



## An in Vivo Assessment of Effects of Various Flap Designs on Overall Implant Performances Estimated at Different Timings: An (Clinical) Original Research Study

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### ABSTRACT:

**Aim:** This study aims to assess the effects of various periodontal flap designs on overall Flap related implant performance estimated at different timings.

**Materials and Methods:** The study involved 80 patients with a missing mandibular right first molar who preferred dental implants. Out of these, 60 patients aged 35 to 60 met the inclusion criteria and underwent a Cone Beam Computed Tomography (CBCT) scan for surgical planning. Exclusion criteria included mental health issues, smoking, pregnancy, and certain systemic diseases. The dental implant was placed after a precise incision, and the mucoperiosteal flap was sutured. Healing abutments were added two months later, with final prostheses fitted three months post-surgery. The patients were divided into three groups based on surgical techniques: Group 1 used the envelope periodontal flap for minimal disruption, Group 2 the triangular flap for better access, and Group 3 the trapezoidal flap for broader access while preserving tissue. Evaluations at 6 and 12 months used CBCT to assess implant performance, with statistical analyses conducted to compare outcomes based on the flap designs.

**Statistical Analysis and Results:** This study involved 60 patients aged 35 to 60, with 29 males and 31 females. Participants were divided into three groups based on surgical techniques for implant placement: Group 1: 20 patients underwent the envelope flap technique. At six months, healing improved for 6 patients, confirmed by the Pearson Chi-Square test. Twelve-month results showed enhanced bone remodelling. Group 2: 20 patients used the triangular periodontal flap technique. Six months later, 7 patients experienced improved aesthetics, and at twelve months, healing was better for 6 patients, with 8 reporting aesthetic improvements. Group 3: The last group of 20 patients received implants via the trapezoidal periodontal flap technique. Six months in, 5 patients showed healing and aesthetic improvements, while



twelve months later, 7 patients benefited from enhanced accessibility and visibility. A summary in Table 8 using one-way ANOVA indicates significant outcome variations based on the flap techniques employed.

**Conclusion:** This study concluded that all periodontal flap designs improved implant success, with the triangular flap notably enhancing aesthetics and minimising gingival recession in certain cases. The choice between triangular and trapezoidal periodontal flaps should depend on specific circumstances, as each has unique pros and cons related to surgical access, implant stability, and healing. The findings highlight the need for further research to refine these techniques and enhance patient outcomes.

## Introduction

Periodontitis is a prevalent chronic inflammatory disease that results from the imbalance of microbial communities in the oral cavity. This condition affects a significant portion of the adult population globally and is marked by the progressive destruction of the periodontal supporting tissues, which include the gums, periodontal ligament, and alveolar bone.<sup>1,2</sup> If left untreated, periodontitis can lead to severe complications, such as tooth loss and a considerable decline in an individual's quality of life. Therefore, early identification and prompt management of the disease are critical in preventing its progression, alleviating associated symptoms, and minimising healthcare costs related to dental treatment.<sup>3,4</sup> The initial approach to managing periodontitis typically emphasises non-surgical interventions, particularly scaling and root planning (SRP). This procedure aims to effectively remove dental biofilm, calculus, and bacterial endotoxins from the tooth surfaces and root structures.<sup>5</sup> Furthermore, educating patients about optimal oral hygiene practices is vital for the successful management of periodontitis. Regular mechanical removal of dental biofilm through proper brushing and flossing techniques is essential in controlling the disease and preventing its recurrence. Additionally, it is important to address modifiable risk factors that can exacerbate the condition, such as overhanging dental restorations that trap food debris and plaque, as well as tobacco use, which is widely recognised as a significant risk factor for periodontal disease.<sup>6,7</sup> In conjunction with periodontal interventions, non-periodontal treatments may also play a vital role in improving the overall prognosis for patients. Procedures such as root canal therapy may be necessary to treat infected dental pulp, while the extraction of severely infected teeth can

