Does Minimal-Invasive Envelope Flap Reduce Side Effects Compared to Conventional Envelope Flap Following Impacted Third Molar Surgery? A Split-Mouth Randomized Clinical Trial

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Purpose: The surgical removal of impacted third molars can lead to various postoperative consequences, which can be influenced by modifiable factors such as flap design. The present study aimed to determine whether a minimal-invasive envelope flap (MIEF) can reduce surgical consequences and improve life quality compared to conventional envelope flap (CEF) after removing impacted mandibular third molars.

Material and Methods: This single-blinded, cross-over randomized clinical trial was conducted on adult patients with bilateral, symmetrically impacted mandibular third molars. The flap design for surgical removal of the third molar was the primary predictor variable. The primary outcome (pain) and secondary outcome variables (swelling, mouth opening limitation [MOL]) were recorded daily and on the second and seventh days after the surgery, respectively. Wound dehiscence and patients' postoperative quality-of-life scores (PPOQL) were recorded on the seventh day. The data were analyzed by Kolmogorov-Smirnov and paired sample t test using SPSS version 22. The P value < .5 was considered significant.

Results: Sixty-eight impacted third molars of 34 subjects with a mean age of 22 ± 12.9 years (35% females) were followed. The postoperative pain level in the MIEF group at rest (0.80 ± 0.53) and chewing (2.10 ± 1.32) up to fifth day was significantly (P value < .01) lower than CEF group (2.40 ± 1.12 and 3.05 ± 1.13, respectively). The difference did not reach a significant level at rest and chewing on the sixth and seventh days (P value > .05). On the seventh day, the subjects in the MIEF group showed a significantly (P value < .001) lower level of swelling (1.13 ± 0.11) and MOL (8.28 ± 4.17) than the CEF group (3.2 ± 2.1 and 12.67 ± 4.92, respectively). Based on the PPOQL scale, patients in the MIEF group (1.82 ± 1.31) expressed a better recovery period than the CEF group (3.5 ± 2.1) (P value < .001).

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Conflict of Interest Disclosures: None to declare.
Conclusions: Considering the reduction of pain, swelling, MOL, and wound dehiscence in MIEF cases, the application of MIEF in surgical removal of impacted mandibular third molars can lead to a significant reduction in postoperative consequences and also a noticeable improvement in PPOQL compared to CEF.


Surgical removal of impacted third molars is a large portion of routine oral surgeries. Various consequences, including pain, swelling, and trismus as the most common side effects, as well as significant complications such as dry socket, bleeding, infection, and nerve injury can occur following impacted third molar surgical removal. Surgical morbidities may also lead to important medical, legal, and economic implications. Surgical technique, the practitioner's experience, and impaction's depth may contribute to the extent and severity of the consequences. Flap design as part of the surgical approach is one of the modifiable factors influencing surgical outcomes. Flap designs should provide adequate accessibility and visibility to facilitate extraction of the impacted tooth, prevent damage to adjacent structures, improve the surgical site healing process, and facilitate proper repositioning and suturing of soft tissue. Various studies have developed different designs and modifications of surgical flaps to improve surgical outcomes. Envelope and triangular flaps are the most frequently investigated flap designs, although the findings are controversial. Most studies have stated envelope flap is superior to the triangular flap in reducing postoperative consequences. However, some studies have shown that the level of pain is related to extension and reflection of mucoperiosteal flap rather than flap design and even ostectomy. Since the general trend in oral and maxillofacial surgery is moving to be minimally invasive, complication-free, and with the shortest recovery time, it seems that any modification in flap design that minimizes the side-effects that the patient may experience and also improves the postoperative recovery period is the practitioners' primary interest.

We conducted this clinical study to test the null hypothesis that there were no differences in postoperative outcomes using minimal-invasive envelope flap (MIEF) or conventional envelope flap (CEF). So, this clinical research aimed to determine whether the MIEF compared to the CEF could achieve the following: 1) reduce postoperative side effects including pain, facial swelling, mouth opening limitation (MOL), and other consequences, and 2) improve the quality-of-life after removing impacted mandibular third molars.

Materials and Methods

To address the research purpose, the investigators designed and implemented a prospective cross-over single-blinded randomized clinical trial. The study population was composed of all patients presenting to the Department of Oral and Maxillofacial Surgery at the Ahvaz Jundishapur University of Medical Sciences for surgical extraction of bilaterally impacted mandibular third molars between September 2019 and December 2020.

