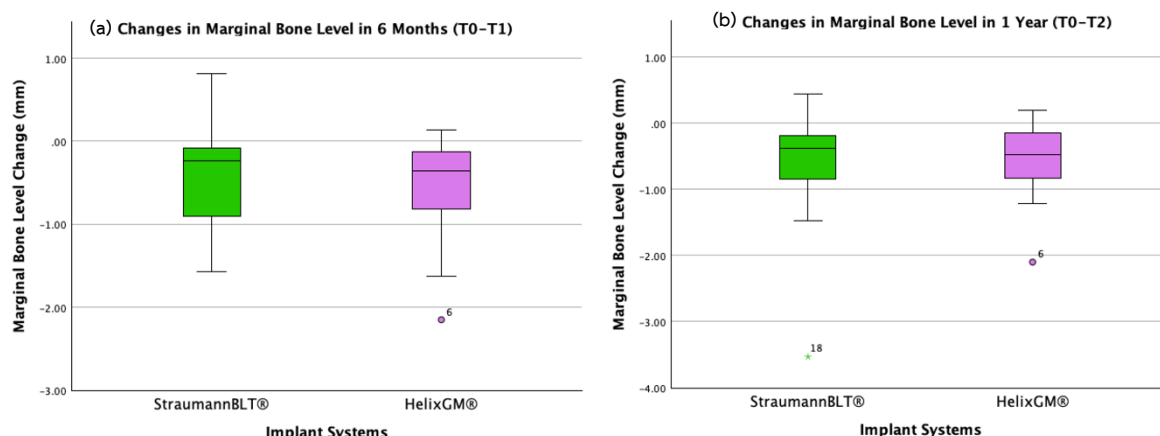
Table 1(a). Changes in Marginal Bone Level in 6 Months (T0 - T1)**Table 1(b).** Changes in Marginal Bone Level in 1 Year (T0 - T2)

Table 1(a). shows an amount of change in marginal bone level in Straumann Bone Level Taper (BLT)[®] and Helix GM[®] groups from baseline to 6 months after implant placement.

Table 1(b). shows an amount of change in marginal bone level in Straumann Bone Level Taper (BLT)[®] and Helix GM[®] groups from baseline to 1 year after implant placement.

The mean marginal bone level of each implant system was demonstrated in Table 2(a) and Table 2(b). For Straumann Bone Level Taper (BLT)[®], the mean marginal bone levels at baseline (T0), 6 months (T1) and 1 year (T2) observed were 1.14 ± 0.802 , 0.719 ± 0.736 , and 0.54 ± 0.772 respectively. For Helix GM[®], the mean marginal bone levels at baseline (T0), 6 months (T1) and 1 year (T2) observed were 1.52 ± 0.687 , 0.90 ± 0.596 , and 0.95 ± 0.465 , respectively. When the average marginal bone levels at all 3 timepoints were compared using Wilcoxon signed rank test for related samples with Bonferroni correction, statistically significant differences were shown between baseline (T0) and 6 months (T1) and between baseline (T0) and 1 year (T2) for both Straumann Bone Level Taper (BLT)[®] and Helix GM[®] groups ($p < 0.001$, $p < 0.001$ and $p = 0.002$, $p = 0.002$ respectively).

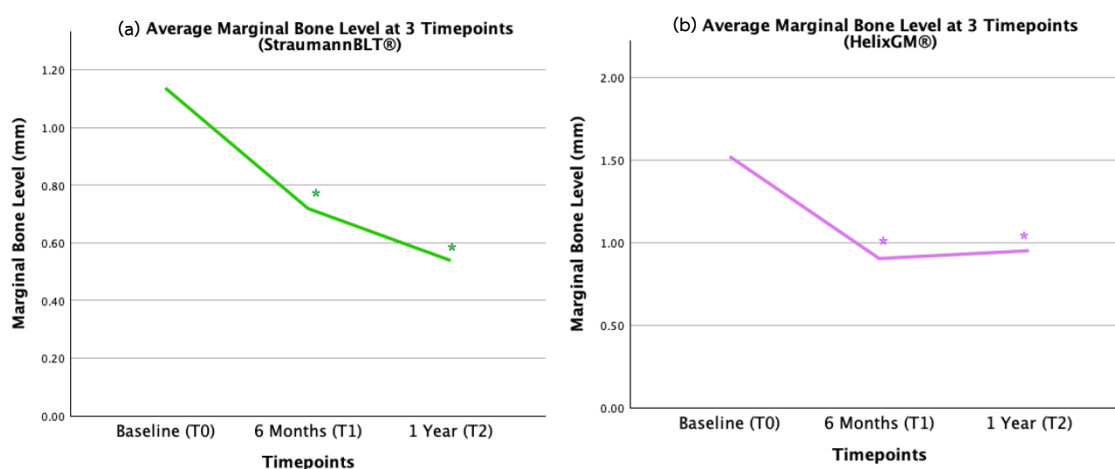
Table 2(a). Average Marginal Bone Levels at 3 Timepoints of Straumann Bone Level Taper (BLT)[®]**Table 2(b).** Average Marginal Bone Levels at 3 Timepoints of Helix GM[®]