prevent further complications and the spread of infection to surrounding tissues. To assess the effectiveness of non-surgical therapy, evaluations typically occur six to eight weeks following treatment. During these assessments, clinicians monitor for continued signs of periodontitis, including inflammation and probing depths around the teeth. Sites exhibiting probing depths of 5 mm or less are generally amenable to non-surgical treatments. However, those demonstrating probing depths of 6 mm or more may warrant surgical intervention to adequately address underlying issues.<sup>8,9</sup> When surgical treatment is deemed necessary for periodontal disease, a variety of periodontal flap designs are utilized, each chosen based on the specific requirements of the surgical procedure. Common designs include envelope, triangular, trapezoidal, and semilunar flaps. The selection of a particular flap design is driven by the need for access to deeper oral structures, which may be necessary for cleaning, bone grafting, or other reconstructive efforts. The envelope flap, characterized by its straightforward, single incision that allows for minimal tissue displacement, is often preferred for less invasive procedures. Its simplicity makes it an ideal choice when only moderate access is required, ensuring a quicker recovery time and reduced risk of complications. In contrast, triangular and trapezoidal flaps provide a three-sided access point, offering greater visibility and accessibility for more complex surgical interventions. These designs are particularly beneficial when extensive tissue removal or manipulation is needed to facilitate thorough cleaning or surgical repair.<sup>10,11</sup> However, it is important to note that the semilunar flap has seen a decline in popularity in recent years. This design, which involves a crescent-shaped incision, has been associated with concerns regarding potential complications, such



as inadequate access to subgingival areas or poor tissue healing. Surgeons must weigh these risks carefully when determining the appropriate flap design for each case.<sup>12</sup> In addition to the choice of flap design, a thorough understanding of the pathophysiology of periodontitis is crucial. This includes recognising the underlying biological mechanisms that contribute to the disease, identifying risk factors such as genetics, smoking, and systemic health conditions, and developing effective treatment strategies. Individualised treatment plans tailored to each patient's needs are essential for the management and prevention of periodontitis. Early intervention plays a vital role in improving patient outcomes, helping to maintain periodontal health over the long term and ultimately enhancing the quality of life for patients.<sup>13</sup> This study aims to assess the effects of various flap designs on overall Flap related implant performance estimated at different timings.

## Materials and Methods

The study began with a cohort of 80 patients who presented with the specific complaint of a missing mandibular right first molar and expressed interest in its replacement. Of these, 60 patients expressed a preference for dental implant placement accompanied by an implant-supported prosthesis. Study was conducted in the department of periodontology of the institute. The inclusion criteria for participation consisted of individuals aged between 35 and 60 years, encompassing both males and females, who had a confirmed absence of the mandibular right first molar. Meanwhile, the exclusion criteria outlined several conditions that would disqualify potential participants, including individuals with mental health issues, smokers, pregnant women, and those with various systemic diseases. Prior to the initiation of the treatment planning phase, a Cone Beam Computed Tomography (CBCT) scan was performed on all eligible patients to facilitate a thorough evaluation of the anatomical structures involved and assist in strategizing the surgical approach. To ensure a sterile surgical environment, each participant was instructed to use a chlorhexidine mouthwash rinse before the implant placement procedure. This step was critical for minimizing the risk of infection during the surgical intervention. Subsequently, an inferior alveolar nerve block was administered to the patients to effectively numb the

