# COMPARISON OF INTERNAL FIXATION METHODS AND MINIMAL INVASIVE SURGICAL APPROACHES IN THE TREATMENT OF MANDIBULAR FRACTURES

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## ABSTRACT

**Background and Aim:** Mandibular fractures are one of the most common fracture types in the maxillofacial region, with condylar and angular fractures being particularly prevalent. In recent years, endoscopic approaches, have become increasingly widespread as alternatives to traditional internal fixation methods, in the treatment of maxillofacial traumas. The endoscopic treatment of mandibular fractures is a minimally invasive technique. The aim of this study is to evaluate and compare the clinical and radiological outcomes of endoscopy-assisted open reduction and internal fixation (EAORIF) and conventional open reduction and internal fixation (ORIF) in the treatment of mandibular fractures.

**Materials and Methods:** In this study, 18 patients diagnosed with mandibular fractures were randomly divided into two groups. Nine patients underwent EAORIF, while the remaining patients underwent ORIF under general anesthesia. Postoperative evaluations were conducted clinically and radiologically to assess the advantages and disadvantages of both techniques.

**Results:** No significant difference was found in both methods in terms of age, time between trauma and operation, and hospital stay ($p>0.05$). However, the surgical duration was longer in the EAORIF group ($p<0.05$). No significant differences were observed between the two groups in terms of occlusion stability and fracture healing ($p>0.05$).

**Conclusion:** These findings suggest that EAORIF is an effective minimally invasive alternative to conventional ORIF, offering improved postoperative recovery despite its technical complexity.

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## INTRODUCTION

Open Reduction and Internal Fixation (ORIF) is a traditional method that has been widely used for fracture treatment. This technique involves large surgical incisions to gain direct access to the fracture site, allowing for precise anatomical reduction and stabilization with plates and screws. However, ORIF has certain disadvantages. The large incisions can cause damage to surrounding tissues, which prolongs the recovery period and increases the risk of infections.[1]

Endoscope-Assisted Open Reduction and Internal Fixation (EAORIF) is a more minimally invasive approach that uses smaller incisions, reducing the risk of tissue damage. This accelerates recovery and reduces complications, particularly infections. Additionally, it may offer aesthetic advantages by leaving smaller scars.[2] However, EAORIF also has limitations. It requires endoscopic visualization, which demands the surgeon's expertise and specialized equipment, increasing costs and making it unsuitable for some complex fractures.

Endoscopy is defined as the process of inserting an illuminated and steerable device into the body through a natural opening or through a surgical incision, used to visualize internal structures.[3,4] With the use of endoscopy in diagnosis and treatment planning, treatment methods in the oral and maxillofacial region have also changed.[5,6] The complex and delicate anatomical structures of this region and the limited access area have led to the necessity of enlarging and illuminating the relevant area in intraoral procedures.[7] In line with these goals, endoscopy has become a promising tool. Endoscopic surgery or minimally invasive surgery has become accepted and standard in many surgical specialties.[8]

Endoscopy has various application areas in the maxillofacial region. Although the indications for open and closed reduction in treatments are controversial, ORIF is definitely necessary in some cases where conservative treatments are not sufficient.[9] Open reduction can be performed with internal fixation, intraoral or extraoral approach. The extraoral approach is the frequently preferred treatment approach as it increases the visibility and accessibility of the surgical area. In literature, extraoral treatment approaches such as preauricular, postauricular, retromolar and submandibular are mentioned, and the success of these treatments is confirmed by previous studies.[10,11] Although the extraoral approach to fractures provides comfort in terms of reduction and fixation, there is a risk of nerve damage.

In particular, ORIF of mandibular condyle fractures is limited by the potential risk of facial nerve damage as well as the risk of arterial bleeding, scarring in the incision area, and a narrow surgical field.[12,13] These limitations lead surgeons to choose nonsurgical methods such as intermaxillary fixation. Nowadays, with the widespread use of minimally invasive surgery, it is seen that maximum beneficial results are achieved even in complex surgeries. Endoscopy-assisted open treatment methods offer a minimally invasive approach to mandibular condyle fractures, shortening the healing period and reducing complications. Both intraoral and extraoral approaches provide lower infection rates and better aesthetic results compared to traditional surgical methods. In long-term follow-up, it has been observed that these techniques allow successful results, especially in complex cases, and provide rapid healing.[14,15] This study aims to compare the clinical and radiological outcomes of EAORIF and ORIF in mandibular fracture treatment in terms of postoperative recovery, complication rates, and functional outcomes.

