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Evaluation of the Intraoperative and Postoperative Complications of Orthognathic Surgery

Ortognatik Cerrahi Operasyonu Sırasında ve Sonrasında Gelişen Komplikasyonların Değerlendirilmesi

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ABSTRACT

Objective: The aim of this study was to evaluate the incidence of preoperative and postoperative complications in patients undergoing orthognathic surgery.

Methods: The clinical records and radiographs of 112 patients who undergone orthognathic surgery between 2014 and 2021 were retrospectively analyzed. Patients' demographics, follow-up period, type of malocclusion and operation were recorded. All surgical complications were evaluated into two groups as intraoperative or postoperative complications.

Results: The mean age of 112 patients (69 female, 43 male) was 24.4 ± 5.5 (ranging from 16 to 47). The most frequent intraoperative complication was the bad split (5 cases, 4.5%), followed by severe hemorrhage due to rupture of facial artery (1 case, 0.9%), dissection of inferior alveolar nerve (1 case, 0.9%), and dental damage (1 case, 0.9%). The most common postoperative complication was the neurosensorial deficit (29 cases, 25.9%), followed by infection (6 cases, 5.4%), extraoral scar formation (5 cases, 4.5%), fracture of fixation material (2 cases, 1.8%), maxillary non-union (2 cases, 1.8%), postoperative nasal hemorrhage (1 case, 0.9%), and failure of fixation material (1 case, 0.9%). There were no fatal complications.

Conclusion: Although the wide range of complications related to orthognathic surgery is reported both in our study and the literature, the frequency of these appears to be uncommon. However, in order to manage the complications of the operation properly, through knowledge and experience are essential.

Keywords: Complication; Le Fort I osteotomy, Orthognathic surgery, Sagittal split osteotomy

ÖZ

Amaç: Bu çalışmanın amacı, ortognatik cerrahi uygulanan hastalarda operasyon sırasında ve sonrasında ortaya çıkan komplikasyonların insidansını değerlendirmektir.

Yöntemler: 2014-2021 yılları arasında ortognatik cerrahi operasyonu uygulanan 112 hastanın klinik kayıtları ve radyografileri retrospektif olarak incelendi. Hastaların demografik verileri, takip süresi, maloklüzyon ve operasyon tipi kaydedildi. Tüm cerrahi komplikasyonlar, operasyon sırasında ve sonrasında olmak üzere iki grupta incelenerek değerlendirildi.

Bulgular: 112 hastanın (69 kadın, 43 erkek) ortalama yaşı 24,4 ± 5,5 (16-47 arasında) idi. Operasyon sırasında en sık görülen komplikasyon kötü kırık oluşumuydu (5 vaka, %4,5) ve bunu fasiyal arter rüptürüne bağlı olarak görülen şiddetli kanama (1 vaka, %0,9), inferior alveolar sinir diseksiyonu (1 vaka, %0,9) ve dental hasar (1 vaka, %0,9) takip etti. Operasyon sonrasında en sık karşılaşılan komplikasyon ise nörosensoriyel bozukluktu (29 vaka, %25,9) ve bunu enfeksiyon gelişimi (6 vaka, %5,4), ekstraoral skar oluşumu (5 vaka, %4,5), fiksasyon materyalinin fraktürü (2 vaka, %1,8), maksillada osteotomi hattının kemikleşmemesi (2 vaka, %1,8), postoperatif nazal hemoraji (1 vaka, %0,9) ve fiksasyon materyalinin kaybı (1 vaka, %0,9) izledi. Hiçbir hastada hayatı tehdit edici bir komplikasyon ile karşılaşılmadı.

Sonuç: Bu çalışmada ve literatürde ortognatik cerrahi ile ilişkili olarak çeşitli komplikasyonlar bildirilse de, bu komplikasyonların görülme sıklığı azdır. Ancak, operasyonda ortaya çıkabilecek komplikasyonların uygun bir şekilde yönetilebilmesi için yeterli bilgi ve deneyime sahip olmak büyük önem taşımaktadır.

