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A COMPARATIVE STUDY ON THE EFFECT OF INTRASULCULAR VERSUS PARAMARGINAL INCISION DESIGN ON INTERPROXIMAL BONE LOSS OF TEETH ADJACENT TO SINGLE IMPLANTS

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Keywords

Single implants, Intrasulcular incision, Paramarginal incision, marginal bone loss.

Abstract

Dental implants represent a contemporary and reliable method for replacing lost teeth, providing patients with both functional restoration and improved aesthetics. The long-term success of these implants is largely determined by the condition of the marginal bone that surrounds them. Consequently, strategies focused on maintaining the integrity of the crestal bone and minimizing its resorption are essential for ensuring the stability and durability of dental implants.

Aims: The objective of this research is to radiographically compare and assess the influence of two incision techniques—intrasulcular and paramarginal—on the condition of marginal bone surrounding single dental implants.

Materials and Methods: "The comparative clinical study was carried out in the Department of Oral and Maxillofacial Surgery at Oxford Dental College, Bangalore, following approval from the Institutional Ethics Committee." A total of twenty-four patients who required prosthetic rehabilitation for a single missing tooth were included in this investigation. The participants were randomly divided into two equal groups. In Group A, dental implants were placed using the intrasulcular incision method, whereas in Group B, the paramarginal incision technique was applied.

"Radiovisiography (RVG) was employed to evaluate and monitor the marginal bone levels surrounding the dental implants." Both clinical and radiographic evaluations were performed at three time points: baseline, three months post-loading, and six months post-loading, in order to compare treatment outcomes between the two groups.

Statistical analysis: "Data analysis was carried out using either the Independent Student's t-test or the Mann–Whitney U test, with statistical significance determined at a threshold of $P < 0.05$."

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RESULTS: Marginal bone loss was evaluated in both groups at baseline, 3 months, and 6 months following loading. Across all time intervals, Group A demonstrated slightly greater mean bone loss compared to Group B. Nonetheless, the magnitude of these differences remained minimal, with p-values ranging between 0.50 and 0.75. This indicates that no statistically significant variation in bone loss was observed between the two groups throughout the study period.

CONCLUSION: The investigation assessed marginal bone loss following Intrasulcular and Paramarginal incision approaches at different time intervals. Both techniques revealed progressive bone reduction, with early fluctuations more noticeable in the Intrasulcular group. Although the Intrasulcular approach showed slightly more pronounced bone alterations, the variation between the two incision techniques was not statistically meaningful. Overall, both methods were found to be equally effective in maintaining long-term marginal bone stability.

[1] INTRODUCTION

Implantology is a progressive field within dentistry which involves the restoration of missing teeth and the establishment of oral function and aesthetics. Endosseous implants, which are increasingly utilized in maxillofacial, dental, and orthopedic surgeries, have become a preferred treatment option for partially or completely edentulous arches.

According to Donath's studies, when a foreign substance is introduced into the human body, it may trigger one of four types of biological responses: rejection, dissolution, resorption, or demarcation. Among these, demarcation serves as a protective defense, in which the body attempts to isolate a substance that cannot be dissolved or resorbed. This process typically leads to the formation of a fibrous capsule around the foreign material. However, when a biocompatible implant is placed within bone under stable and sterile conditions—free from infection and micromovements—an alternative response known as bone encapsulation occurs. This unique reaction results in a stable interface where bone directly bonds to the implant surface. The phenomenon, first described by Brånemark in 1952, is termed osseointegration, and it is defined as the establishment of a direct structural and functional link between living, organized bone and the surface of a load-bearing implant.

Most osseointegrated implants achieve predictable long-term success because of the establishment of a balanced bone remodeling process. However, this state of foreign-body equilibrium can be disrupted by various local or systemic factors over time. When the dynamic balance between bone formation and bone resorption is disturbed, the primary clinical manifestation is marginal bone loss (MBL). Maintaining marginal bone integrity has consistently been regarded as one of the most important indicators for evaluating the overall success and longevity of dental implants.

The sustainability of dental implantology largely depends on a comprehensive evaluation of the patient's clinical profile, which includes periodontal status, occlusal balance, available bone quantity, and general systemic health. Based on this assessment, surgical and prosthetic interventions must be carefully tailored to individual needs. In earlier stages of implantology, the primary focus of clinicians was on achieving osseointegration, which was regarded as the principal criterion for success, often without consideration of esthetic aspects. However, contemporary perspectives emphasize that the condition and stability of the peri-implant soft tissues are equally critical. Healthy and well-maintained soft tissues not only enhance the esthetics but also play a decisive role in the long-term survival and functionality of implants. Conversely, neglecting the biological and structural integrity of these tissues increases the risk of implant complications and peri-implant diseases.

