ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/dentalsci.2022-93092

Causes of Ortognatic Surgery Complications and Comparison of the Literature: Retrospective Cohort Research

Ortognatik Cerrahi Komplikasyonlarının Nedenleri ve Literatür Karşılaştırılması: Retrospektif Kohort Araştırma

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This study was presented as a summary orally in Turkish Association of Oral and Maxillofacial Surgery 24th International Scientific Congress in May 23-27, 2017, Muğla, Türkiye.

ABSTRACT Objective: This paper investigated the incidence, types, and reasons for complications of orthognathic surgery (OS). **Material and Methods:** The sample consisted of the medical records of 250 OS (141 women; 109 men) patients from April 2011 to February 2017. This study retrospectively analyzed follow-up files, radiographic images, and surgery notes and then classified participants for gender, malocclusion type, OS method, and complication. Complications were classified as preoperative, intraoperative, and postoperative. Statistical analysis was performed using IBM SPSS Statistics 21.0 (IBM Corp, Armonk, NY, USA). Descriptive data were calculated for each variable. **Results:** The mean age was 22.9±6.5 (minimum: 17; maximum: 55). The majority of participants (n=166) had Class III dentofacial deformity. Only 24 participants underwent Le Fort I osteotomy alone (12%). Participants had undergone bimaxillary (n=167; 66.8%), single jaw surgery (Le Fort I or sagittal split ramus osteotomy) (n=48; 19.2%), or other types of surgery (n=35; 14%). The patients were followed up for 12 months in the postoperative period. The only preoperative complication (4 patients-1.4%) was errors in planning (occlusal split incompatibility). The major intraoperative complications (38 patients-15.2%) were bad splits, heavy bleeding, and ruptured inferior alveolar neurovascular bundle. The postoperative complications (43 patients-17.2%) were infection, fixation-related problems, neurosensory and temporomandibular joint disorders, facial paralysis, nasal septum deviation, and malunion-nonunion. The total rate of complications was 27.2% (68 patients). **Conclusion:** OS operations are generally safe operations that can be easily managed, although they may rarely cause serious life-threatening complications.

Keywords: Dentofacial deformity; orthognathic surgery; complications; Le Fort I; sagittal split ramus osteotomy

ÖZET Amaç: Bu çalışmada, ortognatik cerrahi komplikasyonlarının insidansı, tipleri ve nedenleri araştırıldı. **Gereç ve Yöntemler:** Çalışma kapsamı, Nisan 2011-Şubat 2017 tarihleri arasında 250 ortognatik cerrahi hastasına (141 kadın; 109 erkek) ait tıbbi kayıtlarından oluşmaktadır. Bu çalışma ile hastaların geriye dönük takip dosyaları, radyografik görüntüleri ve ameliyat notları analiz edildi. Hastalar cinsiyet, maloklüzyon tipi, ortognatik cerrahi yöntemleri ve komplikasyon çeşitlerine göre sınıflandırdı. Komplikasyonlar preoperatif, intraoperatif ve postoperatif olarak belirlendi. İstatistiksel analiz, IBM SPSS Statistics 21.0 (IBM Corp, Armonk, NY, ABD) kullanılarak yapıldı. Her bir değişken için tanımlayıcı veriler hesaplandı. **Bulgular:** Yaş ortalaması 22,9±6,5 (minimum: 17; maksimum: 55) idi. Hastaların büyük çoğunluğunda (n=166) Sınıf III dentofasiyal deformite mevcuttu. Sadece 24'üne tek başına Le Fort I osteotomisi uygulandı (%12). Hastalara bimaksiller (n=167; %66,8), tek çene cerrahisi (Le Fort I veya sagittal split ramus osteotomisi) (n=48; %19,2) veya başka tip ortognatik cerrahi (n=35; %14) yöntemleri uygulandı. Hastaların ameliyat sonrası dönemdeki takipleri 12 ay boyunca yapıldı. Ameliyat öncesi tek komplikasyon (4 hasta-%1,4) planlama hatalarıydı (okluzal split uyumsuzluğu). Başlıca intraoperatif komplikasyonlar (38 hasta -%15,2) kötü bölünmeler, ağır kanama ve inferior alveolar nörovasküler damar sinir paketinin yırtılmasıydı. Postoperatif komplikasyonlar (43 hasta-%17,2); enfeksiyon, fiksasyona bağlı problemler, nörosensör ve temporomandibular eklem bozuklukları, fasiyal paralizi, nazal septum deviasyonu ve malunion/nonuniondu. Toplam komplikasyon oranı %27,2 (68 hasta) olarak tesbit edildi. **Sonuç:** Ortognatik cerrahi ameliyatları nadiren hayatı tehdit edici ciddi komplikasyonlara neden olabilse de genel olarak kolay yönetilebilen güvenli operasyonlardır.