Patients were included in the study with full fulfillment of the following inclusive criteria:

- Symmetrically positioned and angulated bilateral impacted mandibular third molars with comparable technical difficulty based on panoramic radiographs.
- Group B or C, and class 1 or 2 impaction according to Pell and Gregory classification.

Patients were excluded as study subjects in any of the following cases:

- Presence of any systemic disease
- Use of medication that can impair the immune response or wound healing after surgery
- Very deep impaction when the crown is deeper than the mid-root of the adjacent second molar because it may require more access using a releasing incision
- Pulpal involvement due to deep dental caries
- Local inflammation or pathology associated with the third molar at the time of extraction
- Poor oral hygiene or compromised periodontal status

Approval of the original study protocol was obtained from the Ethical Committee of the Ahvaz Jundishapur University of Medical Sciences with the code of IR. AJUMS.REC.1398.705, and was performed following the Helsinki Declaration. The trial was registered on the Iranian Clinical Trials registry with the following registration number: IRCT20181117041685N1. All the protocol characteristics were explained to the patients before signing the informed written consent form.
STUDY DESIGN

The flap design (MIEF or CEF) for surgical removal of the bilateral impacted third molars was the primary predictor variable.

In MIEF, the incision started with the distal relieving incision just medial to the external oblique ridge, following the center of the third molar shelf to the distobuccal surface of the second molar and then extended as a sulcular incision to the mesial line angle of the second molar without papillary involvement. Also, the mucoperiosteal flap was elevated minimally without including the external oblique ridge in the flap extension. If more overview and access to the surgical site is needed, the distal relieving incision can be extended further (Fig. 1 and 2).

In the CEF, the difference with MIEF design was the further extension of sulcular incision to the mesial line angle of the first molar without papillary involvement. Also, the mucoperiosteal flap was elevated entirely with involving external oblique ridge in the flap extension, and the surgical site was generously exposed, ensuring a good overview and access during surgery (Fig 3).

According to the principles of minimally invasive bone surgery, including minimizing bone removal and sectioning the tooth as many as needed, the surgeries were performed under the same circumstances and with the same surgeon. Cases were randomly allocated immediately before surgery with a computer-generated randomization list. Patients were randomly allocated in such a way that at the end, the use of 2 flap designs was the same in number, right and left, and their use in the patient's first or second surgery. The data collector and statisticians were informed only about the side and the code designated to that side. The patient was also unaware of the type of flap performed on each side.

SURGICAL PROCEDURE

Patients were asked to rinse with a 0.2% chlorhexidine solution for 1 minute before the surgical procedure. Surgical procedures were carried out under local anesthesia using 2 cartridges of 1.8 mL 2% lidocaine 1:100,000 epinephrine (Persocaine, Daroupakhsh, Tehran, Iran). A Minnesota retractor was used to reflect the flap after mobilizing the mucoperiosteal flap gently and uncovering the surgical site. The surgeon followed the principles of minimally invasive surgery, including minimal bone removal and tooth sectioning as many as needed using small round bur in a straight handpiece and under copious irrigation with sterile normal saline (Fig 2). Following the removal of the sectioned tooth, the wound was irrigated copiously, and then the flap was repositioned,
and wound closure was carried out with single 4-0 Vicryl sutures (Supa company, Tehran, Iran). The surgery duration was recorded in minutes from the beginning of the incision to the end of the last suture. Four weeks was considered for washout time between 2 sides.

POSTSURGICAL PROTOCOL

Standard postoperative instructions were provided for patients. All patients were given amoxicillin (500 mg/8 h) and celecoxib (100 mg/8 h) 7 days after surgery. Chlorhexidine mouthwash was prescribed twice daily from day 2 until day 7. Patients were instructed to use rescue pain medications (acetaminophen 500 mg) in the case of unpleasant pain. At the second follow-up appointment (day 7), the sutures were removed.