Mucoperiosteal flaps are commonly employed in periodontal, endodontic, and oral surgical interventions to gain access to the underlying bone and root surfaces. During this procedure, soft

tissues are incised, and the periosteum is carefully reflected from the alveolar bone. When dental implants are placed through such surgical flap techniques, a certain degree of bone resorption around the implant site is often observed. This effect is largely attributed to the temporary reduction in blood supply to the surrounding bone following flap elevation, which subsequently contributes to crestal bone loss.

The interdental papilla plays an essential protective role for the surrounding periodontal tissues along with the alveolar bone crest. It serves as a natural barrier, preventing microbial invasion and reducing the risk of food impaction. When the papilla is lost, it can result in esthetic deformities as well as functional problems such as phonetic disturbances. The presence or absence of the papilla primarily depends on the spatial relationship between the contact point of adjacent teeth and the underlying crestal bone. Among the various possible causes of early marginal bone loss, the type of surgical flap design used during periodontal procedures has been identified as a particularly significant factor.

[2] MATERIALS AND METHODS

INCLUSION CRITERIA:

1. Participants may be of either gender, ranging in age from 18 to 60 years.
2. The study requires a single posterior edentulous site in either the maxilla or mandible, with a minimum mesiodistal space of 8 mm.
3. Adjacent teeth must be in a healthy condition, not serving as abutments for any fixed prosthesis and free from periodontal disease.
4. A keratinized mucosal width of at least 3 mm is essential.
5. Subjects should present with full-mouth plaque and bleeding scores below 25%.
6. Implant placement must be indicated in cases not requiring simultaneous bone regeneration procedures.

EXCLUSION CRITERIA:

1) Dental implants should not be positioned within 2 mm of adjacent natural teeth.
2) Patients with systemic conditions negatively affecting wound healing.
3) Sites with acute infection.
4) Patients with history of smoking.
5) Patients with periodontal disease
6) Patients requiring bone augmentation and flap advancement procedures.

STUDY DESIGN

The clinical study was conducted in the Department of Oral and Maxillofacial Surgery at Oxford Dental College, Bangalore. Approval for the placement of dental implants was obtained from the Institutional Ethical Committee before the initiation of the research. Prior to surgery, every participant was thoroughly informed about the study protocol, including possible risks and expected benefits of the treatment. Written informed consent was secured from all patients before carrying out the implant procedures.

Twenty-four subjects of either gender aged between 18-60 years of age were divided randomly and equally into two groups – Group A and Group B.

a. Twenty-four adults (18–60 years), of either sex, were randomly assigned in equal numbers to Group A and Group B.
b. A total of 24 participants, aged 18–60 years and of both sexes, were evenly and randomly allocated to Group A or Group B.
c. Twenty-four volunteers between 18 and 60 years were randomized, with equal allocation, to

Group A and Group B.

d. Twenty-four individuals (ages 18–60; either sex) were randomly divided into two equal cohorts: Group A and Group B.
e. We enrolled 24 adults aged 18–60 years (both sexes) and randomized them equally to Group A or Group B.
f. The sample comprised 24 participants, 18–60 years old and of either sex, randomized in a 1:1 ratio to Group A and Group B.
g. Twenty-four subjects of either sex, aged 18–60, were assigned at random in equal numbers to Group A and Group B.
h. A cohort of 24 adults (18–60 years, both sexes) was split equally and randomly into Group A and Group B.

PROCEDURE:

Group A:

Intrasulcular incision: An intrasulcular approach was carried out by making a crestal incision within the attached gingiva of the edentulous ridge. The incision line extended through the sulcus of the neighboring teeth, and no vertical releasing incisions were added. A no. 15 surgical blade was used for this procedure.

Group B:

Para-marginal incision: A crestal incision was carefully placed within the attached mucosa of the edentulous ridge, ensuring that it did not extend into the interproximal gingival tissues adjacent to the neighboring teeth. Using a no. 15 scalpel blade, two vertical releasing incisions were created to facilitate flap elevation. The mid-crestal incision was positioned at an approximate distance of 1.5–2 mm from the interproximal surface of the adjacent teeth.