## MATERIALS AND METHODS

This clinical research was supported by Dicle University Scientific Research Projects Coordination Office with project number DİŞ.20.022. Ethics committee approval was received from Dicle University Faculty of Dentistry Local Ethics Committee, dated 24.06.2020 and with protocol number 2020-26. 18 adult patients diagnosed with mandibular fractures at Dicle University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery were included in the study. These patients were treated between March 2023-March 2024.

Patients were randomly divided into 2 groups based on their order of admission and different surgical treatment methods (ORIF and EAORIF) were applied to compare the outcomes (n=9). Fracture type, location, and degree of displacement of the fragments were evaluated with panoramic radiographs and computed tomography. After routine examination procedures, the patients were operated under general anesthesia. The fracture site was fully exposed, and the fracture fragments were manually reduced. Following proper alignment of the fracture, stabilization was achieved by directly placing plates and screws. During ORIF, titanium alloy plates and screws were used. The shape and size of the plates were planned according to the characteristics of the fracture. While placing the fixation materials, care was taken to protect the soft tissues and neural structures. Once stabilization of the fracture site was ensured, the surgical field was irrigated, and the incision was closed in layers.

The EAORIF surgical procedures were completed with a 4 mm diameter rigid 30 degree viewing angle endoscope system (Karl-Storz® Tuttlingen, Germany). First, a small incision was made to gain access to the fracture site. The endoscope was guided through this incision to the fracture site and provide extensive visualization of the surgical field. The manipulation of the fracture segments was performed using small surgical instruments. After achieving anatomical reduction, titanium plates and screws were placed for internal fixation. The size and shape of the plates were selected based on the type and location of the fracture. Under endoscopic visualization, the position of the plates and screws was confirmed. The surgical field was cleaned with minimal bleeding, and the incision was closed. During the surgeries, extraoral or intraoral approaches were determined based on each patient's clinical condition and the characteristics of the fracture. The extraoral and intraoral approaches were applied according to indications. Some of the surgical procedures were recorded as digital videos and photographs (Figure 1). The patients' hospital stay and surgical operation times were recorded. Then, the patients were followed up at 1 month and 3 months. In this process, patients' occlusion evaluation was done using cephalometric and panoramic radiographs. Angle classification was taken as reference in the evaluation. Angle class 1 cases were accepted as normal occlusion, and occlusion types occurring in other cases were described as malocclusion (Table 1).