CLINICAL ASSESSMENT AND OUTCOMES

The primary outcome variable was postoperative pain. Pain intensity was recorded daily (in the evening) by patients (subjective measurement) using the Visual Analogue Scale (VAS) during the week after surgery. Patients were instructed to score the intensity of daily experienced pain using a 10-cm VAS from 0 (no pain) to 10 (worst pain imaginable) at rest as the rest-VAS (r-VAS) and during chewing as the chewing-VAS (c-VAS). Patients were also asked to record the number of rescue pain medications used.

The secondary outcome variables were postoperative side effects, including swelling and MOL. An independent measurer blinded to the flap designs conducted the clinical measurements of maximum mouth opening and facial swelling on day 0 just before the operation and the second and seventh days after the surgery. Facial swelling was recorded using a tape measuring method through 3 facial lines while the patient was sitting straight at a 90° angle, and the mandible was at rest. These lines include the tragus distance to the corner of the mouth as line A, the tragus distance to soft tissue pogonion as line B, and the distance of the outer corner of the eye to the angle of the mandible as line C.\textsuperscript{16} The facial measurement was calculated as (A + B + C)/3, and facial swelling (%) was calculated as: \( \frac{[\text{postoperative measurement on a particular day} - \text{preoperative measurement}] / \text{preoperative measurement}}{\times 100} \).\textsuperscript{5,15}

Maximum mouth opening was recorded, measuring the maximum distance between the maxillary incisor's incisal edge to the lower incisor (to the nearest mm) using a metal ruler. MOL was calculated as: \( \frac{[\text{preoperative measurement} - \text{postoperative measurement on a particular day}] / \text{preoperative measurement}}{\times 100} \).\textsuperscript{5}

Any surgically related complications, including intraoperative complications such as flap tear, postoperative complications such as wound dehiscence, dry socket, bleeding, infection, and nerve injury, were recorded. Also, the need for an urgent postoperative visit was recorded.

During surgery, the flap tear was defined as a rupture along the edge of the flap due to excessive flap traction. The wound dehiscence diagnosis was made visually on the seventh day if there was significant gaping along the incision line.\textsuperscript{5} Since the assessor could not be blinded when evaluating intraoral parameters such as dehiscence, this step was performed after measuring the mouth opening and swelling. The occurrence of dry-socket was determined by detecting an exposed alveolar bone that was not filled by granulation tissue and is accompanied by increasing pain on the second or third day. The possible postoperative bleeding and infection were diagnosed through the definite hemorrhage from the surgical site and the presence of pain, swelling, redness, and pus discharge, respectively. Postoperative nerve injury was confirmed in sensory disturbances in the innervation area of inferior alveolar or lingual nerves.

In a second follow-up session before suture removal, the patient completed a questionnaire to assess the postoperative quality-of-life (PPOQL) to express how the discomfort during the week after

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig3.png}
\caption{Conventional envelope flap design with generous mucoperiosteal flap elevation.}
\label{fig:3}
\end{figure}
surgery affected their quality-of-life. This questionnaire, which was taken from Shugars’ proposed questionnaire, was divided into 8 subscales, including discomfort in chewing, speech, and swallowing, dissatisfaction with appearance, pain perception, feeling of sickness, interference with oral hygiene and activities, which according to the VAS, each subscale scored from 0 to 10. Since the consequences of surgery were closely recorded in the present study, the Shugars’ index was revised into 8 subscales to assess postoperative feeling and appearance, daily activities, nutrition, and oral hygiene.

DATA ANALYSIS

According to the pilot study, considering a mean difference of 0.89 in pain, a standard deviation of 1.02, type I error \( \alpha = 0.05 \), and a power of 95%, the sample size was determined as 68 individuals divided into 2 groups with 34 individuals for each experimental group. The Kolmogorov-Smirnov test initially evaluated the distribution of data. In the normal distribution of collected data, significant differences between the 2 groups of minimal-invasive and conventional envelope flaps were evaluated by paired sample \( t \) test, and a \( P \) value less than .05 considered significant. All analyses were performed with Statistical Package for the Social Sciences (SPSS version 22, IBM, New York, NY).

Results

The distribution of impaction types of mandibular third molars in each group was demonstrated in Figure 4. The duration of surgery for MIEF and CEF groups was 20 ± 3.21 and 21 ± 3.46 minutes, respectively, in which the difference was not significant (\( P \) value = .22).