After performing the incision, a mucoperiosteal flap was gently reflected to reveal the underlying bone. The implant platform was then placed at a depth of approximately 1–1.5 mm below the crest of the ridge. A submerged placement protocol was employed, after which the surgical flap was repositioned and stabilized using sutures. For postoperative management, the patient was prescribed Amoxicillin 500 mg and Diclofenac sodium 50 mg, to be taken orally three times a day for a duration of five days. "The patient was further instructed to rinse with a 0.2% chlorhexidine digluconate solution twice daily for a duration of two weeks, ensuring each rinse lasted for one minute". "The sutures were taken out one week after surgery, and following a 12-week healing phase, the implants were restored with a prosthetic device."

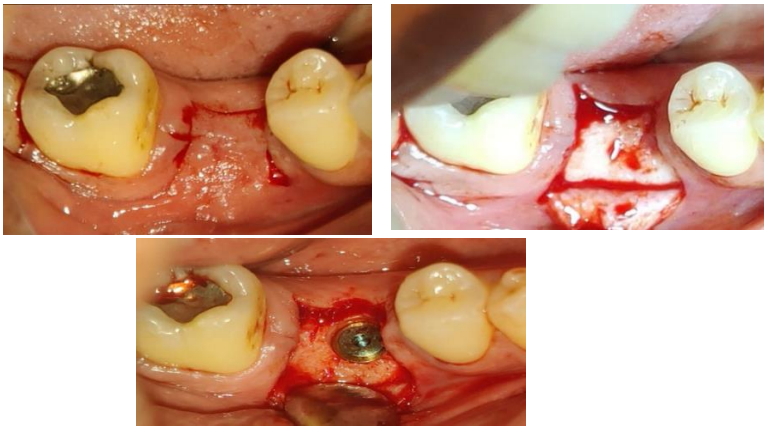

Figure-1: PARAMARGINAL INCISION

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Figure-2: INTRASULCULAR INCISION

RADIOGRAPHIC EXAMINATION:

A. Assessment Method

The extent of interproximal bone resorption around dental implants was evaluated using radiovisiographs (RVGs).

B. Baseline Measurement

1. Immediately after surgery, a radiograph was recorded as the baseline reference image.
2. On the proximal surface of adjacent teeth, two key anatomical landmarks were identified:
   - Point A – representing the cementoenamel junction (CEJ).
   - Point B – representing the most coronal point of the alveolar bone crest.

C. Reference Line and Baseline Level

1. A reference line was drawn along the long axis of the root.
2. This line extended from Point A (CEJ) to Point B (alveolar crest).
3. The linear distance between these two points was recorded as the baseline crestal bone level.

D. Follow-Up Evaluation

1. At each scheduled radiographic follow-up, the same reference points and line were used.
2. The distance measured at follow-up RVGs was compared with the baseline to assess changes in crestal bone height over time.
   - Baseline: Immediately following the placement of the implant.
   - At Abutment Connection: Three months after implant placement.
   - Six-Month Evaluation: Conducted six months after the implant has been loaded.
   - One-Year Evaluation: Conducted one year following implant loading.

Figure-3: PRE-OP

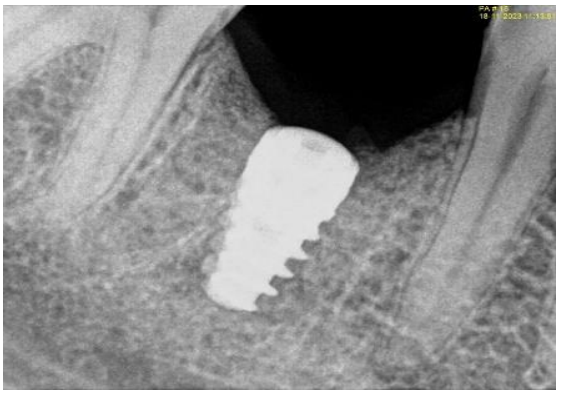

Figure-4: IMPLANT PLACEMENT

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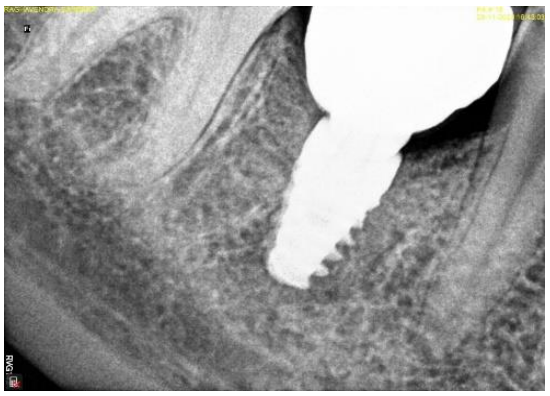