Anahtar Kelimeler : Le Fort I osteotomisi, Komplikasyon, Ortognatik cerrahi, Sagittal split osteotomy

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INTRODUCTION

Orthognathic surgery is a method used for treating dentofacial deformities and malocclusion. The aim of orthognathic surgery is to surgically reposition the facial skeleton, especially the maxilla and mandible, to restore a proper anatomical and functional relationship. With this surgical method, in addition to correcting malocclusions that cannot be corrected with orthodontic treatment, correction of facial aesthetics is also possible.[1]

The most commonly used surgical techniques for ensuring ideal jaw relations are Le Fort 1 osteotomy and mandibular bilateral sagittal split osteotomy (BSSO) in the maxilla and mandible, respectively. With Le Fort 1 osteotomy, it is possible to reposition the maxilla in three dimensions according to the cranial base. The treatment of various pathologies, such as maxillary hypoplasia or hyperplasia, transverse anomalies and malocclusions, obstructive sleep apnea, and craniofacial tumors, can be performed successfully with Le Fort 1 osteotomy.[2] Because BSSO is a safe surgical technique that allows movement in all directions in the repositioning of the mandible, it is now applied more frequently than other surgical techniques in the correction of dentofacial deformities in the mandible.[3]

Although there have been many scientific developments in terms of diagnosis, planning, surgical application, and materials, all of which have increased the applicability and reliability of these surgical techniques, various complications may still occur in the intraoperative and postoperative periods.[4] In the literature, the most common complications associated with Le Fort 1 osteotomy and BSSO are infection, hemorrhage, neurosensory disorders, bad split, postoperative malocclusion, wound dehiscence, fracture or loss of fixation materials, soft tissue injuries, extraoral scar formation, and periodontal or dental damage.[1,5,6] Factors affecting the emergence of all these complications include the age and gender of the patient, the amount of movement of the jaws, the surgeon's level of experience, and the type of craniofacial deformity.[7,8]

It is therefore of great importance to know the incidence rate and types of complications that occur in orthognathic surgery, both to prevent intraoperative and postoperative complications and to overcome them, when necessary, using appropriate management techniques. Accordingly, this study aimed to determine the incidence of complications that occur during and after orthognathic surgery.

MATERIALS and METHODS

The pre- and post-treatment clinical records, and panoramic and lateral cephalometric radiographs of patients who underwent orthognathic surgery in Kocaeli University, Faculty of Dentistry between 2014 and 2021 were retrospectively evaluated in this study. The study was approved by the ethics committee of the Kocaeli University, Faculty of Medicine, Kocaeli, Turkey (approval date: 10/03/2022; approval no.: 2022/83). It was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent forms were obtained from all patients who were followed up with.

Patients with complete panoramic and lateral cephalometric radiographs before and after orthognathic surgery and who had at least six months of regular clinical and radiological follow-up after treatment were included in the study. Patients with congenital craniofacial deformities, with a history of maxillofacial trauma, and who had undergone maxillofacial surgery before orthognathic surgery were excluded from the study. Panoramic radiographs of all patients included in the study were taken with the same device (Planmeca, Romexis, Finland) at 65 kVp, 5 mA, and 8.1 sec exposure time. Lateral cephalometric radiographs of the patients were obtained with the same device (Planmeca, Romexis, Finland) at 69 kVp, 5 mA, and 4.9 sec exposure time.

