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# The Effect of Flap Design on Wound Healing after Periapical Surgery: A Comparative Study.

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## ABSTRACT

**Aims:** To assess the clinical effect of different flap design that used in periapical surgery and their relation to untoward postoperative sequel. **Materials and methods:** Forty five patients were included in the present study, they were divided randomly into three groups, each comprised of (15) patients. In the first group, apicectomy was done using intrasulcular triangular (2–sided) flap. Whereas, in the second group, a submarginal (Luebke–Ochsenbein) scalloped 2–sided flap was used. While in the third group, a new experimental (straight mucogingival) 2–sided flap was tested. Postoperative healing was evaluated clinically in regard to oedema, alteration of soft tissue colour, recession of marginal gingiva, extent of scarring, and closure of the wound site. Assessment was done at 2, 7, 15 and 30 days postoperative intervals. **Results:** Comparison among the three study groups was performed. Statistical analysis revealed significant differences in the results of experimental flap over the other two types in regard to oedema, colour and wound closure with the superiority of the former on the latter flaps. Both experimental and Luebke–Ochsenbein flaps showed significant differences from intrasulcular incision in their effect on gingival recession. In contrast, scarring was less evident in intrasulcular flap followed by experimental flap while in Luebke–Ochsenbein incision, this complication was significant. **Conclusion:** This study; however, revealed that the experimental flap allows for rapid and recession free healing following periapical surgery. In addition, inflammatory changes persist for longer time in the intrasulcular and submarginal (Luebke–Ochsenbein) incision than in experemintal incision. So it was concluded that the new flap design could provide an alternative.

**Key Words:** Periapical surgery, flap design, apicectomy.

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## INTRODUCTION

The ultimate goal in surgical endodontics is the eradication of periapical pathosis using properly designed flaps for the purpose of preserving the periodontal condition of the surrounding area following surgery [(1)]. Acceptable treatment outcomes are no longer possible without consideration of esthetic consequences for all involved dentoalveolar structures. Many types of incisions can be selected, including horizontal, sulcular, submarginal and vertical releasing incisions [(2)]. The variety of flaps reflects the number of variables to be considered before choosing an appropriate flap design. While many flap designs have been suggested over the years, some have become absolute and new techniques have emerged [(1)].

Oral surgeons and endodontists always desire to improve methodology of this procedure by means of instrumentation, materials and different approaches to have a better success rate [(2–5)].

Case selection and planning with good visual and manipulative acess is a prerequisite for the successful apicectomy. Selecting the most appropriate flap design and knowing the advantages and disadvantages of each type, coupled with proper reflection and retraction is the key step for improved post–operative healing and reduces the complications occuring during and following surgery [(6)]. To attain this task, many surgical flaps have been designed and practiced since decades. Two major catogaries of periradicular surgical flaps are:

I. Full mucoperiosteal flaps including triangular, rectangular, trapezoidal and horizontal (envelope) flap.
II. Limited mucoperiosteal flaps: Including semilunar and submarginal (triangular or rectangular)Luebke–Ochsenbein flaps [(7–10)].

The two most commonly used flaps are the intrasulcular triangular (2–sided) flap and Luebke–Ochsenbein flap due to their advantages. The intrasulcular flap involves one vertical releasing incision and one horizontal intrasulcular (gingival) incision, while Luebke–Ochsenbein flap is formed by one scalloped horizontal incision made in the attached gingiva about 3–5 mm from the depth of gingival sulci and a single vertical releasing incision. Although these two flaps have several advantages, yet each one carries some complications making it not amenable to all surgical cases. With the intrasulcular flap, wound healing is rapid, surgical access is good, there is minimal disruption of blood supply and healing is done by primary intention but there is loss of crestal bone height and loss of soft attachment level with subsequent recession [(9)]. Luebke–Ochsenbein flap has the opposite criteria in that marginal and interdental gingiva are spared, unaltered soft tissue attachment level and crestal bone is not exposed and as a result gingival recession is minimized [(11)]. This flap; however, results in disruption of vertically oriented blood vessels supplying the marginal gingiva and in such a situation must rely on collateral circulation, flap shrinkage, secondary intention healing and scar formation, but this scar is always temporal and resolves spontaneously [(12)].