targeted area, alleviating discomfort and ensuring a pain-free surgical experience. A precise incision was made with a number 15 scalpel blade, which allowed for the careful reflection of a mucoperiosteal periodontal flap. This step was vital to gain unimpeded access to the underlying bone, which would serve as the foundation for the dental implant. Upon successful elevation of the flap, the dental implant was strategically placed in the meticulously prepared site, ensuring optimal positioning for functionality and aesthetics. After the implant placement, the mucoperiosteal periodontal flap was delicately repositioned to cover the implant, and sutures were applied to secure the tissue and promote proper healing throughout the recovery phase. Following two months after the implant placement, healing abutments were placed to facilitate the next stages of prosthetic development. Three months post-implant placement, patients received their final prosthesis supported by the newly integrated implants. To evaluate the overall performance of the implants, assessments were conducted at 6- and 12-months post-placement using cone beam computed tomography (CBCT). In this comprehensive study, a cohort of 60 patients was examined, all of whom were categorized into three distinct groups based on the surgical technique/periodontal flap utilized for the placement of dental implants. Group 1 encompassed 20 patients who underwent the implant placement using the envelope periodontal flap surgical technique. This approach is characterized by its minimal disruption to the surrounding soft tissue, allowing for a more conservative access to the implant site. The performance of the implants in this group was meticulously evaluated at both the 6-month and 12-month follow-up periods through the use of Cone Beam Computed Tomography (CBCT) imaging, a sophisticated imaging modality that provides detailed three-dimensional views of the dental structures. Evaluation was conducted by a single clinician to ensure consistency and reliability of the results. Group 2 consisted of another cohort of 20 patients, who received their implants through the triangular periodontal flap surgical technique. This method, which creates a triangular section of the gingiva for improved visibility and access, allowed for similar detailed assessments of implant performance at the same intervals as Group 1, again employing CBCT imaging under the supervision



of the same clinician. Lastly, Group 3 included the final set of 20 patients whose implants were placed utilising the trapezoidal periodontal flap surgical technique. This approach, which offers a broader flap for surgical access while preserving surrounding tissue integrity, was also subjected to evaluations at the prescribed 6 and 12-month marks through the same imaging technique by the same clinician. To assess the differences in implant performance related to the various flap designs, thorough statistical analyses were conducted across all three groups. The overarching goal of this study was to intricately evaluate the influence of diverse flap designs on the long-term performance of dental implants, thereby contributing invaluable insights into optimal surgical practices within the realm of implant dentistry. This study not only aims to enhance the understanding of surgical techniques but also seeks to inform best practices that can lead to improved patient outcomes.

## Statistical Analysis and Results

In this study, we used SPSS software for statistical analyses. To evaluate our findings, we employed the chi-square test to examine differences in proportions across groups. This method facilitated a rigorous comparison of categorical data, ensuring our results accurately reflect underlying trends and relationships within the dataset.

## Results

This study encompassed a total of 60 patients, aged between 35 and 60 years, with a near-equal distribution of males and females. Specifically, the cohort comprised 29 males and 31 females, as illustrated in Table 1, which presents a statistical description of the participants' age and gender distribution. Additionally, Graph 1 provides a visual representation of the patients' demographic details. The study was categorized into three distinct groups based on the surgical techniques employed for implant placement. Group 1 included 20 patients who underwent implant placement using the envelope flap technique. The overall performance of these implants was assessed through Cone Beam Computed Tomography (CBCT) at two intervals: six months and twelve months post-placement. Group 2, also consisting of 20 patients, utilized the triangular flap