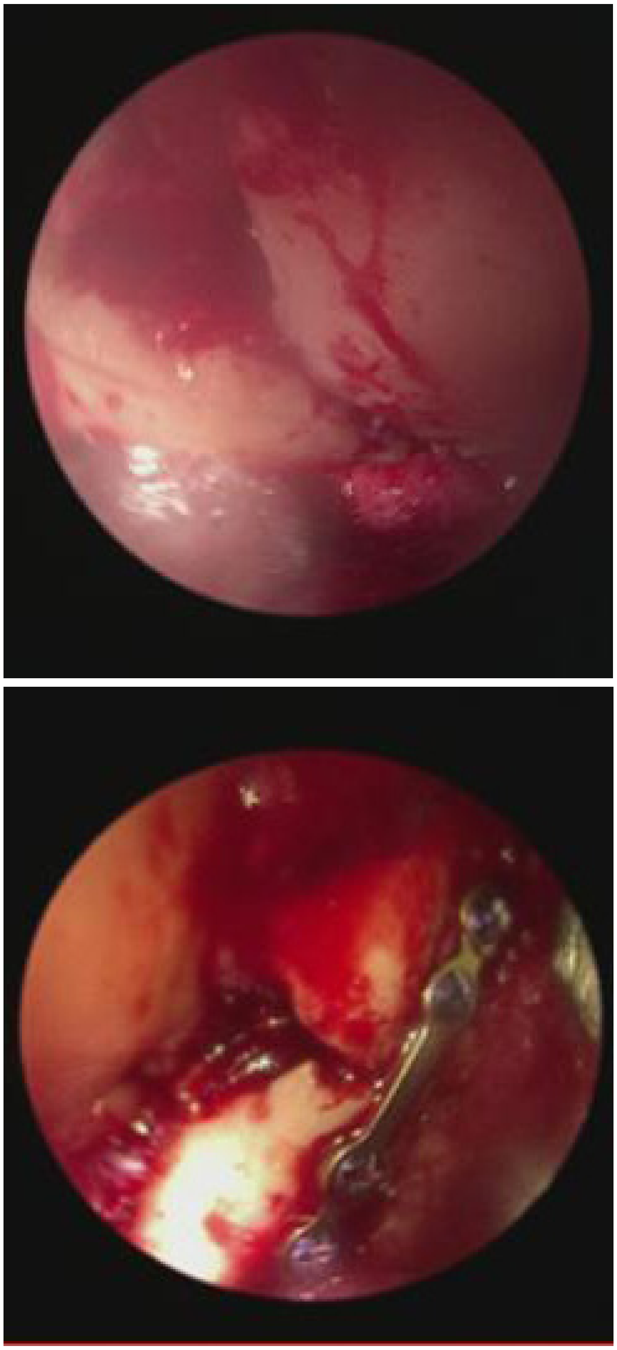

Figure 1. Image of the mandibular fracture line (top) and treatment of fractured segments after mini plate screw fixation with EAORIF method (bottom).

### *Statistical Analysis*

Statistical Package for the Social Sciences for Windows (version 21.0, IBM Corp., Armonk, NY, US) was used in the statistical evaluation of the research data. Quantitative variables were presented as mean±standard deviation (SD), and categorical variables were presented as number and percentage (%). Whether the data conformed to a normal distribution was checked with Shapiro Wilk's normality test. Independent t test was used for the age variable while Mann Whitney U test was used for the variables of time between trauma and operation, surgical procedure duration in minutes, and hospital stay duration in days. Chi-square ($\chi 2$) analysis (Continuity Correction test and Fisher's Exact test) was used in the analysis of categorical variables. Spearman correlation analysis was performed for the relationship between variables. Hypotheses were taken two-sided and $p \leq 0.05$ was considered a statistically significant result.

## RESULTS

The average age range was between 23-72. Two of the 18 patients were female. While the time between trauma and surgical operation varied between 7 and 12 days in 16 patients, 2 patients could be operated after intensive care (1 was after 1.5 months, and 1 was after 2 months). In the EAORIF group, 2 patients had a right parasymphyseal left condyle fracture, 3 patients had an angulus fracture, 1 patient had a bilateral angulus fracture, and 3 patients had parasymphyseal fractures. In the ORIF group, 2 patients had condyle fractures, 4 patients had angulus fractures, and 3 patients had parasymphyseal fractures. The mean surgical time was approximately 90 ± 15 minutes for patients undergoing ORIF and 150 ± 25 minutes for those undergoing EAORIF. It was observed that these times varied depending on the number of fractures and the location of the fracture.

The trauma etiologies of the patients varied due to assault, falling from height, traffic accident and pathological formation. Patients underwent intermaxillary fixation (IMF) for 2 to 6 weeks after surgery. In patients with mandible fracture accompanied by condyle fracture, IMF was applied for 15 days due to the risk of ankylosis. No major complications were encountered during the intraoperative period. No permanent facial nerve injury was observed in either group.

Extraoral swelling occurred for 2 weeks in one patient who underwent EAORIF via the transparotidal approach. Complete recovery was observed after 2 weeks.

In the evaluation of occlusion in patients treated with ORIF, as a result of the 1st and 3rd month post-operative controls, normoocclusion was observed in all cases, while normoocclusion was observed in 6 of the patients treated with the EAORIF method and malocclusion was observed in 3 patients.

No statistically significant difference was found in both methods in terms of age, time between trauma and operation, and hospital stay ($p>0.05$). It was observed that the surgical procedure time in patients who underwent EAORIF method increased to a statistically significant extent ($p<0.001$) (Table 2).