The purpose of the present study was to evaluate the clinical features of healing for two different flap designs: Full intrasulcular triangular flap and Luebke–Ochsenbein (limited submarginal flap), and comparing them with a new experimental flap which is anticipated to be more beneficial in terms of healing.

## MATERIALS AND METHODS

Forty five out patients aged between 15 and 35 years, and of both genders (21 males and 24 females) who were attending Oral and Maxillofacial Surgery Department, Teaching Hospital of Dentistry College, Mosul University; for apicectomy of upper anterior and premolar teeth, only teeth with periapical granuloma or abscess were eligible for inclusion in this study. Teeth with cystic lesions or lesions associated sinus tract opening were excluded from the study.

It was decided that the tooth involved with pathosis could not be conventionally restored (i.e. conventional root canal filling) due to technical difficulty, economic status, failure of previous root canal therapy. Hence, the rationale for apicectomy procedures performed was as follows:

1. Failure of conventional root canal treatment.
2. Presence of a periapical lesion over the apex of the tooth [(11)].

Before participation in the study, and for the purpose of standardization, full medical histories were obtained from all patients, those with systemic diseases or penicillin allergy and pregnant or lactating women were excluded from the study. In addition, smoker patients or any patient who had taken any medications for dental or medical purposes at least 3 days before operation and patients with periodontal pocketing and class 3 periodontal mobility, were excluded. Patients were subjected to detailed history, clinical examination, and investigations as needed and randomly enrolled into three groups, each containing 15 patients that showed in Table (1), as follows:

**Group 1**: Intrasulcular (full triangular) flap, which was composed of a single horizontal intrasculcular incision + single vertical releasing incision, Figure (A).

**Group 2**: Submarginal (Luebke–Ochsenbein) flap, this flap was composed of single scalloped horizontal submarginal incision + one vertical releasing incision, Figure (B).

**Group 3**: Experimental flap which was formed by single straight horizontal mucogingival incision + one vertical releasing incision, Figure (C).

The random allocation of patients to the three treatment groups ensured that patient and treatment variables such as age, sex, operation time and degree of surgical difficulty were uniformly distributed among the study groups. A standard surgical protocol for periapical surgery was adopted. All operations were carried out under local anaesthesia which was achieved by infiltration of (2.2–4.4 ml) of 2% lignocaine hydrochloride with 1:80000 adrenaline[(2)]. Flaps were raised with Howarth periosteal elevator, the removal of bone and root apex was carried out with

no.2 round bur on low speed straight hand piece under sufficient cooling with normal saline, then apical lesion currated with surgical currate, the root canal then irrigated, dried and obturated with gutta purcha. The flap was repositioned and sutured using 3/0 black silk suture (Mersilk, Ethicon, Scotland), three simple interrupted stitches were used, one of them for the vertical incision and the remaining two for the horizontal incision [1].

Table (1): Sex distribution and mean age of patients in relation to treatment groups

| Group | Type of flap | Sex | | Total | Age Range (Years) | Mean Age (Years) |
|---|---|---|---|---|---|---|
| | | Male | Female | | | |
| **1** | Intrasulcular (Full Triangular) | 7 | 8 | 15 | 16–34 | 23 |
| **2** | Submarginal (Luebke–Ochsenbein) | 6 | 9 | 15 | 15–35 | 21 |
| **3** | Experimental (Mucogingival) | 8 | 7 | 15 | 17–35 | 24 |

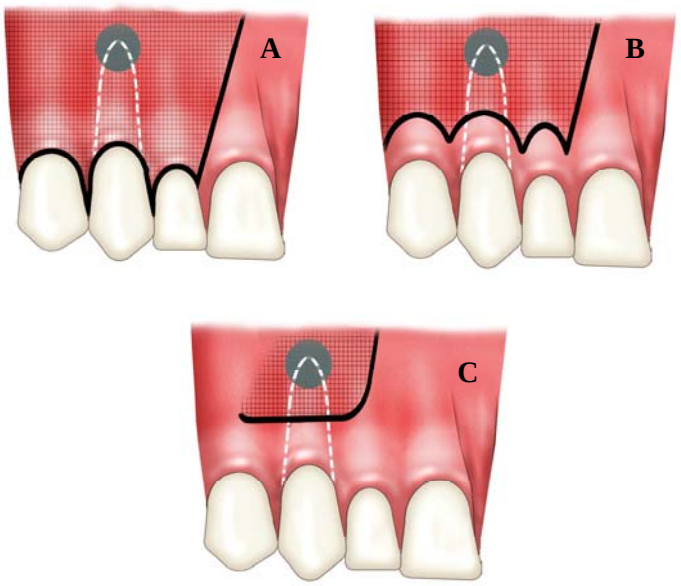


Figure (1): Types of flaps used in the study:
A: Intrasulcular; B: Submarginal; C: Experimental.

