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Comparative Clinical Evaluation of Effects of Different Flap Designs of Osseointegrated Implants on Post-Operative Complications Measured at Different Timings- An (In Vivo) Original Research Study

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KEYWORDS

Envelope Flap, Flap Design, Osseointegrated Implants, Electronic Visual Analog Scales (e-VAS)

ABSTRACT:

Aim: This study aims to evaluate the effects of different flap designs of osseointegrated implants on postoperative complications measured at various timings.

Materials and Methods: The study involved 60 patients aged 25 to 50 with missing mandibular right premolars and molars. Of these, 40 chose dental implants after thorough evaluations and consent. Patients were divided into three groups based on flap design: Group 1 (envelope), Group 2 (triangular), and Group 3 (trapezoidal). Postoperative complications were assessed at three and six months, and pain levels were measured with an electronic visual analog scale (e-VAS) by the same operator for consistency.

Statistical Analysis and Results: This study analyzed data using SPSS software and involved 60 patients. They were divided into three groups of 20 based on flap design for implant placement: Group 1 (envelope flap), Group 2 (triangular flap), and Group 3 (trapezoidal flap). Post-operative complications were assessed within three months and again after six months using the Pearson Chi-Square test. Group 1 had minimal complications that decreased over time, Group 2 experienced moderate complications that improved after six months, while Group 3 had a higher incidence initially, with a moderate decrease later. Pain was measured using the e-VAS, and results were summarized through one-way ANOVA.

Conclusion: This study found that different flap designs for osseointegrated implants have a potential impact on their respective postoperative complications. The envelope flap is more effective, resulting in less pain, fewer infections, and reduced swelling while preserving periodontal health. Trapezoidal flaps offer improved visibility but require meticulous handling. The best flap design depends on the situation and the surgeon's experience.

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Introduction

A dental implant is a method for replacing missing teeth; addressing both complete and partial tooth loss.[1] It uses materials that are not from the body, which are placed into the mouth to support fixed or removable teeth. Contemporary implant techniques typically include flap surgery.[2] This indicates that a section of soft tissue is raised through a surgical incision to reach the bone, and it is anticipated to heal appropriately afterward. Flap designs are tailored to meet specific procedural requirements and reflect the surgeon's preferences, with careful consideration of flap size being pivotal for achieving optimal access while minimizing trauma to surrounding tissues. Each design offers unique advantages and potential challenges. Some common flap designs include.[3] Envelope Flaphas design features, a single-sided incision that liberates the interdental papillae, facilitating excellent visibility of the surgical site. Its simplicity allows for straightforward manipulation during procedures.[4] Triangular Flap Characterized by two incisions, one horizontal and one vertical; this flap design is widely utilized across various surgical applications. While effective for accessing the area of interest, it may complicate the process of achieving proper wound closure.[5,6] Trapezoidal Flap design involves a horizontal incision paired with two vertical incisions, offering increased access during more extensive surgical procedures. It is particularly beneficial in situations requiring deeper access to underlying structures.[7] In addition to these, other specialized flap types, such as the Semilunar and Luebke-Ochsenbein flaps, are employed depending on the specific needs of the surgical case.[8] Flap surgeries are frequently performed to reconstruct defects that arise following tumour excision, although they carry risks of complications, including bleeding, ischemia (insufficient blood supply), and infection. Hence, meticulous planning and execution are critical to mitigate these potential complications.[9,10] Visual analog scales (VAS) and electronic visual analog scales (e-VAS) are tools used to measure subjective experiences like pain intensity. Visual analog scales (VAS) and electronic visual analog scales (e-VAS) are widely utilized instruments designed to quantify subjective experiences such as pain intensity. These scales offer a simple yet effective way for individuals to communicate the severity of their discomfort. Electronic visual analog scales (e-VAS) present a similar concept but leverage technology for enhanced precision and ease of use.[12,13] The primary objective of this study is to investigate the impact of various flap designs on the incidence of post-operative complications associated with Osseointegrated implants, monitored across multiple postoperative time points.