There was no statistically significant difference between the two groups in terms of gender, etiology, fracture localization, post-operative fixation time and post-operative occlusion ($p>0.05$) (Table 3).

## DISCUSSION

The management and treatment of facial fractures have evolved significantly over the past century. In particular, over the last 10 years, surgeons have increasingly used endoscopic techniques to achieve accurate fracture repairs while minimizing the morbidity associated with the surgical approach in the management of facial fractures.[16,17] Traditionally, most condylar fractures have been managed with closed techniques, typically involving intermaxillary fixation and elastics. Open approaches were avoided to minimize treatment morbidity, the risk of facial nerve damage and the presence of a visible facial scars.[18] The main point in the widespread use and development of endoscopic methods are the search for less invasive methods.[19] The use of endoscopic-assisted surgery has become preferred due to visualization through a small incision, good visualization of the area in hard-to-access area surgeries, absence of visible scars, reduced risk of surgical trauma and bleeding, and lower risk of nerve damage.[20] The goal of endoscopically assisted or minimally invasive surgery is to preserve health, reduce surgical trauma, increase flap/wound stability, allow stable primary wound closure, reduce surgical time, and minimize patient discomfort and side effects. Additionally, this technique requires a core team of endoscopic and specially trained surgeons.[21] Considering the advantages and disadvantages of both methods, the most appropriate treatment option should be determined depending on the patient's condition and the surgeon's experience.

The study reported by Lee et al.[22] is the first large clinical series in which subcondylar fractures were treated with endoscopically assisted open reduction. It was observed that 22 subcondylar fractures treated with the intraoral approach yielded successful functional results.[22] In a later study, Lee et al.[23] treated 40 patients with subcondylar fractures with an endoscope-assisted approach and observed a temporary facial nerve injury along with 3 plate fractures. Lee et al.[23] showed that EAORIF did not avoid facial nerve damage and did not increase the risk of reoperation compared to ORIF.

According to the findings of Lee et al.[22] and Cavalcanti et al.[24], the EAORIF method increases operation time. They concluded that this difference is related to factors inherent to the method, such as equipment usage and surgical precision. This aligns with the results of our study. Cavalcanti et al.[24] show that EAORIF does not prevent facial nerve lesion. On the other hand, EAORIF has shown that it does not increase the need for reoperation compared to ORIF for the treatment of mandibular condyle fractures.

Although no cases of facial nerve injury were observed in our study, the potential risk associated with surgical

**Table 1.** Distribution of demographic and operative data of operated patients. ORIF: Open Reduction and Internal Fixation, EAORIF: Endoscope Assisted Open Reduction and Internal Fixation, M/F: Male/Female Min: Minutes