Table 2(a). shows the average marginal bone levels of Straumann Bone Level Taper (BLT)[®] at baseline (T0), 6 months (T2), and 1 year (T2) after implant placement. (The asterisks represent statistical significance)

Table 2(b). shows the average marginal bone levels of Helix GM[®] at baseline (T0), 6 months (T2), and 1 year (T2) after implant placement. (The asterisks represent statistical significance)

DISCUSSION AND CONCLUSION

The favorable marginal bone stability observed around the Straumann Bone Level Taper (BLT)[®] implants in this study may be associated with several beneficial fixture design characteristics. Straumann Bone Level Taper (BLT)[®] implant fixtures incorporate a tapered geometry placed at bone-level in combination with an internal conical connection and platform-switching configuration. All of these mentioned features are known to be associated with reduced crestal bone remodeling and improved peri-implant tissue stability. Tapered fixture design is suggested to enhance primary stability and promote favorable stress distribution which are beneficial on the surrounding crestal bone. (Zhong et al., 2025) Platform switching design diverts inflammatory cell infiltrate and mechanical stress concentration away from the crestal bone by shifting the implant–abutment interface inward, resulting in minimal marginal bone loss around implants. (Strietzel et al., 2015) Additionally, internal conical connections may reduce micromovement and bacterial microleakage at the implant–abutment interface, contributing to preservation of peri-implant bone levels. (Hamudi et al., 2021) Similarly, the Helix GM[®] implants, which share similarity in fixture designs with slight differences, incorporate a hybrid tapered macrodesign and progressive thread geometry intended to enhance primary stability and optimize osseointegration, particularly in challenging bone conditions. (Neodent[®], 2020)

Hence, from a previous study by van Staden et al., evidences showed that the implant fixture geometry alone was not the sole factor which influenced the peri-implant bone level. The procedures of an implant placement itself, including insertion speed, insertion torque, and frictional force exerted on the implant-bone interface, affected the stress distribution on the marginal bone. (van Staden et al., 2008) These biological and biomechanical properties may help explain the peri-implant marginal bone stability observed around Straumann Bone Level Taper (BLT)[®] implants. Despite slight differences in fixture designs, such as fixture geometry and thread structures, Helix GM[®] implants were found to have similar amount of marginal bone loss in the first 6 months and 1 year after placement with no statistically significant differences. This finding may be attributed to the fact that both implant systems share several contemporary design concepts, including tapered implant geometry, bone-level placement, internal connections, and platform-switching features, which collectively contribute to comparable peri-implant bone preservation during the early healing and loading periods.

From the result of the study, there were statistically significant amounts of marginal bone loss observed at 6 months and 1 year in both groups of the implants. According to Taheri et al., there could be early marginal bone loss observed in bone surrounding implants. The early marginal bone loss is a non-infective remodeling process, influenced by multifactorial causes such as surgical and prosthetic factors, that may occur within the first year of an implant placement procedure. (Taheri et al., 2020) Therefore, the reduction in marginal bone levels observed in the study may represent physiologic peri-implant bone remodeling rather than pathologic bone loss.

Another phenomenon that commonly occurs to the peri-implant bone interface is the biologic width establishment which happens during the healing and the prosthesis loading periods. Zheng et al. mentioned about biologic width around an implant as a 3 - 4 mm distance from the upper part of peri-implant mucosa to the first bone-to-implant contact. Comprising sulcular epithelium, junctional epithelium, and fibrous connective tissue, the biologic width serves as a barrier against pathogens and influences peri-implant hard and soft tissue remodeling. (Zheng et al., 2021) Biologic width establishment is a complex process that takes time to occur after an implant placement. In the study by Sun et al., it was concluded that initial biologic width