POSTOPERATIVE PAIN AT REST AND CHEWING

The results of 7 days’ records of pain score at rest and chewing are presented in Table 1. The value of r-VAS and c-VAS decreased in both studied groups over 7 days of the study, indicating overtime healing (\( P \) value < .001). The postoperative pain level in the MIEF group at rest (0.80 ± 0.53) and chewing (2.10 ± 1.32) up to fifth day was significantly (\( P \) value < .01) lower than the CEF group (2.40 ± 1.12 and 3.05 ± 1.13), respectively. The difference did not reach a significant level at rest and chewing on sixth and seventh days (\( P \) value > .05). An insignificant difference was observed on the sixth and seventh days of the study at rest (\( P \) value = .06 and .054, respectively) and at chewing (\( P \) value = .117 and .09, respectively) between the 2 study groups (Table 1).

FACIAL SWELLING AND MOL

The measurement of facial swelling and MOL for MIEF and CEF groups is presented in Table 2. On the second and seventh days after surgery, facial swelling

![Figure 4](image-url)
Table 1. COMPARISON OF PAIN AT R-VAS AND C-VAS VALUES RECORDED ON 7 DAYS BETWEEN THE 2 GROUPS BASED ON THE VAS SCALE.

<table>
<thead>
<tr>
<th>Flap Design</th>
<th>First Day</th>
<th>Second Day</th>
<th>Third Day</th>
<th>Fourth Day</th>
<th>Fifth Day</th>
<th>Sixth Day</th>
<th>Seventh Day</th>
<th>Overtime P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain at r-VAS</td>
<td>Minimal-invasive envelope flap</td>
<td>3.50 ± 1.13</td>
<td>2.98 ± 1.18</td>
<td>1.80 ± 1.13</td>
<td>1.40 ± 1.03</td>
<td>0.80 ± 0.53</td>
<td>0.63 ± 0.43</td>
<td>0.51 ± 0.39 &lt;.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>4.89 ± 1.39</td>
<td>4.25 ± 1.2</td>
<td>3.80 ± 1.21</td>
<td>3.20 ± 1.2</td>
<td>2.40 ± 1.12</td>
<td>1.2 ± 1.69</td>
<td>1.02 ± 1.47 &lt;.001</td>
</tr>
<tr>
<td>Between groups P value</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>.06</td>
<td>.054</td>
<td>N/A</td>
</tr>
<tr>
<td>Pain at c-VAS</td>
<td>Minimal-invasive envelope flap</td>
<td>4.53 ± 1.19</td>
<td>3.85 ± 1.17</td>
<td>3.05 ± 1.13</td>
<td>2.50 ± 1.1</td>
<td>2.10 ± 1.32</td>
<td>1.7 ± 1.21</td>
<td>1.3 ± 1.11 &lt;.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>6.18 ± 1.22</td>
<td>5.50 ± 1.11</td>
<td>4.85 ± 1.13</td>
<td>4.15 ± 1.17</td>
<td>3.05 ± 1.13</td>
<td>2.21 ± 1.44</td>
<td>1.8 ± 1.32 &lt;.001</td>
</tr>
<tr>
<td>Between groups P value</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>.002</td>
<td>.117</td>
<td>.09</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Abbreviations: c-VAS, chewing-Visual Analogue Scale; r-VAS, rest-Visual Analogue Scale; VAS, Visual Analogue Scale.


Table 2. CLINICAL OUTCOMES OF THE FACIAL SWELLING AND MOUTH OPENING LIMITATION (MOL) DURING THE STUDY PERIOD, SECOND AND SEVENTH DAYS AFTER SURGERY.

<table>
<thead>
<tr>
<th>Clinical Outcome</th>
<th>Flap Design</th>
<th>Second Day (%)</th>
<th>P Value</th>
<th>Seventh Day (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial swelling</td>
<td>Minimal-invasive envelope flap</td>
<td>5.61 ± 0.12</td>
<td>&lt;.001</td>
<td>1.13 ± 0.11</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>12.68 ± 0.27</td>
<td></td>
<td>3.20 ± 2.1</td>
<td></td>
</tr>
<tr>
<td>Mouth opening limitation</td>
<td>Minimal-invasive envelope flap</td>
<td>20 ± 11.18</td>
<td>.001</td>
<td>8.28 ± 4.17</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>30 ± 13.64</td>
<td></td>
<td>12.67 ± 4.92</td>
<td></td>
</tr>
</tbody>
</table>

and MOL levels were significantly lower in the MIEF group compared to the CEF group \((P \text{ value } < .01)\). The overtime evaluation revealed a significant difference, indicating healing, in both studied groups \((P \text{ value } < .001)\) (Table 2).