| Patient | Age | Gender | Etiology | Time Between Trauma and Operation | Fracture Localization | Surgical Approach | Surgical Procedure Duration | Duration of Hospitalization | Post-op intermaxillary fixation time | Post-op occlusion |
|---|---|---|---|---|---|---|---|---|---|---|
| PATIENT 1 | 25 | M | ASSAULT | 7 DAYS | CONDYLAR FRACTURE | (ORIF) PREAURICULAR INCISION | 80 MIN | 2 DAYS | 1-2 WEEKS | NORMOOCCLUSION |
| PATIENT 2 | 45 | M | ASSAULT | 8 DAYS | CONDYLAR FRACTURE | (ORIF) PREAURICULAR INCISION | 75 MIN | 2 DAYS | 1-2 WEEKS | NORMOCCLUSION |
| PATIENT 3 | 50 | M | ASSAULT | 10 DAYS | ANGULUS FRACTURE | (ORIF) SUBMANDIBULAR INCISION (RISDON) | 100 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 4 | 28 | M | TRAFFIC ACCIDENT | 8 DAYS | PARASYMPHYSEAL FRACTURE | (ORIF) INTRAORAL INCISION | 80 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |
| PATIENT 5 | 36 | F | PATHOLOGICAL FORMATION | 7 DAYS | PARASYMPHYSEAL FRACTURE | (ORIF) INTRAORAL INCISION | 75 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |
| PATIENT 6 | 42 | M | ASSAULT | 12 DAYS | PARASYMPHYSEAL FRACTURE | (ORIF) SUBMANDIBULAR INCISION (RISDON) | 80 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 7 | 38 | M | ASSAULT | 12 DAYS | ANGULUS FRACTURE | (ORIF) SUBMANDIBULAR INCISION + INTRAORAL INCISION | 80 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 8 | 26 | M | TRAFFIC ACCIDENT | 10 DAYS | PARASYMPHYSEAL FRACTURE | (ORIF) INTRAORAL INCISION | 85 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |
| PATIENT 9 | 47 | M | TRAFFIC ACCIDENT | 7 DAYS | ANGULUS FRACTURE | (ORIF) SUBMANDIBULAR INCISION | 95 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 10 | 52 | F | FALLING FROM HEIGHT | 8 DAYS | PARASYMPHYSEAL FRACTURE | (EAORIF) INTRAORAL INCISION | 135 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |
| PATIENT 11 | 29 | M | FALLING FROM HEIGHT | 10 DAYS | PARASYMPHYSEAL FRACTURE | (EAORIF) INTRAORAL INCISION | 140 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |
| PATIENT 12 | 44 | M | ASSAULT | 75 DAYS | RIGHT PARASYMPHYSEAL LEFT CONDYLAR FRACTURE | (EAORIF) TRANSPAROTIDAL APPROACH SUBMANDIBULAR INCISION | 170 MIN | 3 DAYS | 1-2 WEEKS | MALOCCLUSION |
| PATIENT 13 | 60 | M | ASSAULT | 45 DAYS | RIGHT PARASYMPHYSEAL LEFT CONDYLAR FRACTURE | (EAORIF) INTRAORAL INCISION | 165 MIN | 2 DAYS | 1-2 WEEKS | MALOCCLUSION |
| PATIENT 14 | 34 | M | ASSAULT | 10 DAYS | BILATERAL ANGULUS FRACTURE | (EAORIF) INTRAORAL APPROACH, ADDITIONAL TRANSBUCCAL INCISION FOR SCREW PLACEMENT | 175 MIN | 3 DAYS | 4 WEEKS | MALOCCLUSION |
| PATIENT 15 | 54 | M | ASSAULT | 8 DAYS | ANGULUS FRACTURE | (EAORIF) INTRAORAL APPROACH, ADDITIONAL TRANSBUCCAL INCISION | 150 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 16 | 33 | M | TRAFFIC ACCIDENT | 10 DAYS | ANGULUS FRACTURE | (EAORIF) SUBMANDIBULAR INCISION | 140 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 17 | 28 | M | TRAFFIC ACCIDENT | 8 DAYS | ANGULUS FRACTURE | (EAORIF) SUBMANDIBULAR INCISION | 145 MIN | 2 DAYS | 4 WEEKS | NORMOCCLUSION |
| PATIENT 18 | 41 | M | TRAFFIC ACCIDENT | 8 DAYS | PARASYMPHYSEAL FRACTURE | (EAORIF) INTRAORAL INCISION | 140 MIN | 1 DAY | 4 WEEKS | NORMOCCLUSION |

Table 2. Mann whitney U test and Independent T-test analysis results

| | ORIF | | EORIF | | |
|---|---|---|---|---|---|
| | mean±SS | Median(Min-Max) | mean±SS | Median(Min-Max) | P |
| Age | 37.44 ±9.38 | 38.00 (25-50) | 41.67 ±11.63 | 41.0 (28-60) | 0.409* |
| Time Between Trauma and Operation | 83.33 ±8.66 | 80.00 (75-100) | 151.11 ±14.95 | 145.00 (135-175) | 0.294 |
| Surgical Procedure Duration | 9.00 ±2.062 | 8.00 (7-12) | 20.22 ±23.78 | 10.00 (8-75) | 0.000 |
| Hospital Stay Duration (Day) | 1.67 ±0.50 | 2.00 (1-2) | 1.89 ±0.78 | 2.00 (1-3) | 0.552 |

* Independent T-test was used in age analysis.
Mann Whitney u test was used in the analysis of other variables.