Materials and Methods

The study involved a total of 60 patients who were missing a mandibular right premolar and molar and were seeking replacement options for these teeth. Out of these, 40 patients expressed a preference for replacement through dental implant placement and subsequent implant-supported prosthesis. These 40 individuals, aged between 25 and 50 years, included both male and female participants. Before proceeding with the implant placements, all patients provided informed consent and underwent thorough clinical examinations. Diagnosis was conducted using cone beam computed tomography, which allowed for a detailed assessment of the dental anatomy in the affected region. The inclusion criteria specified that patients must have a missing mandibular right premolar and molar within the designated age range, while the exclusion criteria ruled out individuals with any systemic diseases that could affect the treatment process.Implants were placed through a meticulous surgical procedure in the area of the missing right mandibular premolar and molar. The implant placement was conducted using a consistent operatory system and the same implant kit, all performed by a single experienced operator. Before the initiation of the procedure, the patient underwent a thorough rinse with chlorhexidine mouthwash to minimize the risk of infection. To ensure effective anesthesia, an inferior alveolar nerve block was administered before beginning the implant placement. A precise incision was made, allowing the flap to be carefully reflected. Following this, the implant was inserted, and a cover screw was placed to protect the implant site. Once the implants were securely positioned, the flap was meticulously repositioned, and sutures were applied to facilitate optimal healing. In total, 60 patients were involved in the study, categorized into three distinct groups based on the surgical technique employed for implant placement. Group 1 consisted of 20 patients who underwent implant placement utilizing an envelope flap design. Group 2 also included 20 patients but implemented a triangular flap design for the procedure. Lastly, Group 3 comprised 20 patients who received implants using a trapezoidal flap design. After the implants were placed through these three different flap designs, postoperative complications were thoroughly evaluated at two intervals, three months and six months post-implantation. Pain levels were measured using an electronic visual analog scale (e-VAS), and any other complications were uniformly assessed by the same operator, ensuring consistency in the evaluation process.

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Statistical Analysis and Results

This research used SPSS software for a comprehensive analysis of the data, revealing different patient attributes and treatment factors. The analysis presented means and standard deviations to summarize the data, along with numerical figures to illustrate proportions. To assess statistical significance, the chi-square test was used, allowing for robust comparisons of categorical data across different groups.

Results

This study included 60 patients with missing right mandibular premolar and molar teeth. The implants were placed in the right mandibular premolar and molar regions. The implant placements within the 60 patients were divided into three categories. Group 1include 20 patients who underwent implant placement utilizing an envelope flap design.Group 2 includes 20 patients who received implants using a triangular flap design.Group 3 included20 patients who had implants placed using a trapezoidal flap design.Table 1 presents the categorization of the various groups, which systematically classifies each group consisting of 20 patients and three different flap designs. The patients included in the study were aged between 25 and 50 years, comprising both males and females. Table 2 provides a statistical description of the age and gender of the contributing patients, who included 31 males and 29 females. Graph 1 illustrates the demographic distribution of the patients and associated details.Table3 includes statistical details of post-operative complications for Group 1 (n=20) using the envelope flap design within the first three months following dental implant surgery. Statistical analysis was performed using the Pearson Chi-Square test, revealing minimal occurrences of pain, swelling, infection, and bleeding, with pain evaluated using the electronic visual analog scale (e-VAS). Table 4 presents the findings for Group 1 (n=20) regarding post-operative complications arising within six months after the envelope flap design. The analysis again utilized the Pearson Chi-Square test, showing a decrease in pain, swelling, infection, and bleeding.Table 5 focuses on Group 2 (n=20) and reports post-operative complications following the triangular flap design within the first three months. Statistical analysis via the Pearson Chi-Square test indicated moderate occurrences of pain, swelling, trismus, bleeding, and hematoma after three months of implant placement.Table 6 discusses Group 2 (n=20) and postoperative complications arising after six months following the triangular flap design. The analysis revealed that pain, swelling, trismus, bleeding, and hematoma decreased after six months of implant placement.Table 7 examines Group 3 (n=20) and the post-operative complications arising from the trapezoidal flap design within the first three months of surgery. The statistical analysis showed a higher presence of pain, swelling, trismus, infection, and bleeding after three months post-implant placement.Table 8 presents data for Group 3 (n=20) regarding complications occurring after six months with the trapezoidal flap design. The analysis indicated that while pain, swelling, trismus, bleeding, infection, and hematoma were less frequent after six months, the post-operative complications remained moderately more prevalent compared to the other groups.Aftercomparing the groups, pain was evaluated using the electronic visual analog scale, while swelling, trismus, hematoma, infection, and bleeding were assessed with the same operator's response method. Table 9 displays the estimates among all studied groups using one-way ANOVA.