The study was conducted by analyzing the clinical and radiological data of 112 patients between the ages of 16 and 47 years who met the inclusion criteria. Patients' demographics, follow-up period, type of malocclusion, and type of operation performed were recorded. The type of malocclusion was determined based on the ANB angle (Class 1: $0° < ANB < 4°$; Class 2: $ANB \geq 4°$; Class 3: $ANB \leq 0°$) in the lateral cephalometric radiography image taken before treatment.[9] The period between the surgical procedure and the last control time was considered as the follow-up time. Patients were divided into three subgroups according to the surgical procedures performed: (1) combined Le Fort I osteotomy and BSSO; (2) Le Fort I osteotomy or BSSO; and (3) combined Le Fort I osteotomy and BSSO with genioplasty. Patients who underwent orthognathic surgery were divided into two subgroups:

- Those with intraoperative complications, which include bad split, intraoperative hemorrhage, nerve laceration or rupture, and dental or periodontal damage
- Those with postoperative complications, which include infection, fracture of the fixation material, dislocation of the fixation material, non-union, facial scar formation, postoperative hemorrhage, and neurosensory disorder

For the statistical analyses, normality was determined with using the Kolmogorov–Smirnov test. All data were analyzed descriptively and expressed as mean and median values (standard deviation) and minimum and maximum values. Categorical variables were expressed as numbers and percentages. All statistical analyzes were performed using statistical software (SPSS Statistics Version 25, IBM SPSS Corp., Armonk, NY, USA).

RESULTS

The mean age of the 112 patients included in the study was 24.4 ± 5.5 (range: 16–47 years). The mean follow-up period of the 69 female (61.6%) and 43 male (38.4%) patients was 25.8 ± 17.9 months (range: 6–79 months). Among the evaluated patients, 78 (69.6%), 26 (23.2%), and 8 (7.1%) were operated on to correct skeletal Class 3 malocclusion, skeletal Class 2 malocclusion, and skeletal anterior open bite, respectively. In terms of the type of operation that was performed, combined Le Fort I osteotomy and BSSO, Le Fort I osteotomy or BSSO, and combined Le Fort I osteotomy and BSSO with genioplasty were performed in 73 (65.2%), 29 (25.8%), and 10 (8.9%) cases, respectively. More specifically, only Le Fort I osteotomy was performed in 10 (8.9%) cases and only BSSO was performed in 19 (17.0%) cases.

The most common complication during orthognathic surgery was bad split, which occurred in 5 cases (4.5%). Other complications observed during the operation were severe hemorrhage due to facial artery rupture in 1 case (0.9%), inferior alveolar nerve rupture in 1 case (0.9%), and dental damage in 1 case (0.9%; Table 1).

The most common complication after orthognathic surgery was permanent neurosensory disorder, which occurred in 29 cases (25.9%). Of the permanent neurosensory disorders, 26 (89.7%) were observed in the inferior alveolar nerve, 2 (6.9%) in the infraorbital nerve, and 1 (3.4%) in the lingual nerve areas. Other postoperative complications were infection in 6 cases (5.4%), extraoral scar formation in 5 cases (4.5%), fracture of the fixation material in 2 cases (1.8%), non-union of the maxilla in 2 cases (1.8%), postoperative nasal hemorrhage in 1 case (0.9%), and dislocation of the fixation material in 1 case (0.9%; Table 1). The treatment methods applied for the management of intraoperative and postoperative complications are shown in Table 2.

Table 1. Frequency of intraoperative and postoperative complications

Complication	n (%)
Intraoperative complications	
Bad split	5 (4.5)
Facial artery hemorrhage	1 (0.9)
Inferior alveolar nerve dissection	1 (0.9)
Dental damage	1 (0.9)
Postoperative complications	
Neurosensory disorder	29 (25.9)
Infection	6 (5.4)
Extraoral scar	5 (4.5)
Fracture of fixation material	2 (1.8)
Non-union of maxilla	2 (1.8)
Dislocation of fixation material	1 (0.9)
Nasal hemorrhage	1 (0.9)

Table 2. Intraoperative and postoperative complications and treatment methods.