technique for implant placement. The performance of these implants was similarly evaluated via CBCT at the six and twelve-month marks. Group 3 featured another set of 20 patients who received implants through the trapezoidal flap technique, with their implant performance evaluated at the same six and twelve-month intervals. Tables 2 and 3 detail the findings for Group 1. In Table 2, the analysis reveals that an implant was successfully positioned using the envelope flap technique, with a comprehensive evaluation of its performance conducted six months after placement. Statistical significance was determined using the Pearson Chi-Square test, which indicated that healing time was notably improved, as observed in 6 of the patients. Table 3 follows up on the same group, reporting on the twelve-month evaluation of implant performance using the envelope flap technique. Here too, the Pearson Chi-Square test was utilized to confirm that bone remodeling had improved after a year, which was evident in 6 patients. Moving on to Group 2, Table 4 illustrates the successful placement of an implant with the triangular flap technique, evaluated six months post-surgery. The findings highlighted a significant enhancement in aesthetics, as noted in 7 patients, confirmed by the Pearson Chi-Square test. In Table 5, the twelve-month follow-up data for Group 2 reveals sustained improvements. An analysis showed that healing was demonstrably better in 6 of the patients, while aesthetic outcomes had noticeably advanced in 8 participants. Table 6 presents data for Group 3, where implants were placed using the trapezoidal flap technique. After six months, the statistical evaluation indicated improvements in both healing and aesthetic outcomes among 5 patients. Lastly, Table 7 reviews the twelve-month results for Group 3, revealing that accessibility and visibility of the implants had enhanced significantly, as reported by 7 patients. To summarize the overall findings across all groups, Table 8 utilizes one-way ANOVA to present a comprehensive estimation of the results. This detailed analysis underscores the varying outcomes associated with different flap techniques used for implant placements and highlights significant areas of improvement across the study parameters.

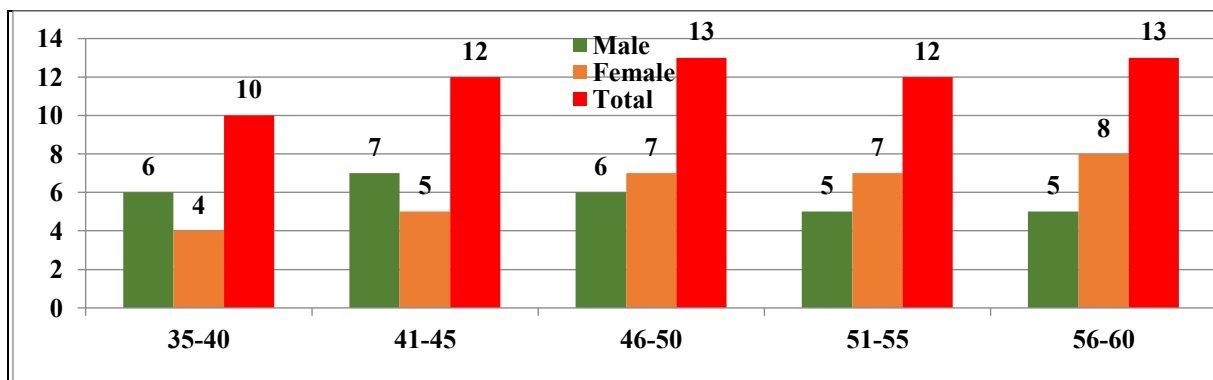


**Table 1:** Age & gender based statistical description of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
35-40	6	4	10	0.06
41-45	7	5	12	0.04*
46-50	6	7	13	0.01*
51-55	5	7	12	0.50
56-60	5	8	13	0.60
Total	29	31	60	*Significant

\*p<0.05 significant

**Graph 1:** Patients demographic distribution and associated details



**Table 2:** Group 1 (n=20) An implant was successfully placed using an envelope flap technique, and the overall performance of the implant was thoroughly evaluated six months following the placement. To analyze the results statistically, the Pearson Chi-Square test was utilized to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 6 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	Df	P Value
Initial Bone Remodelling	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Soft Tissue Stability	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Healing Time	6	2.29	2.034	2.032	2.30	2.20	1.2	0.01*
Aesthetics	3	2.19	2.017	2.022	2.21	2.15	1.0	0.05*
Visibility And Access	2	2.15	2.013	2.020	2.18	2.14	1.0	0.04*

\*P<0.05 Significant



**Table 3:** Group 1 (n=20) An implant was successfully placed using an envelope flap technique, and the overall performance of the implant was thoroughly evaluated 12 months following the placement. To analyze the results statistically, the Pearson Chi-Square test was utilized to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 12 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	Df	P Value
Initial Bone Remodelling	6	2.29	2.034	2.032	2.30	2.20	1.2	0.01*
Soft Tissue Stability	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Healing Time	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Aesthetics	3	2.19	2.017	2.022	2.21	2.15	1.0	0.05*
Visibility And Access	2	2.15	2.013	2.020	2.18	2.14	1.0	0.04*
*P<0.05 Significant								