Table 3. Analysis of categorical variables using Chi-square ($\chi 2$) test (Continuity Correction test and Fisher's Exact Test)

| | | ORIF NUMBER n(%) | EAORIF NUMBER n(%) | P |
|---|---|---|---|---|
| GENDER | F | 1(50%) | 1(50%) | 1.000[a] |
| | M | 8(50%) | 8(50%) | |
| ETIOLOGY | Assault | 5(55.6%) | 4(44.4%) | 0.375[c] |
| | Traffic accident | 3(50%) | 3(50%) | |
| | Pathological Fracture | 1(100%) | 0(0%) | |
| | Falling From Height | 0(0%) | 2(100%) | |
| | Condyle | 2(100%) | 0(0%) | |
| | Angulus | 4(57.1%) | 3(42.9%) | |
| FRACTURE LOCALIZATION | Parasymphysis | 3(50%) | 3(50%) | 0.273[c] |
| | Right Parasymphysis. Left Condyle | 0(0%) | 2(100%) | |
| | Bilateral Angulus | 0(0%) | 1(100%) | |
| POST-OP IMF DURATION | 1-2 Weeks | 2(50%) | 2(50%) | 1.000[a] |
| | 4 Weeks | 7(50%) | 7(50%) | |
| POST-OP OCCLUSION | Normoocclusion | 9(60%) | 6(40%) | 0.206[b] |
| | Malocclusion | 0(0%) | 3(100%) | |

a. Continuity Correction test
b. Fisher's Exact Test
c. Chi-square tes

approaches, particularly extraoral techniques, remains a significant concern. This emphasizes the importance of meticulous dissection and anatomical precision to minimize complications and is consistent with the existing literature.

Sanati-Mehrizy et al.[25] in their analysis, representing the largest patient cohort undergoing endoscopic mandibular fracture fixation, including 509 patients, found an acceptably low rate of postoperative complications, including permanent nerve damage, complications, and fixation failure. In the present study, no significant difference was found between the two groups. It was concluded that the treatment duration of patients who received only EAORIF was longer than that patients who received ORIF, due to the need for technical knowledge and skills, as well as sensitivity required in the use of equipment. Additionally, it was observed that the scar appearance was significantly more satisfactory in patients who underwent EAORIF.

Similar to the present study, Haug et al.[26] stated that the endoscope-assisted approach took longer than the traditional approach and longer operation time and investment costs for equipment cause the endoscopic approach to be more expensive than the traditional method. Ellis et al.[27] evaluated post-operative occlusion photographically in 142 trauma patients. While malocclusion was detected in 22% of patients treated with the closed reduction method, all cases were reported as normoocclusion in patients treated with the open reduction method.[28] In our study, cephalometric and panoramic radiographs were used when evaluating the post-operative occlusion of the patients. Based on our findings, malocclusion was not observed in patients treated with the ORIF method, while malocclusion was detected in 33% of the patients treated with the EAORIF method.

The limitation of the present study is the small sample size, which is due to the rarity of patients with mandible fractures. Future studies with a larger sample size will provide more satisfactory and generalizable results. The treatment methods demonstrated a satisfactory level of effectiveness and patient safety. Additionally, the low complication rates observed following the application of the treatment methods, along with high patient satisfaction, serve as further indicators of the clinical success of our findings.

## CONCLUSION

Based on the present study, both surgical approaches are suitable for treating mandible fractures, as both treatment methods gave similar and good results in clinical and functional parameters. In terms of operation time, it was observed that the procedure time increased significantly in patients treated with the EAORIF method.

The impact of fracture localization and number on operation time was limited, with a similar distribution observed between the groups. This supports the conclusion that the time difference is method-related. Apart from this, no distinguishing differences or complications were found. However, as the number of patients increases, complications and facial nerve injuries may occur, especially in condyle fractures, and it is inevitable that the risk of complications increases with the increase in surgical operation time. Therefore, further studies with larger sample sizes should be conducted to reach consensus on this controversial issue.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## ETHICS STATEMENT

Ethics committee approval was received from Dicle University Faculty of Dentistry Local Ethics Committee, dated 24.06.2020 and with protocol number 2020-26.

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