Table 1: Categorization of various groups involves the systematic classification

S.NO.	FLAP DESIGN	N	GROUPS
1	Envelope Flap	20	Groups I
2	Triangular Flap	20	Groups II
3	Trapezoidal Flap	20	Groups III

Table 2: Age & gender based statistical description of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
25-30	8	6	14	0.01*
31-35	8	8	16	0.20

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36-40	6	6	12	0.60
41-45	4	5	9	0.90
46-50	5	4	9	0.60
Total	31	29	60	*Significant
*p<0.05 significant				

Graph 1: Patients demographic distribution and associated details

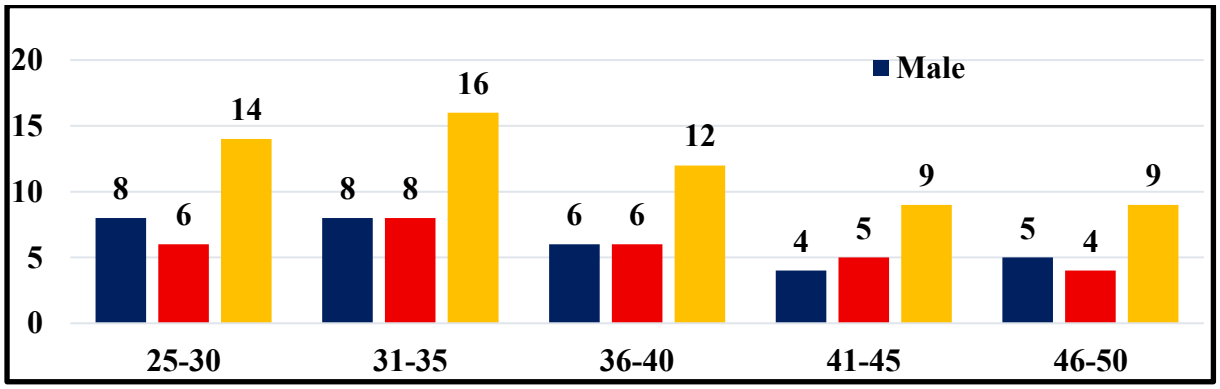

Table 3: Group 1 (n=20) investigated statistical details of post-operative complications arising after giving the envelop flap design within the first three months following dental implant surgery, and statistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (3 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Post-Operative Complications	Pain	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Swelling	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Trismus	0	-	-	-	-	-	-	-
	Infection	1	1.02	0.187	0.145	1.24	1.035	1.0	0.06
	Bleeding	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Hematoma	0	-	-	-	-	-	-	-
*p<0.05 significant									

Table 4: Group 1 (n=20) investigated postoperative complications after giving the envelop flap arising within six months of following dental implant surgery, and statistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (6 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value

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Postoperative Complications	Pain	2	2.24	1.067	1.567	2.18	2.009	1.0	0.25
	Swelling	2	2.24	1.067	1.567	2.18	2.009	1.0	0.15
	Trismus	0	-	-	-	-	-	-	-
	Infection	2	2.24	1.067	1.567	2.18	2.009	1.0	0.15
	Bleeding	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Hematoma	0	-	-	-	-	-	-	-
*p<0.05 significant									

Table 5: Group 2 (n=20) investigated post-operative complications arisingafter giving the triangular flap design within the first three months following dental implant surgery, andstatistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (3 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Post-Operative Complications	Pain	5	2.67	2.564	1.067	2.56	1.789	1.0	0.03*
	Swelling	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Trismus	1	1.02	0.187	0.145	1.24	1.035	1.0	0.06
	Infection	2	2.24	1.067	1.567	2.18	2.009	1.0	0.06
	Bleeding	4	2.54	2.504	1.047	2.36	1.029	1.0	0.03*
	Hematoma	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
*p<0.05 significant									

Table 6: Group 2 (n=20) investigated postoperative complications arising after giving the triangular flap design within six months of following dental implant surgery, and statistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (6 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Postoperative Complications	Pain	4	2.54	2.504	1.047	2.36	1.029	1.0	0.03*
	Swelling	2	2.24	1.067	1.567	2.18	2.009	1.0	0.15
	Trismus	0	-	-	-	-	-	-	-
	Infection	2	2.24	1.067	1.567	2.18	2.009	1.0	0.25
	Bleeding	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Hematoma	2	2.24	1.067	1.567	2.18	2.009	1.0	0.45
*p<0.05 significant									

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Table 7: Group 3 (n=20) investigated post-operative complications arising after giving the trapezoidal flap design within the first three months following dental implant surgery, and statistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (3 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Post-Operative Complications	Pain	6	2.68	2.566	1.068	2.60	1.790	1.0	0.02*
	Swelling	5	2.67	2.564	1.067	2.56	1.789	1.0	0.03*
	Trismus	2	2.24	1.067	1.567	2.18	2.009	1.0	0.25
	Infection	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Bleeding	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Hematoma	0	-	-	-	-	-	-	-
*p<0.05 significant									

Table 8: Group 3 (n=20) investigated postoperative complications arising after giving the trapezoidal flap design within six months of following dental implant surgery, and statistical analysis was performed using the Pearson Chi-Square test.