Following surgery, verbal postoperative instructions were given and necessary medications prescribed and as follows:

A. The patient was instructed to apply an icepack externally over the area of surgery as long as possible (on and off) for the first three hours postoperatively.
B. On the next day, frequent saline mouth washes (5 times daily for 5 days) [2, 9, 12].
C. Medications prescribed:
1. Ampicloxacillin Cap. 500 mg tid.
2. Parcetamol tabs. 500 mg qid. The medications dispensed were continued for five consecutive days. Suture removal was performed at day seven after surgery [9]. Each patient was scheduled for a dental visit on the second, seventh, fifteen and thirty days postoperatively. The likely postoperative complications that were to be encountered were explained to each patient.

Healing criteria selected for the purpose of postoperative comparison were:

- Presence of oedema.
- Alteration of soft tissue color.
- Recession of marginal gingiva.

- Extent of scarring; they were assessed on the basis of Kramper *et al.*,[11] criteria and as follows :

0 = None; 1= Mild; 2 = Moderate; 3 = Severe.

- Closure of the wound site was evaluated as:

0= Complete epithelial closure through out the length of the wound.

1= Some epithelial closure of the incision.

2= An open wound with only a clot present.

Comparison was done after 2, 7, 15 and 30 postoperative days and statistical analysis was performed by analysis of variance (ANOVA) followed by Duncan's Multiple Range Test to compare if there is any significant differences among the three study groups regarding the specific criteria for the healing. Significant difference was recorded at 0.01 levels.

## RESULTS

A total of 45 patients were involved in the study, the healing was evaluated clinically after 2, 7, 15 and 30 days post operatively, Table (2).

Concerning postoperative oedema, it was observed that the intensity of oedema was maximal after 24–48 hours for all study groups and reduced with time, Table (2). Statistical analysis revealed significant differences among all groups with the best result obtained from experimental flap followed by Luebke–Ochsenbein (submarginal), while intasulcular showed the worst results as shown in Table (3).

Table (2): Distribution of the sample for the three study groups according to the healing criteria

| Healing Criteria | Score | Group 1 (Intrasulcular Flap) | | | | Group 2 (Submarginal Flap) | | | | Group 3 (Experimental Flap) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Day | | | | Day | | | | Day | | | |
| | | 2 | 7 | 15 | 30 | 2 | 7 | 15 | 30 | 2 | 7 | 15 | 30 |
| **Oedema** | **0** | 0 | 4 | 14 | 15 | 0 | 8 | 12 | 15 | 0 | 13 | 15 | 15 |
| | **1** | 0 | 10 | 1 | 0 | 9 | 7 | 3 | 0 | 13 | 2 | 0 | 0 |
| | **2** | 8 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| | **3** | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Color** | **0** | 0 | 0 | 13 | 15 | 0 | 6 | 15 | 15 | 0 | 10 | 15 | 15 |
| | **1** | 0 | 8 | 2 | 0 | 8 | 9 | 0 | 0 | 10 | 5 | 0 | 0 |
| | **2** | 8 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| | **3** | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Wound Closure** | **0** | 0 | 5 | 12 | 15 | 0 | 4 | 11 | 14 | 0 | 11 | 15 | 15 |
| | **1** | 0 | 10 | 3 | 0 | 6 | 11 | 4 | 1 | 10 | 4 | 0 | 0 |
| | **2** | 15 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| **Recession** | **0** | 13 | 2 | 0 | 0 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| | **1** | 2 | 11 | 8 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **2** | 0 | 2 | 7 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Scarring** | **0** | 15 | 6 | 12 | 15 | 11 | 0 | 0 | 7 | 14 | 0 | 12 | 12 |
| | **1** | 0 | 9 | 3 | 0 | 4 | 10 | 9 | 8 | 1 | 15 | 1 | 3 |
| | **2** | 0 | 0 | 0 | 0 | 0 | 5 | 6 | 0 | 0 | 0 | 2 | 0 |
| | **3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

- Regarding presence of edema, alteration of soft tissue color, recession of marginal gingiva and extent of scarring: 0 = None; 1= Mild; 2= Moderate; 3= Severe.
- For wound closure: 0 = Complete epithelial closure throughout the length of the wound; 1 = Some epithelial closure of the incision; 2 = Open wound with only a clot present.