Figure-5: IMPLANT PROSTHESIS

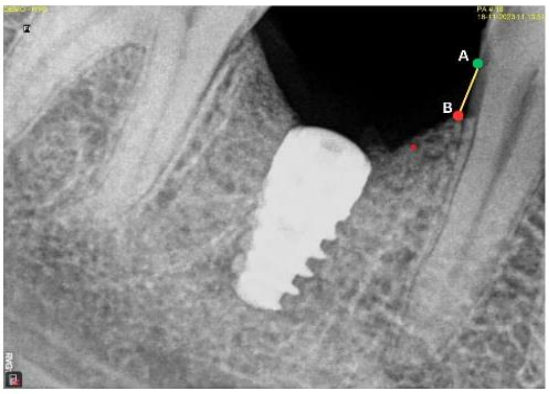

Figure-6: RADIOGRAPHIC EXAMINATION

[3] RESULTS

A total of 24 patients received 24 implants in this study. Among them, 12 patients were treated using an intrasulcular incision approach, while the remaining 12 underwent a paramarginal incision. At the one-year follow-up, all implants demonstrated successful osseointegration and were fully functional. Out of the 24 implants, 20 were positioned in the molar region, whereas 4 were placed in the premolar region. Anatomically, 16 implants were inserted in the mandible and 8 in the maxilla. The implants used had lengths ranging between 10 mm and 11.5 mm, with diameters varying from 3.7 mm to 4.3 mm.

In Group A, the mean age was 37.25 years with a standard deviation of 12.23 years, whereas Group B showed a slightly lower mean age of 34.42 years and a standard deviation of 11.45 years. The ages in Group A ranged from 24 to 59 years, while in Group B they varied between 21 and 56 years. Statistical comparison indicated that the age difference between the two groups was not significant ($p = 0.29$).

In Group A, males represented 66.7% (n=8), while females comprised 33.3% (n=4). In Group B, males accounted for 58.3% (n=7) and females for 41.7% (n=5). Statistical analysis indicated no significant difference in gender distribution between the two groups ($p = 0.67$).

At the initial assessment, Group A showed an average bone loss of 2.68 ± 1.50, whereas Group B presented a slightly lower mean value of 2.40 ± 1.42. The mean difference between the two groups was 0.28, and the corresponding p-value of 0.64 confirmed that this variation was not statistically significant.

At the three-month follow-up, the average bone loss observed in Group A was 2.78 ± 1.50, while Group B showed a mean loss of 2.58 ± 1.48. The difference between the groups was 0.20, with a p-value of 0.75, indicating that marginal bone loss was statistically similar across both groups at this interval.

At the six-month assessment, Group A recorded an average bone loss of 2.71 ± 1.50, while Group B showed a mean value of 2.47 ± 1.43. The observed difference of 0.24 was statistically insignificant ($p = 0.69$), indicating comparable bone loss between the groups.

At the twelve-month follow-up, Group A demonstrated a mean marginal bone loss of 2.85 ± 1.49 mm, while Group B showed a mean loss of 2.44 ± 1.40 mm. The calculated mean difference was 0.41 mm, with a p-value of 0.50, suggesting that although Group A exhibited slightly greater bone loss, the variation between the two groups was not statistically significant.

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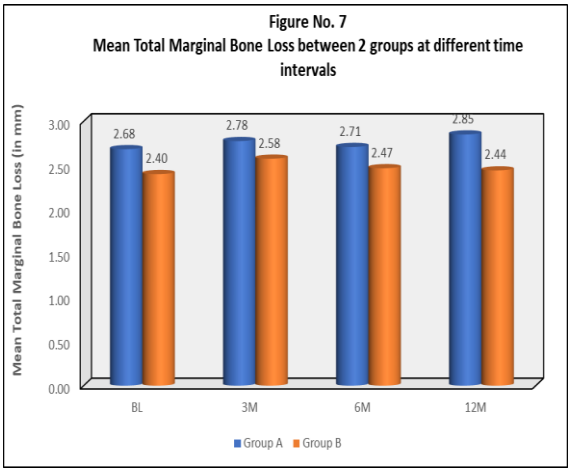
"At all evaluated time points, the extent of marginal bone loss was similar across both groups, and no statistically significant variation was detected."