Timing of Complications (6 months)	Complications	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Postoperative Complications	Pain	4	2.54	2.504	1.047	2.36	1.029	1.0	0.03*
	Swelling	4	2.54	2.504	1.047	2.36	1.029	1.0	0.03*
	Trismus	1	1.02	0.187	0.145	1.24	1.035	1.0	0.06
	Infection	2	2.24	1.067	1.567	2.18	2.009	1.0	0.35
	Bleeding	3	2.46	2.017	1.036	2.12	1.765	1.0	0.03*
	Hematoma	0	-	-	-	-	-	-	-
*p<0.05 significant									

Table 9: Estimation amongst all studied groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares ∑	Mean Sum of Squares m∑	F	Level of Sig. (p)
Between Groups	4	1.124	1.076	1.3	0.001*
Within Groups	20	2.198	0.409	_	
Cumulative	223.10	5.034	*p<0.05 significant		

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Discussion

AL-Jubouri et al reviewed in their research that dental implants serve as a vital treatment choice for individuals requiring replacement of lost teeth. Recently, there has been a growing interest among both dentists and patients in this procedure. A fundamental aspect of implant surgery involves making an incision to form a flap of tissue, which enables the dentist to access the site intended for the implant. Various flap designs have been created to enhance access while minimizing invasiveness during the procedure. The design of the flap is essential during the initial surgery and the subsequent follow-ups. It helps to avoid complications such as excessive bleeding or tissue necrosis.[14,15] Ahmed MV et al included in their study thatan effective method in surgical procedures is the use of an envelope flap, which adeptly covers bone defects while ensuring a sufficient blood supply to the wound edges. This technique plays a crucial role in promoting healing by securing vital nutrients and oxygen to the area.[16] Jephcott A et al included in their study that another commonly utilized type of flap is the triangular flap, specifically designed to reshape the gum tissue around the second molar. This innovative configuration aids in the precise movement and closure of the surgical site, which is particularly beneficial for patients who smoke, as it helps mitigate complications related to healing.The process begins with a carefully planned horizontal incision along the gum line, paired with a vertical cut at one end to create the triangular flap. This flap is then gently lifted, exposing the underlying surgical area for treatment.[17] Chindia ML et al reviewed in their study that the trapezoidal flap is more extensive, featuring incisions along the bone ridge. This type provides significant access during surgery and is often essential for intricate procedures such as bone grafting. It allows for excellent visibility of the surgical area.[18,19] Kwon MS et al reviewed in their study that local flaps refer to small segments of tissue relocated from adjacent areas to repair defects following tumour or growth removal in the oral cavity. When performed by skilled surgeons, these flaps can yield favourable functional and aesthetic outcomes. However, as with all surgeries, complications may arise due to the procedure itself, the patient's health status, or the healing process.[20,21] Escalona-Marfil C et al reviewed in their study that accurately measuring pain following these procedures is also crucial for enhancing care. One effective tool for this is the Visual Analog Scale (VAS), an Electronic visual analog scale which assists patients in indicating their level of pain. There is even a digital adaptation of this scale available as an app, streamlining the process for patients to report their pain. Research indicates that VAS is a dependable method for evaluating pain intensity and gaining insights into how patients experience discomfort over time.[22,23]

Conclusion

This study concluded that different flap designs for osseointegrated implants impact postoperative complications over time. The envelope flap is more effective, resulting in less pain, fewer infections, and reduced swelling after surgery. It also helps maintain periodontal health and provides good access for treatment. In contrast, trapezoidal flaps offer better access and visibility but require careful handling to prevent complications. The ideal flap design is one that enables gentle surgical practices, provides adequate access to the treated area, and promotes effective healing. This ideal design may vary depending on the specific situation and the surgeon's experience. Future long-term studies are planned to reinforce and validate these findings. Such research endeavours will further explore the complex relationship between flap designs and postoperative complications related to osseointegrated implants.

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