Table (**3**): Analysis of variance and Duncan's Multiple Range test for the presence of oedema in all groups.

| One–way ANOVA | | | Groups | Duncan's Test | |
|---|---|---|---|---|---|
| Number | F–value | *p*–value | | Number | Mean* |
| 45 | 19.070 | 0.000 | Intrasulcular Flap | 15 | 0.8333 C |
| | | | Submarginal Flap | 15 | 0.5000 B |
| | | | Experimental Flap | 15 | 0.3167 A |

*Means with different letters were statistically significant ($p \leq 0.01$).

In regard to soft tissue colour alteration, both experimental and submarginal (Luebke–Ochsenbein) flaps showed significant differences from intrasulcular incision. However, no statistically significant differences were observed between submarginal and experimental flaps, Table (4). Mean time, at Table (5) revealed that the exact approximation and closure of the flap edges was found most effective in the experemintal flap which was signficantly differ from both intrasulcular and submarginal flaps. However, gingival recession in experimental and submarginal flaps was significantly different from intrasulcular type with more prominent recession in the intrasulcular incision while in the other two flaps this complication was absent, Table (6).

For analysis of tissue scarring, significant differences among three types were observed with the worst result in submarginal flap followed by experemintal while intrasulcular type revealed minimal or even negligable value than was shown in Table (7).

Table (4): Analysis of variance and Duncan's Multiple Range test for the soft tissue color alteration in all groups.

| One–way ANOVA | | | Groups | Duncan's Test | |
|---|---|---|---|---|---|
| Number | F–value | *p*–value | | Number | Mean* |
| 45 | 20.302 | 0.000 | Intrasulcular Flap | 15 | 0.9833 B |
| | | | Submarginal Flap | 15 | 0.5167 A |
| | | | Experimental Flap | 15 | 0.4833 A |

*Means with different letters were statistically significant ($p \leq 0.01$).

Table (5): Analysis of variance and Duncan's Multiple Range test for the wound closure in all groups.

| One–way ANOVA | | | Groups | Duncan's Test | |
|---|---|---|---|---|---|
| Number | F–value | *p*–value | | Number | Mean* |
| 45 | 7.523 | 0.002 | Intrasulcular Flap | 15 | 0.6833 B |
| | | | Submarginal Flap | 15 | 0.6500 B |
| | | | Experimental Flap | 15 | 0.4000 A |

*Means with different letters were statistically significant ($p \leq 0.01$).

Table (6): Analysis of variance and Duncan's Multiple Range test for the recession assessment in all groups.

| One–way ANOVA | | | Groups | Duncan's Test | |
|---|---|---|---|---|---|
| Number | F–value | *p*–value | | Number | Mean* |
| 45 | 129.365 | 0.000 | Intrasulcular Flap | 15 | 1.0333 B |
| | | | Submarginal Flap | 15 | 0.0000 A |
| | | | Experimental Flap | 15 | 0.0000 A |

*Means with different letters were statistically significant ($p \leq 0.01$).

Table (7): Analysis of variance and Duncan's Multiple Range test for the scar assessment in all groups.

| One–way ANOVA | | | Groups | Duncan's Test | |
|---|---|---|---|---|---|
| Number | F–value | *p*–value | | Number | Mean* |
| 45 | 26.064 | 0.000 | Intrasulcular Flap | 15 | 0.2000 A |
| | | | Submarginal Flap | 15 | 0.8833 C |
| | | | Experimental Flap | 15 | 0.4000 B |

*Means with different letters were statistically significant ($p \leq 0.01$).