Anahtar Kelimeler: Dentofasiyal deformite; ortognatik cerrahi; komplikasyonlar; Le Fort I; sagittal split ramus osteotomisi

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Peer review under responsibility of Turkiye Klinikleri Journal of Dental Sciences.

Received: 27 Aug 2022 ***Received in revised form:*** 08 Dec 2022 ***Accepted:*** 08 Dec 2022 ***Available online:*** 20 Dec 2022

Dentofacial deformities cause different functional and aesthetic problems in the jaws.[1] Orthognathic surgery (OS) is a standard treatment option for congenital or acquired maxillofacial deformities. Le Fort I osteotomy and sagittal split ramus osteotomy (SSRO) are the most common orthognathic surgical techniques to treat maxillary and mandibular deformities. Those techniques are used to correct dentofacial deformities and remove tumors and treat sleep apnea.[2,3] OS results in a properly occluded jaw, reclaimed jaw functions, and facial profiles, as well as psychological and social improvement.[4,5]

OS complications are not very common but can cause prolonged operative duration and permanent damage. In that case, the patient may have to undergo revision surgery, resulting in discomfort and mental distress.[6-8]

Some OS complications are joint problems, nerve damage, infections, bone necrosis, bad splints, heavy bleeding, postoperative nausea/vomiting, sinusitis, soft tissue injury, dentoalveolar damage, foreign body, malunion/nonunion, relapse, malocclusion, and failed fixation.[9-12]

This is the first study to analyze the complications of OS in the Turkish population.

MATERIAL AND METHODS

This retrospective cohort study was approved by the Clinical Research Ethics Committee of Erciyes University (date: February 17, 2017; no: 2017/98). Written informed consent was obtained from participants. This study was performed in line with the principles of the Declaration of Helsinki. The sample consisted of the medical records of 250 patients who underwent OS between April 2011 and February 2017 at the department of oral and maxillofacial surgery (OMFS) of the dentistry faculty of Erciyes University in Kayseri, Türkiye. Statistical analysis was performed using IBM SPSS Statistics 21.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics were used to introduce the patients' baseline characteristics. The data are presented as number (n), percentages (%), and mean±standard deviation values.

The conventional orthognathic operations in question were corrective surgeries for congenital or acquired skeletal deformities. Patients who underwent distraction osteogenesis and surgically-assisted palatal expansion and those whose medical records were missing were not included.

The surgical protocol of the OMFS department was as follows: 1) All patients were under general anesthesia with nasotracheal intubation, 2) All operations were performed by the same surgical team, 3) Hypotensive anesthesia was used in all patients, 4) A reciprocal saw, Piezosurgery® (Mectron, Italy), and a Lindemann bur (Karl Storz, Germany) were used to cut the bones, 5) A curved osteotome and a mallet were used to separate the pterygomaxillary junction, 6) The maxilla was down fractured using a hook and a bone spreader, and 7) The down fractured maxilla was stabilized in its new position using 4 L-shaped osteosynthesis mini plates at the zygomaticomaxillary buttress and the apertura piriformis.

The Hunsuck modification of SSRO was employed (1968), and then 2 segments (distal and proximal) were formed. Intermaxillary fixation (IMF) was carried out, and rigid internal fixation was performed using a bilateral flat miniplate with 4 holes. The flaps were primarily sutured with 3-0/4-0 polyglactin.

This study retrospectively analyzed follow-up files, radiographic images, and surgery notes and then classified participants for gender, malocclusion type, OS method, and complication. It discussed the causes and management of preoperative (errors in planning), intraoperative (life-threatening bleeding, bad splits, etc.), and postoperative complications (neurosensory and temporomandibular joint disorders, fixation-related problems, infection, etc.), and lastly, made recommendations. Descriptive statistics were computed for each variable.

RESULTS

The sample consisted of medical records of 250 (141 women; 109 men) patients who underwent OS. Table 1 shows the demographic characteristics and types of deformity and surgery. Only 24 participants underwent Le Fort I osteotomy alone (12%). The mean age was 22.9±6.5 (minimum: 17; maximum: 55). The majority of participants (n=166) had Class III dentofacial deformity. Participants had undergone bimax-

illary (n=167; 66.8%), single jaw surgery (Le Fort I or SSRO) (n=48; 19.2%), or other types of surgery (n=35; 14%). The patients were followed up for 12 months in the postoperative period (Table 1).