**Discussion**

The present study was designed to answer whether using the MIEF in the surgical removal of impacted mandibular third molar can reduce the postoperative side effects, including pain, facial swelling, MOL, and other consequences, and improve PPOQL. The pain index as a primary outcome variable in the MIEF group from the first to the fifth days after surgery was significantly lower than the CEF group. The difference between the 2 groups did not reach a significant level on the sixth and seventh days. However, the patients experienced more pain in the CEF group.

Facial swelling and MOL measurements showed that the MIEF design results were significantly superior to the CEF design on the second and seventh days after surgery. In terms of quality-of-life, the MIEF group showed better scores at the end of the week after surgery. Wound dehiscence was recorded significantly more in the CEF group.

Duration of the operation, surgical procedure's difficulty, impaction's depth, surgical technique, and surgeon's experience may impact the severity of postoperative consequences.\(^{21,22}\) The mucoperiosteal flaps have also been suggested to affect postoperative outcomes.\(^{4,5,8,9,15,23,24}\) In general, flap designs have been modified to minimize bone exposure, minimize the extension of sulcular incisions, or prevent the involvement of attached gingiva in the vertical incision. Raising a mucoperiosteal flap causes trauma to the underlying bone\(^{9}\) and induces osteoclasts' activity, leading to bone resorption.\(^{25,26}\) Therefore, the flap with a minor extension may lead to less discomfort.\(^{13}\) Pain and trismus were closely related to the flap elevation and ostectomy. However, the effect of flap elevation was greater than that of ostectomy.\(^{18,27}\)

In the present study, the envelope flap was modified by limiting the extension of the sulcular incision to the second molar and minimizing the mucoperiosteal flap elevation from the buccal aspect and without involving the external oblique ridge. Also, more visibility and access can be achieved by further extension of the distal relief. Loganathan et al introduced an approximately similar envelope flap in which sulcular incision is confined to the middle of the second molar.\(^{24}\) However, in this modification, the midfacial gingiva may be prone to rupture due to traction concentration, and limited flap reflection also leads to inadequate access.\(^{24}\)

The most common unpleasant and annoying experience for patients after dental surgery is pain. The factors inducing postoperative pain are complex. However, most are physiologically attributed to inflammatory reaction and consequent release of many biochemical mediators caused by surgical trauma and local tissue damage.\(^{28}\) It is reasonable to assume that postoperative pain can be reduced by reducing flap length and minimizing flap reflection. In this regard, several authors reported significant associations between pain and flap designs.\(^{1,5,23,24}\) In contrast, several other authors failed to find a significant relationship in this case.\(^{8,9,13-16}\) The MIEF leads to minor tissue incision and minimal flap elevation, resulting in a significant reduction in postoperative pain, which agrees with the study from Loganathan et al.\(^{24}\) In the present study, the pain scale peaked within the first postoperative day in both groups, and severity was continuously reduced on the following days.

The greater the amount of surgical trauma, the more secretion of inflammatory mediators and more swelling after surgery.\(^{27}\) Measuring facial swelling is complicated due to the need for 3-plane measurements.\(^{5,15}\) Tape measurement is a noninvasive, straightforward, cost-effective, and time-saving method for measuring soft tissue changes.\(^{4}\) In the present study, we assessed swelling in the vertical and horizontal planes by measuring the changes in 3 lines through 5 points.\(^{15,16}\) Postoperative swelling has been attributed to the flap reflection.\(^{27}\) Several studies have shown a significant relationship between
Table 3. PATIENTS’ POSTOPERATIVE QUALITY-OF-LIFE (PPOQL) SCORES.