has an effect on crestal bone loss. (Sun et al., 2022) This is in congruence with the studies by Hedayatipanah et al. and Sargolzaie et al. The vertical position in which an implant is placed in bone leads to different amount of marginal bone loss. Both studies demonstrated the same result that as an implant was placed subcrestally, more marginal bone loss was noted when compared to implant placed at crestal level. Though not clinically significant, a slight difference was shown. (Hedayatipanah et al., 2024) (Sargolzaie et al., 2022) The recommended vertical placement depth of the Straumann Bone Level Taper (BLT)[®] implants is approximately at crestal or slightly subcrestal level while the Helix GM[®] implants are designed for deeper subcrestal positioning. (AG, 2023) (Neodent[®], 2020) This difference may account for distinct patterns of bone remodeling observed at 6 months and 1 year: a continuous loss in the Straumann Bone Level Taper (BLT)[®] group and a loss followed by slight coronal bone regain in the Helix GM[®] group. Nonetheless, it is still inconclusive on whether crestal or subcrestal implant positioning is more superior to the other as of the current existing evidences. (Palacios-Garzón et al., 2019)

However, marginal bone levels in this study were measured in retrospective periapical radiographs calibrated to the known implant length. All radiographs were obtained under similar clinical conditions and analyzed using the same calibration and measurement protocol across all timepoints, ensuring consistent scaling and measurement procedures. This approach—commonly used in previous studies, such as those by Jacobs et al. and Galindo-Moreno et al.—supports the comparability of sub-millimeter bone level measurements between groups and timepoints. Nonetheless, prospective studies employing standardized radiographic guides may further corroborate these findings. (Galindo-Moreno et al., 2022) (Jacobs et al., 2010)

Even though marginal bone loss of -0.60 ± 0.168 (95% CI: $-0.947, -0.247$) and -0.57 ± 0.150 (95% CI: $-0.903, -0.250$) was observed in Straumann Bone Level Taper (BLT)[®] and Neodent Helix GM[®] at one year, respectively, the differences between two groups were not statistically significant. Based on Albrektsson et al.'s criteria, marginal bone loss up to 1.5 mm is acceptable in the first year following abutment connection and less than 0.2 mm annually thereafter. (Albrektsson et al., 2012) The bone loss observed in this study, while measurable, remained within these acceptable thresholds. Hence, other factors should also be considered when classifying an implant as successful, including the absence of pain and discomfort, the lack of implant mobility, and the absence of infection. (Karthik et al., 2013) Ultimately, in despite of the fact that marginal bone loss was observed to be statistically significant overtime in the first year after implant placement in this study, the loss was still within acceptable range and was, in fact, not clinically significant. It could possibly be concluded that the fixture designs of both systems of implants used in this research were proper for clinicians to choose from. Nevertheless, clinical aspects were still lacking and may be further studied.

SUGGESTIONS

1) Fabrication of Jig for Radiographic Examination: In the current study, due to the retrospective study design, the radiographs of each patient obtained were taken at different angles. This could mislead the bone level although calibration was done using the known implant length. Radiographic jig would allow researchers obtain radiographs with the same angle and parallelism at different timepoints. The bone level would be more accurate with the jig than with calibration using known implant length.

2) Longer Period of Follow-Up: This research included three timepoints, including implant placement day, 6 months, and 1 year after implant placement. The results shown reflected only short-term effect on the marginal bone level. Further studies are recommended to extend the follow-up period to investigate the longer-term influence of the implant fixture designs.

3) Prosthetic Factor Consideration: The timepoints included in this research were based on the date of implant placement. Nevertheless, it is undeniable that, not only the surgical

procedures, the prosthetic factors also have influences on the peri-implant marginal bone. Including prosthetic factors, such as emergence angle and crown contact, would help improve the study design.

4) Clinical Consideration: It is known that implant success criteria include both radiographic and clinical aspects. The lack of clinical information, such as implant mobility and sign of infection, after implant placement and prosthesis loading may not give enough insights for the clinicians in assessing the implants. The clinical aspects may lead to more understanding of the effects of an implant fixture design on the marginal bone stability.

5) Potentially Residual Confounders: A limitation of this study is that a variety of implant diameters and lengths were used and may represent residual confounders affecting marginal bone change. The main objective of the study was to analyze the difference in marginal bone change between two implant systems and the available sample size precluded reliable multivariable adjustment without risking model overfitting and unstable estimates. Therefore, such analyses were not undertaken. Larger, adequately powered studies are suggested to be conducted in further researches to determine the independent effect of implant dimensions on marginal bone outcomes.

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