Intraoperative complications	Case	Treatment method
Bad split	1	Segments were fixed during the operation.
	2	Segments were fixed during the operation.
	3	Segments were fixed during the operation.
	4	Segments were fixed during the operation.
	5	Closed reduction was performed after the operation.
Facial artery hemorrhage	6	Cauterization was performed during the operation.
Inferior alveolar nerve dissection	7	Suturing was performed during the operation.
Dental damage	8	Root canal treatment was performed after the operation.
Postoperative complications	**Case**	**Treatment method**
Infection	9	Antibiotics were administered.
	10	Antibiotics were administered.
	11	Antibiotics were administered, and plates and screws were removed.
	12	Antibiotics were administered, and plates and screws were removed.
	13	Antibiotics were administered, and plates and screws were removed.
	14	Antibiotics were administered, and plates and screws were removed.
Extraoral scar	15	Scar revision was performed.
	16	No treatment was performed.
	17	No treatment was performed.
	18	No treatment was performed.
	19	No treatment was performed.
Fracture of fixation material	20	Reoperation was performed, and, in combination with an iliac bone graft, plates and screws were applied.
	21	Reoperation was performed, and plates and screws were applied.
Dislocation of fixation material	22	Reoperation was performed, and plates and screws were applied.
Non-union of maxilla	23	Reoperation was performed, and, in combination with an iliac graft, plates and screws were applied.
	24	Reoperation was performed, and plates and screws were applied.
Nasal hemorrhage	25	Nasal packing was performed on the day of the surgery.

DISCUSSION

The factors that affect the occurrence of orthognathic surgery complications include inadequate or inappropriate preoperative planning, the surgeon's failure to show the necessary sensitivity and attention during the procedure, the length of the surgical procedure, anatomical variations, and the surgeon's experience.[10] In this study, the complications observed in orthognathic surgery patients were evaluated by first dividing them into two groups: intraoperative and postoperative complications. The most common intraoperative complication observed was bad split, while the most common postoperative complication was permanent neurosensory disorder.

Within the related literature, the reported incidence rate of bad split is not very high, although it varies. Steenen et al.,[11] in their systemic review and meta-analysis, reported that the incidence of bad split was between 0.0% and 6.9%. In a study by Jiang et al.[12] of 964 cases, the incidence of patients with bad split was reported as 7.4%. In our study, the most common intraoperative complication was bad split, at a rate of 4.5%. Accordingly, the rate of bad split in this study can be evaluated as consistent with the rates reported in the literature.

There are various studies in the literature investigating factors that may affect the formation of a bad split, such as age, presence of third molar teeth, and gender. Eshghpour et al.[13] reported that the presence of an impacted mandibular third molar caused an increase in the incidence of bad split in elderly patients and women. In our study, none of the five cases with bad split had a third molar in the osteotomy line. However, it was noted that, at the time of the operation, two of the patients were in their fourth decade and three were in their third decade. The authors, therefore, suggest that independent of third molar teeth in the osteotomy line, the effect of advancing age, bone density, and the thickness of the ascending ramus bone cortex are the most likely causes of bad split. Thus, in elderly patients who have high bone density and a thin ramus, conducting detailed radiological examinations before procedures and paying as much attention as possible during osteotomies may reduce the incidence of such complications.

If a bad split occurs away from the surgical site and it is not possible to use diagnostic imaging techniques during the surgical procedure, it may not be possible to complete the surgical procedure in accordance with the current orthodontic planning of the patient. In such cases, following the end of the operation, the patient may need to be reoperated in light of data obtained using three-dimensional imaging methods. In the current study, four of the bad fractures reported were localized in the ascending ramus and condyle of the mandible, and one was localized in the anterior of the distal segment. In four of these cases, split bone segments were fixed with mini-plates, monocortical screws, and bicortical screws, and the operations were completed as planned before the procedures. In a bad split case including mandibular condyle, open reduction and internal fixation with an extraoral approach was recommended to the patient postoperatively. However, the patient refused this treatment method because of the possible risk of facial paralysis, and the patient's treatment was ended by providing the desired occlusion with closed reduction.