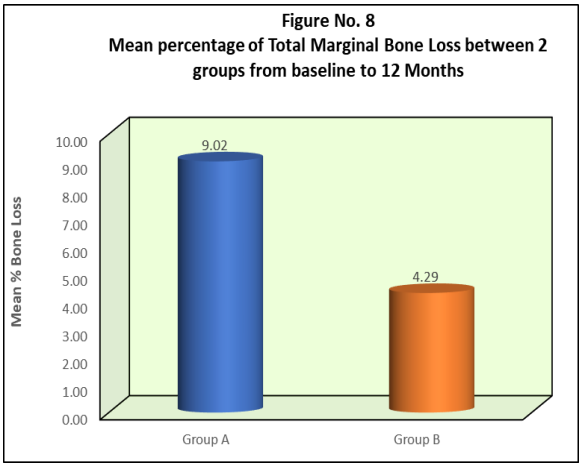
Table No. 1: Age and Gender Distribution between Two Groups

Variable	Category	Group A		Group B		p-value
		Mean	SD	Mean	SD	
Age	Mean	37.25	12.23	34.42	11.45	0.29[a]
	Range	24 – 59		21 - 56		
		n	%	n	%	
Sex	Males	8	66.7%	7	58.3%	0.67[b]
	Females	4	33.3%	5	41.7%	

Table No. 2: Comparison of Mean Total Marginal Bone Loss between Two Groups at Different Time Intervals Using Independent Student's t-Test

Parameter	Group	N	Mean	SD	Mean Diff	p-value
BL	Group A	12	2.68	1.50	0.28	0.64
	Group B	12	2.40	1.42		
3M	Group A	12	2.78	1.50	0.20	0.75
	Group B	12	2.58	1.48		
6M	Group A	12	2.71	1.50	0.24	0.69
	Group B	12	2.47	1.43		
12M	Group A	12	2.85	1.49	0.41	0.50
	Group B	12	2.44	1.40		





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[4] DISCUSSION

This prospective clinical study aimed to compare the impact of two different flap designs intrasulcular and paramarginal incisions on the interproximal bone levels of teeth adjacent to single implants. The hypothesis tested was whether preserving the integrity of the interdental papilla and limiting flap elevation with a paramarginal incision would result in significantly less interproximal bone loss compared to the conventional intrasulcular design. Our results demonstrated that although the paramarginal incision group exhibited consistently lower interproximal bone loss at all intervals baseline, 3, 6, and 12 months the differences between the two groups were not statistically significant. However, the observed trend holds biological and clinical relevance and aligns with the current understanding of peri-implant soft and hard tissue dynamics.

The influence of flap design on peri-implant tissue stability is well-documented. Gómez-Román et al. showed that intrasulcular incisions caused greater interproximal bone loss due to impaired vascularization near the papilla.13 Girbés-Ballester et al. reported no statistically significant differences in bone loss between intrasulcular and trapezoidal incisions, though soft tissue healing was more favorable with the latter.33 Histologic analyses by Fickl et al. and Binderman et al. confirmed that full-thickness flap elevation involving the papilla leads to bone remodeling via osteoclastic activity.(12,38) These findings suggest a biologic basis for the soft and hard tissue preservation seen with paramarginal approaches. Hutchens et al. emphasized that mid-crestal bone is particularly susceptible to ischemic injury when flap design disrupts vascular supply, recommending minimal trauma incisions.39 This aligns with our findings and surgical approach. The esthetic relevance of papilla preservation is also paramount. Chang et al. and Salama et al. demonstrated that even 1 mm of interproximal bone loss can lead to the disappearance of the papilla and the formation of black triangles, compromising the esthetic result. (40,41) Lombardi et al. identified incision design as a key determinant of early marginal bone loss, along with other factors like abutment height and tissue biotype.42 Our uniform surgical protocol and single implant system eliminated many such confounders. A randomized trial by Abdulhameed et al. demonstrated significantly greater bone loss and higher biochemical markers of inflammation in intrasulcular incisions than in papilla-sparing incisions.31` Yilmaz et al. observed similar bone loss between sulcular and papilla-sparing flaps but better soft tissue esthetics with the latter.43

In our study, although the difference in interproximal bone loss was not statistically significant, the observed trend of less loss in the paramarginal group reflects broader evidence advocating for tissue-preserving strategies. Tonetti et al. also stressed that minor hard tissue changes can significantly influence esthetic outcomes, especially in anterior implants.44