The complications were classified as preoperative, intraoperative, and postoperative. Errors in preoperative planning were observed in 4 (1.6%) patients, and therefore, an occlusal split (surgical guide plate) could not be used during surgery. The rate of intraoperative complications was 15.2% (n=38), which were bad splits (n=17; 6.8%), heavy uncontrollable bleeding (n=10; 4%), ruptured inferior alveolar nerve sections (n=3; 1.2%), and others (dento-alveolar injury, the presence of a foreign body, soft tissue injury, and punctured intubation tubes) (n=8; 3.2%). The incidence of postoperative complications is 17.2% (n=43 patients). These complications are fixation-related problems (n=14; 5.6%), infections (n=4; 1.6%), neurosensory disorders (n=8; 3.2%), temporomandibular joint injury (n=2; 0.8%), nasal septum deviation (n=4; 1.6%), and malunion-union (n=1; 0.4%). Other complications were eye problems, hematoma, facial paralysis, dermatitis, and hypernasal speech (n=10; 4%). The overall rate of complications was 27.2% (68 patients). Some patients had different types of complications (multiple). The rate of incidence was based on the number of patients with complications (Table 2).

TABLE 1: Summary of variables.

Sample Size	250
Demographic characteristics	
Age, $\bar{X}$±SD, years, minimum-maximum	22.9±6.5 (17-55)
Gender, female	141 (56.4%)
Deformity types	
Class I	9 (3.6%)
Class II	66 (26.4%)
Class III	166 (66.4%)
Asymmetry	9 (3.6%)
Surgical Operations	
SSRO	24 (9.6%)
Le Fort I	24 (9.6%)
Le Fort I + SSRO	155 (62%)
Le Fort I + SSRO + genioplasty	12 (4.8%)
SSRO + genioplasty	4 (1.6%)
Le Fort I + genioplasty	5 (2.0%)
Le Fort I + mandibular anterior segmental osteotomy	2 (0.8%)
Le Fort I (anterior segmental osteotomy) + genioplasty	1 (0.4%)
Le Fort I + mandibular osteotomy (corpus ostectomy)	1 (0.4%)
SSRO+ maxillary anterior segmental osteotomy	1 (0.4%)
SSRO + genioplasty + mandibular osteotomy (inferior border ostectomy)	1 (0.4%)
Genioplasty	20 (8.0%)

SD: Standard deviation; SSRO: Sagittal split ramus osteotomy.

TABLE 2: Classification of complications.

Complications	Number of Patients	%
Preoperative complications		
Errors in planning (occlusal split incompatibility)	4	1.6
Intraoperative complications		
Bad splits	17	6.8
Bleeding	10	4.0
Dentoalveolar trauma	2	0.8
Presence of a foreign body	2	0.8
Ruptured inferior alveolar neurovascular bundle section	3	1.2
Soft tissue injury	3	1.2
Perforated intubation tube	1	0.4
Postoperative complications		
Nasal septum deviation	4	1.6
Neurosensory disorders	8	3.2
Facial paralysis	1	0.4
Eye diseases	2	0.8
Hematoma	3	1.2
Temporomandibular joint disorders	2	0.8
Infections	4	1.6
Fixation-related problems	14	5.6
Dermatitis	3	1.2
Hypernasal speech	1	0.4
Malunion-nonunion	1	0.4

DISCUSSION

OS is the standard treatment of maxillofacial deformities, but it may cause numerous preoperative, intraoperative, and postoperative complications. Intraoperative complications, in particular, are quite challenging for maxillofacial surgeons. The most prevalent intraoperative complications are bad splits, nerve damage, heavy bleeding, as well as soft tissue and dentoalveolar injury.[11,12]

Bad splits are the most serious intraoperative complications, the incidence of which is 0.9% to 20%.[11,13-15] Based on the number of splits, the incidence of bad splits is 0.2% to 14.6%.[16,17] Steenen and Becking conducted a systemic review and reported a 2.3% incidence of bad splits during SSRO

(n=19.527). Lingual splits in the proximal and distal segments are common, while coronoid and condylar neck splits are rare patterns of bad splits.[18] Robl et al. found that the incidence of bad splits in SSRO was 3.9% (n=684), while Kim and Park reported it as %3.7.[19] This study took 393 sagittal splits into account, were bad splits observed in 17 (6.8%) patients. Bilateral bad splits occurred in 2 patients. Thus, a total of 19 (4.8%) bad splits took place. The 19 bad splits were proximal segment (n=15; 3.8%), distal lingual segment (n=1; 0.25%), distal lingual and proximal segment (n=1; 0.25%), coronoid process (n=1; 0.25%), and inferior border angulus fracture (n=1; 0.25%). These splits were caused by shallow and short cortical incisions during SSRO, wrong horizontal incision site on the lingula, underextension of the vertical osteotomy to the lingual area and the lower border of the mandible, and anatomical differences (thin and weak mandible with inadequate spongy structure between the cortical bones, etc.).