Orthognathic surgery procedures such as BSSO and Le Fort 1 are generally considered as safe. However, vascular complications—including, hemorrhage, thrombosis, arteriovenous fistula, and pseudoaneurysm—may occur during or after these procedures.[14] In a patient in our study, who underwent bimaxillary orthognathic surgery and simultaneous genioplasty, superficial facial artery bleeding was observed during the incision made on the skin for trocar entry to fixate the segments after BSSO. The artery causing severe bleeding was held with a clamp and cauterized with the help of a bipolar cautery, and the bleeding was brought under control. In the literature, it has been reported that penetration or blunt injury to the thin arterial structures during the surgical procedure may rarely cause damage to the arteries; later, pseudoaneurysm may develop due to this. For this reason, it is necessary to be careful that vascular structures that are likely to be damaged in orthognathic surgery, such as the internal maxillary artery, sphenopalatine artery, descending palatine artery, and facial artery, as damage to these may cause life-threatening postoperative

complications.[14] The use of piezo surgical devices instead of saws in orthognathic surgical procedures will reduce the possibility of damage to direct vascular structures. However, it is also possible that the inferior alveolar artery and vein may be damaged due to the penetration of sharp bone protrusions during the separation of osteotomy lines in the mandible. To reduce hemorrhage, it is very important for surgeons to pay maximum attention at every stage of orthognathic surgery and to see the surgical site clearly.

After sagittal split osteotomy was first defined by Trauner and Obwegeser,[15] modifications to this osteotomy were described by Dal Pont, Epker, and Hunsuck.[16] Initially, proximal and distal segments were provided with a wire placed around the ramus or by intermaxillary fixation in BSSO. However, rigid fixation with bicortical screws and mini-plates is currently used as a standard in BSSO and Le Fort I surgeries.[15,17] Osteosynthesis materials may need to be removed for reasons such as the patient's desire for removal, infection, irritation, pain, hot/cold sensitivity, and paresthesia.[18] In our study, the mini-plates and mini-screws of four patients were removed due to infection. Factors that may cause or contribute to the development of infection include the intraoral exposure of plates and screws, poor oral hygiene, and insufficient wound care.

Additionally, Dubron et al.[18] reported a positive correlation between an increase in the number of osteosynthesis materials used and the need for the removal of these materials. Verweij et al.[17] reported that the rate of bicortical screw removal after BSSO was less than that of mini-plates. In the current study, two of the patients who developed postoperative infection were treated successfully with only the use of oral antibiotics (i.e., amoxicillin + clavulanic acid), an anti-inflammatory (i.e., dexketoprofen trometamol), and mouthwash (i.e., chlorhexidine gluconate). In four patients, exposed fixation materials were removed under the use of oral antibiotics (i.e., amoxicillin + clavulanic acid) and uneventful healing was observed in these patients. In this study, it could be seen that personal oral care and postoperative hygiene directly affected infection risk, based on a review of the patients who developed infection. Additionally, the time of removal of the fixation materials was found to be important. If the infection develops in the postoperative sixth month or later, the fixation materials can be removed by observing the union of the osteotomy lines with the help of cone-beam computed tomography or conventional radiography; if the removal of the plates occurs within the first six months after the operation, open reduction and internal fixation or closed reduction may be required, depending on the case.

Davis et al.[19] reported that the primary determinant of surgical site infection was antibiotic use with the secondary variables being age, gender, medical comorbidities, smoking, duration of operation, and third molar tooth extraction. Davis et al.[19] and Van Camp et al.[20] reported the incidence of infection after orthognathic surgery as 8% and 14.6%, respectively. Posnick et al.[21] reported the incidence rate of surgical site infection as 1% in orthognathic surgery patients using cefazolin or cephalexin, in their retrospective study. In the same study, the simultaneous extraction of third molar teeth during BSSO was associated with surgical site infection, albeit with a low incidence rate. Gil et al.[22] found that long-term antibiotic use following to orthognathic surgery reduced infection risk.