**Table 4:** Group 2 (n=20), An implant was successfully placed using a triangular flap technique, and the overall performance of the implant was thoroughly evaluated six months following the placement. To analyse the results statistically, the Pearson Chi-Square test was utilised to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 6 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	Df	P Value
Initial Bone Remodelling	3	2.19	2.017	2.022	2.21	2.15	1.0	0.05*
Soft Tissue Stability	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Healing Time	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Aesthetics	7	2.30	2.032	2.043	2.34	2.45	1.2	0.08
Visibility And Access	1	2.10	2.009	2.010	2.08	2.09	1.0	0.01*
*P<0.05 Significant								

**Table 5:** Group 2 (n=20), An implant was successfully placed using a triangular flap technique, and the overall performance of the implant was thoroughly evaluated 12 months following the placement. To analyse the results statistically, the Pearson Chi-Square test was utilised to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 12 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square	Df	P Value
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						Value		
Initial Bone Remodelling	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Soft Tissue Stability	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Healing Time	6	2.29	2.034	2.032	2.30	2.20	1.2	0.01*
Aesthetics	8	2.32	2.034	2.045	2.35	2.44	1.3	0.01*
Visibility And Access	7	2.30	2.032	2.043	2.34	2.45	1.2	0.08
*P<0.05 Significant								

**Table 6:** Group 3 (n=20), An implant was successfully placed using a trapezoidal flap technique, and the overall performance of the implant was thoroughly evaluated six months following the placement. To analyse the results statistically, the Pearson Chi-Square test was utilised to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 6 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	Df	P Value
Initial Bone Remodelling	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Soft Tissue Stability	4	2.20	2.022	2.020	2.28	2.17	1.0	0.07
Healing Time	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Aesthetics	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Visibility And Access	2	2.15	2.013	2.020	2.18	2.14	1.0	0.04*
*P<0.05 Significant								

**Table 7:** Group 3 (n=20), An implant was successfully placed using a trapezoidal flap technique, and the overall performance of the implant was thoroughly evaluated 12 months following the placement. To analyse the results statistically, the Pearson Chi-Square test was utilised to assess the significance of the findings

Periodontal Flap related Overall Implant Performance Factors After 12 M	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	Df	P Value
Initial Bone Remodelling	2	2.15	2.013	2.020	2.18	2.14	1.0	0.04*
Soft Tissue Stability	2	2.15	2.013	2.020	2.18	2.14	1.0	0.04*
Healing Time	5	2.23	2.024	2.022	2.30	2.19	1.0	0.02*
Aesthetics	4							



Visibility And Access	7	2.30	2.032	2.043	2.34	2.45	1.2	0.08
*P<0.05 Significant								

**Table 8:** Estimation amongst all studied groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares $\Sigma$	Mean Sum of Squares $m\Sigma$	F	Level of Sig. (p)
Between Groups	3	1.342	1.732	1.2	0.01*
Within Groups	17	2.214	0.472		–
Cumulative	111.10	07.644	*p<0.05 significant		