## DISCUSSION

The effect of any flap design on tissue healing is dependent, first and foremost on the degree of vascular disruption and histological nature of tissues involved by surgery [9]. The selected modalities of flap design used in this study included two types of oral tissues that differ in their criteria and texture (gingiva and oral mucosa). The surface of oral mucosa is covered by a thin non–keratinized, stratified squamous epithelium which has a high mitotic rate (about twice) than that of keratinized stratified squamous epithelium that cover the attached gingiva [13–15]. Hansen [16] and Anderson and Stern [17] indicated in their studies that the mitotic activity of oral epithelium was highest in the labial or buccal mucosa and decreased in descending order, in palatal mucosa, sulcular epithelium, junctional epithelium, outer surface of marginal gingiva and was least in the attached gingiva. This remarkable mitotic activity of epithelium in labial or buccal mucosa combined with high cellular content and rapid collagen synthesis play an important role in wound healing by allowing connective tissue regeneration without further insults from oral environment. In contrast; attached gingiva has a more limited blood supply and a slower rate of epithelial growth. This may explain the faster closure of experemintal flap as the incision involves mucosa while the other two flaps incise attached gingiva [9]. This fact was disagreed by Schoeffel who recommended that all horizontal incisions should be placed in attached gingiva [18].

Regarding oedema, the statistical analysis revealed significant differences among three groups with higher degree in intrasulcular followed by submarginal and least value in experimental flaps. The incrreased and prolong hyperemia and oedema present in intrasulcular incision may have been resulted from several factors:

**First**: Greater trauma received by marginal gingiva and interdental papillae at operation by reflection of more periosteum and post operatively by mastication and parafunctional oral habits [11].

**Second**: With intrasulcular incision there is extra time consumption due to reflection of interdental papilla and marginal gingiva; whereas in experemintal design there is no difficulty in reflecting vertical and horizontal portion. Since the oedema is usually proportional to time and amount of tissue reflected, swelling (oedema) was more significant in intrasulcular incision [19].

**Third**: Marginal gingiva is more susceptible to inflammation originating from plaque and debris. These irritants disrupt tissue strength primarily through collagen fibers degradation. All these factors will retard repair and prolong chronic inflammatory state, this inturn will affect the colour of tissue and it's ruturnning to normal appearance [9], and this fact could explain why intrasulcular flap gave the highest amount of colour alteration compared with experimental flap which showed the least colour alteration.

For all groups, oedema reached its maximum intensity at the second post-operative day and reduced afterwards as shown in Table (2). This finding was accepted by Garcia *et al*.,[20] who stated that oedema peaked on the second post operative day. Likewise, Kvist and Reit [21] reported that oedema was present in all patients and reached the maximum on the second post operative day. This may be due to the accumulation of fluid exudates in the interstitial tissue spaces [22]. In addition, other researchers [23–24] concluded that the oedema was caused by the reflection of periosteum and not by making a relaxing incision.

Gingival recession was more significant in full (intrasulcular) versus limited flaps (submarginal and experimental). This may be due to crestal bone loss and post surgical flap dislodgment, while the limited flaps allow for recession free healing [25–27].

From a clinical standpoint, the experimental flap demonstrated better results than intrasulcular incisions except in the area of scar formation (which is not a permanent complication, in addition it lies in an invisible area and so it will not affect the esthetics), this could be attributed to the fact that the horizontal incision in labial or buccal oral mucosa severs the vertically oriented supraperiosteal vessels and disrupts normal collagen tension. This causes loss of tissue fluid and combined with collagen retraction, provides a high

potential for shrinkage and results in healing by secondary intention with scar formation [9]. This opinion was greatly accepted by Schoeffel [18], who stated that compromising blood flow during and after surgery tends to leave scars that will subside spontaneously.

## CONCLUSIONS

From scope of this study, the following conclusions can be drawn: In patients with healthy periodontal conditions the experimental flap allowed rapid and recession free healing following surgical exposure of the soft tissues. In addition, postoperative oedema, colour alteration of soft tissues and inflammatory changes persist for longer time in the intrasulcular and submarginal incision than in experimental incision. However, scarring that occurred with submarginal and experimental incisions had minimal clinical value, because this problem is a "transient" problem since there is a secondary blood supply from vessels which emerge from the periodontal ligaments and intraosseous blood vessels, and even with its occurrence it does not affect the esthetics because it lies in an invisible area. Moreover, it is not a permanent complication and it will resolve spontaneously.

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