Chen et al. and Cosyn et al. reported that flapless or papilla-sparing designs favour peri-implant soft tissue outcomes. (45,46) Similarly, Buser et al. and Van der Weijden et al. emphasized the role of ridge preservation and minimally invasive surgery in limiting resorption and supporting esthetics.(47,48) Studies on socket preservation and immediate implants also provide indirect evidence. Araujo and Lindhe, as well as Cornelini et al., showed that tissue trauma at the time of surgery influences long-term ridge dimensions and osseointegration.(49,50) Tal et al. and Schropp et al. found that attached gingiva width and flap design affect long-term mucosal stability.(51,52)

Caneva et al. compared flap vs. flapless approaches and found that flapless surgeries preserved more hard tissue volume.53 While our study did not directly compare flapless methods, the paramarginal group showed preservation benefits consistent with these findings. Hämmerle et al. and Barone et al. supported minimizing flap elevation to optimize socket healing.(54,55) Flap design also influences soft tissue profiles post-implantation, as shown by Chen et al. and Cosyn et al. using PES/WES indices,(45,46) which we recommend for future studies. Furthermore, the long-term clinical

significance of even small bone level variations is becoming increasingly apparent. As the field of implantology evolves toward precision-based, esthetically driven outcomes, the ability to preserve or enhance peri-implant architecture is of utmost importance. The paramarginal flap, by conserving vascular networks and minimizing trauma, appears to support such goals. In esthetically critical zones especially the maxillary anterior region—the maintenance of interproximal bone is directly linked to soft tissue integrity and visual harmony. Even if differences in bone levels do not reach statistical significance, the biological implications on soft tissue support cannot be understated. While our clinical and radiographic parameters suggest equivalence between the techniques, it is plausible that patients might perceive differences in postoperative discomfort, esthetic satisfaction, or functional integration factors that merit inclusion in future prospective trials. A potential avenue for exploration is the relationship between flap design and peri-implantitis risk. By minimizing flap elevation and preserving soft tissue seals, techniques like the paramarginal incision could potentially reduce bacterial infiltration and mucosal recession, contributing to long-term implant stability. Although this study did not include inflammatory markers or long-term biological complications, integrating such outcomes into future trials could offer a more comprehensive understanding of surgical flap design impact.

[5] CONCLUSION

The study examined the progression of marginal bone loss over time between two different incision techniques, providing insights into how each method influenced bone resorption. While both the Intrasulcular and Paramarginal Incision groups exhibited variations in bone loss, the differences between them remained subtle, suggesting that neither technique led to significantly distinct outcomes in long-term bone stability. Within each group, marginal bone loss followed a progressive pattern, with fluctuations observed at specific intervals. In the early months, more pronounced variations were noted, particularly in the Intrasulcular Incision group, where changes appeared to be more dynamic. However, as time progressed, both groups demonstrated relative stability in bone loss patterns.

Although the percentage increase in bone loss was greater in the Intrasulcular Incision group compared to the Paramarginal Incision group, the difference did not reach significance, indicating that the overall impact of incision technique on bone resorption was comparable. These findings suggest that both methods may be similarly effective in maintaining marginal bone stability over time. The results contribute valuable information for clinical decision-making, reinforcing the need for further investigation into additional factors that may influence long-term bone loss outcomes following surgical procedures.

[6] AUTHOR(S) CONTRIBUTION

Dr. Zealous Mary comprehended and conducted the study, as well as evaluated and interpreted the results. Dr. Vathana wrote and updated the main manuscript. All authors read and approved the final version of the manuscript.

[7] LIMITATIONS

The size of the sample was very small.

The study was completely conducted on senior citizens.

[8] RECOMMENDATIONS

Needs to conduct in Tai-chi exercise to assess the physical problems in old age people.

Comparison research may be done to discover changes in adults and old age

recommend to do this study as qualitative research.

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[9] ACKNOWLEDGEMENT

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[10] SOURCES OF FUNDING

The authors received no financial aid to support the study.

[11] PLAGIARISM POLICY

The authors declare that any kind of violation of plagiarism, copyright, and ethical matters will be handled by all authors. Journalists and editors are not liable for the aforesaid matters.

[12] CONFLICT OF INTEREST

The authors declared that no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

[13] PROTECTION OF RESEARCH PARTICIPANTS

This study do not involve any such criteria or condition.

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