## Discussion

Widman L et al review in this study that periodontal flap is to provide essential access to the root surfaces of teeth and the adjacent bone during surgical procedures that aim to effectively manage periodontal diseases. These surgical flaps play a critical role in the meticulous removal of plaque, calculus, and diseased tissue during procedures such as scaling and root planning. Their importance is further underscored in more complex surgeries, including bone grafting and guided tissue regeneration, where a clear view and access to the anatomical structures are crucial for successful outcomes. When executed properly, the approximation of these flaps not only protects the surgical site from external contaminants but also reduces the risk of complications and facilitates a smoother healing process by promoting optimal tissue adaptation.<sup>14,15</sup> Kirkland OE et al included in their study that the envelope flap is recognised as a fundamental and often utilised surgical design in periodontal procedures. This technique involves a linear incision along the gingival margin, which extends distally without any vertical cuts. The simplicity of this design allows for excellent visibility and exposure of the periodontal area, making it easier for clinicians to perform necessary interventions and facilitating effective suturing afterwards. However, this approach can sometimes pose challenges, such as compromising the health of the interproximal papilla and presenting risks associated with damage to underlying structures,

including bone and tendons.<sup>16,17</sup> Nanditha Chandran et al showed in their study that in cases that require addressing small to medium periodontal defects, the trapezoidal flap emerges as an ideal choice. This flap design is characterised by diverging vertical incisions, which help to enhance blood circulation to the surgical site. The divergence of the incisions also minimises tension during closure, contributing to better cosmetic outcomes. Nevertheless, there may be instances where this flap configuration restricts access to deeper tissues, potentially complicating complete treatment.<sup>18</sup> Ho KD et al review in their study that another effective flap design is the triangular flap, commonly referred to as the three-cornered flap. This approach utilises a sulcular incision along the gingival margin and is complemented by a vertical incision, creating a triangular shape that provides optimal access to the tooth roots. While this design is relatively straightforward to implement and allows for effective treatment access, it often encounters challenges related to visibility and may lead to stretching issues during the surgical process. These limitations have motivated ongoing research aimed at discovering innovative modifications and alternative flap designs to enhance surgical outcomes and reduce associated complications.<sup>19,20</sup> Patila T et al included in their study that the selection of different flap designs is pivotal in determining the overall effectiveness and longevity of dental implants. The implications of these designs extend beyond mere aesthetics; they can profoundly influence crucial biological processes. For instance, the choice of flap design can significantly



affect the initial remodelling of the bone surrounding the implant site. This remodelling is crucial for establishing a robust foundation for the implant, as it determines how well the bone integrates with the implant over time. Additionally, a well-considered flap design helps ensure the stability of the soft tissues that form a protective barrier around the implant.<sup>21</sup> Lopes da Silva BC et al review in their study that the stability is essential for preventing complications such as soft tissue recession or inflammation, which could compromise both the health of the implant and the overall aesthetic outcome. Furthermore, flap design can influence the rate of healing, as certain designs may facilitate better blood flow and nutrient delivery to the healing tissues, thereby accelerating recovery. The implications of these choices are particularly pronounced at various stages post-surgery, from the immediate aftermath to the long-term maintenance of the implant. This underscores the necessity for dental professionals to meticulously plan and evaluate flap design options when undertaking periodontal and implant-related procedures. By doing so, they can enhance not only the functional aspects of dental implants but also ensure that the long-term results meet patients' aesthetic expectations. Ultimately, careful attention to flap design is vital for achieving optimal clinical outcomes in dental Implantology.<sup>22,23</sup>

## Conclusion

Within the limitations of this study the author undertook a comprehensive examination of the effects of different periodontal flap designs on the performance of dental implants, with assessments conducted at various intervals post-surgery. The results indicated that all investigated periodontal flap designs contribute positively to the overall success of implant procedures. Notably, the triangular flap design emerged as particularly advantageous; offering enhanced aesthetic outcomes and minimising gingival recession in certain clinical scenarios. However, it is crucial to note that the selection of the optimal flap design, be it triangular or trapezoidal, vastly depends on the unique circumstances of each case. There is no universally superior periodontal flap design; each option carries distinct pros and cons related to surgical access, stability of the implant, and the healing process that follows. The findings highlight the pressing need for thorough and detailed future research to deepen our understanding of

these surgical techniques. Such investigations will be instrumental in refining their application within clinical settings, ultimately leading to improved patient outcomes and more effective treatment strategies.

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