<table>
<thead>
<tr>
<th>Questionnaire Item</th>
<th>Flap Design</th>
<th>Mean</th>
<th>SD</th>
<th>Between Groups Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discomfort in chewing</td>
<td>Minimal-invasive envelope flap</td>
<td>2.45</td>
<td>1.13</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>4.66</td>
<td>1.32</td>
<td></td>
</tr>
<tr>
<td>Discomfort in speech</td>
<td>Minimal-invasive envelope flap</td>
<td>1.85</td>
<td>0.84</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>2.33</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>Discomfort in swallowing</td>
<td>Minimal-invasive envelope flap</td>
<td>1.38</td>
<td>0.93</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>3.28</td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td>Dissatisfaction with appearance</td>
<td>Minimal-invasive envelope flap</td>
<td>0.92</td>
<td>1.18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>2.72</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>Pain perception</td>
<td>Minimal-invasive envelope flap</td>
<td>2.25</td>
<td>1.36</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>3.98</td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td>Feeling of sickness</td>
<td>Minimal-invasive envelope flap</td>
<td>0.63</td>
<td>0.83</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>0.98</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Interference with oral hygiene</td>
<td>Minimal-invasive envelope flap</td>
<td>3.7</td>
<td>0.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>6.8</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>Interference with activities</td>
<td>Minimal-invasive envelope flap</td>
<td>1.34</td>
<td>0.41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>3.21</td>
<td>1.24</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Minimal-invasive envelope flap</td>
<td>1.82</td>
<td>1.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Conventional envelope flap</td>
<td>3.5</td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: SD, standard deviation.

flap designs and postoperative swelling compared to other studies that could not find any association.

In the present study, the use of MIEF revealed a significant reduction in facial swelling which agreed with the study of Loganathan et al. It could be due to minor sulcular extension, limited flap elevation, not including the external oblique ridge in the flap extension, and therefore not entering beyond the oblique ridge to detach the buccinator and masseter muscle fibers, as well as the readily detachable periosteum of the lateral aspect of the mandible. It seems that in the use of CEF, extending the flap beyond the lateral oblique ridge and detaching the periosteum of the lateral aspect of the mandible can create a potential space for edema formation.

MOL after third molar surgery is usually due to inflammation or irritation of the masticatory muscles with subsequent spasms attributed to raising a mucoperiosteal flap or hematoma formation. Remarkably, MOL has been observed significantly associated with flap elevation. Although most studies have not been able to find a clear relationship between flap designs and trismus, a limited number of studies have found a significant relationship. In the present study, the MIEF group showed a significantly lower degree of MOL during the study, which could be due to limited flap elevation, not including the external oblique ridge in the flap extension and therefore not entering beyond the oblique ridge to detach the buccinator and masseter muscle fibers, as well as the readily detachable periosteum of the lateral aspect of the mandible that all resulted in a lower degree of inflammatory response.

Despite primary wound closure, wound dehiscence may occur at the second molar's distofacial edge, where the distal relieving incision joins to the sulcular incision. Postoperative hematoma, edema, and masticatory movements may induce wound dehiscence that may potentially prolong the healing time, and thereby increase the period of discomfort and pain. It is assumed that flap design significantly affects primary wound healing. The envelope flap is fixed anteriorly with intersulcular sutures; therefore, soft-tissue edema and masticatory movements cause tension to result in dehiscence. In the present study, noticeable dehiscences were observed in association with CEF in agreement with previous studies. Also, we found a significant reduction in dehiscence using MIEF, which could be due to the further extension of the distal relieving incision, allowing flap movement toward the tongue to ensure tension-free closure.

Other complications were not observed in our study; although, in this context, the limited number of samples and the apparent impact of minimally invasive surgery should be considered. In the present study, the surgery duration did not show any difference between the 2 groups, so we could not evaluate its relationship with postoperative side effects. Finally, the PPOQL was investigated in our study, which revealed favorable results in the quality-of-life during the week after surgery for the MIEF group. This index also confirmed the findings of other subjective and objective measurements of the present study. Unfortunately, there are very few studies that have evaluated the quality-of-life following the use of different flap designs.

In the present study, to standardize the surgical protocol and reduce the effects of variables on the final results, the symmetrically impacted mandibular third molars were removed according to the principles of minimally invasive bone surgery under the same circumstances and with the same surgeon. Also, the patient compliance factor was removed using a split-mouth design. So that, the flap design was the only variable influencing the postoperative consequences. Despite the minimal flap elevation, the MIEF design provides convenient access without the need for vertical release or extended sulcular incision to extract most of the mandibular impacted third molars.

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