Materials such as saws, burs, osteotomes, and mini-screws used for fixation during orthognathic surgery may cause pulp necrosis, mobility, fractures, discoloration of teeth, or loss of teeth.[23] In the current study, devitalization was observed in the relevant teeth after the procedure in one patient due to the positioning of one of the monocortical screws applied during the fixation of the distal and proximal segments after BSSO, close to the roots of the lower first and second molars. Endodontic treatment was applied to these teeth, and no complications were observed during the patient's two-year follow-up. In this case, due to the lack of strength in one of the monocortical screws during the placement of the mini-plates, it was replaced with emergency screws. The different length, diameter, and angle of the replaced screw caused it to be positioned closer to the tooth roots than it should have been. If a screw must be changed when such a situation occurs, positioning the fixation material differently—or preferring a different fixation method if that is not possible—may reduce the risk of dental damage. In cases where bicortical screws are used for the fixation of segments in BSSO, it is suggested to consider the position of existing teeth and to pay more attention to reducing dental damage risk.

In the literature, motor nerve and sensory nerve injuries have also been reported in relation to orthognathic surgery.[24] Neurosensory damage is observed more frequently in the mandible in these operations. Although the permanent or temporary involvement of the inferior alveolar nerve in orthognathic surgical procedures varies, it has been reported in the literature at rates of up to 99%.[24,25] Phillips et al.[26] observed an altered sensation in all patients in the first week of follow-up after mandibular surgeries, while this rate was observed as 85% in the sixth-month control. In our study, 23% of the patients had inferior alveolar nerve injury lasting more than 1 year and considered as permanent. Lee et al.[27] reported that the most common terms they used regarding the altered sensory states of patients were "tingling" and "numbness," in their study investigating sensory changes affecting the lower lip after orthognathic surgery.

Nerve damage may occur due to the incorrect positioning of bone osteotomy lines or fixation errors in ramus osteotomies during the separation or manipulation of the distal segment.[25] Posnick et al.[28] concluded that lingual nerve injury in patients undergoing BSSO is not associated with age, gender, simultaneous third molar extraction, or bicortical screw use, and reported the incidence of permanent lingual nerve injury as less than 1%. In our study, 1 patient developed permanent lingual nerve damage, which is a rate of less than 1%, consistent with the literature. Karas et al. [29] reported that 96% of patients who underwent Le Fort I osteotomy returned to preoperative feeling after 3 months. However, permanent infraorbital nerve damage was observed in 2.1% of all cases in our study. It should be kept in mind that these rates may vary depending on many factors, such as the amount of movement in the maxilla, the need for interpositional graft placement, the experience of the surgeon, and the number of samples calculated.

After Le Fort 1 osteotomy, the non-union of the maxilla is a rare complication. Imholz et al.[30] detected that osteotomy lines did not ossify in the maxilla in 4 (2.6%) of 150 patients who underwent Le Fort I osteotomy. This complication was observed in 2 cases (1.8%) in our study, similar to the rate reported in the literature. In one of the patients who experienced the non-union of the maxilla, fixation was restored by changing only infected plates and screws; in the other patient, who underwent maxillary vertical elongation, autogenous iliac bone grafting was performed to graft the space between the segments again. The maxilla and autogenous block were fixed with grafts, mini-plates, and mini-screws, and both patients showed uneventful healing over the course of at least two years of follow-up.

In the prevention and treatment of complications that develop during or after orthognathic surgery, the patient's anatomical structure, age, systemic status, and medication, as well as the biomaterials used in the surgery and the knowledge and experience of the surgeon performing it, are of great importance. To prevent or reduce complications, it is recommended to pay the utmost attention during the planning, application, and postoperative follow-up process of orthognathic surgery.

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