The incidence of vascular complications is 0.39% to 38%.[14] Teltzrow et al. detected vascular complications in 15 out of 1265 OS patients.[15] Panula et al. observed severe bleeding in only one (0.15%) out of 655 patients, while Kramer et al. found the incidence of intraoperative bleeding as 1.1%.[15,20] Olate et al. reported only one case with controllable (local techniques) severe bleeding associated with maxillary down-fracture.[13] We observed intraoperative vascular complications only in 10 (4%) patients due to descending palatine artery (DPA) (n=8) and vascular diffuse and persistent hemorrhage from the pterygoid venous plexus (n=2). We suspected the down-fracture (n=8) and the separation of the pterygomaxillary junction (n=2) as the possible causes of the hemorrhage. We ligated the DPA using clips in 3 cases and cauterized it in 5 cases to manage the arterial bleeding. We used a hemostatic matrix kit with thrombin (Surgiflo, Ethicon, USA) to take the venous bleeding under control in 2 cases because we could not identify the bleeding source and could not stop it by any other methods. We observed no hemorrhage in these patients and administered no blood replacement during the postoperative period.

SSRO may damage the inferior alveolar neurovascular bundle (IANB) section. Damage to IANB during SSRO, the incidence of which is 0.8% to 9.0%, may be due to nerve strain or compression during the separation of the proximal and distal segments or during rigid fixation via mini screw-plates.[11,21,22] We observed IANB damage in 8 (3.2%) patients more than six months after surgery. The IANB section was ruptured during surgery in 3 (1.2%) patients. We think that the nerve in proximity to the buccal cortex was ruptured by rotary instruments or by the impact of the osteotome in 2 cases and that the nerve was stretched and ruptured by the uncontrollable sagittal split in the third case. It is critical to accurately specify the osteotomy line before surgery and place fixation screws according to the nerve trace. Surgeons can prevent such complications by utilizing computed tomography and detecting the anatomical trace of the IANB section.

Post-op facial nerve paralysis usually occurs during on the mandible set-back surgery. Paralysis is caused by a) A facial nerve compressed near the skull base, b) A nerve compressed by a postoperative hematoma, c) A marginal mandibular nerve traumatized during genioplasty, and d) A compressed nerve trunk during sagittal split.[22] De Vries et al. found that the seventh cranial nerve was affected in 5 out of 1,000 cases who had undergone SSRO before.[23] Choi et al. reported facial nerve paralysis only in 3 (0.1%) out of 3,105 SSRO cases.[24] We observed facial paralysis only in 1 (0.4%) patient, whose mandible was repositioned 10 mm advanced by SSRO. He still has paralysis, albeit minimally. Facial paralysis may be caused by excess posterior propagation of long retractors placed at the posterior margin of the mandibular ramus; a facial nerve stuck between the retractor and the mastoid protrusion; and the uncontrolled use of the osteotome.

Maxillary osteotomy may affect the alar base, tip, and the dorsum of the nose and cause a non-aesthetic facial appearance.[25] In maxillary impaction surgery, leaving bony protrusions in the upper part of the nasal cartilage or maxilla may result in a deviated septum and a rotated nasal tip. We observed nasal septum deviation in 4 (1.6%) patients, who were re-operated for nasal septum correction. Chow et al. and Robl et al. reported nasal septum deviation in 7 (0.53%) and 2 (0.2%) per 1,000 OS cases, respec-

tively.[19,26] In order to prevent nasal septum rotation, the surgeon should plan before surgery how much reduction to be -or not to be- made from the anterior nasal spina. A curled dorsum or deviated nasal tip is associated with inadequate removal of the nasal cartilage. It is also recommended that the surgeon employ cinch sutures to prevent the alar bases from expanding.

Mini screw-plate systems used in OS to fix the jaws rigidly can cause complications, such as dehiscence in the wound site, infections, and impaired fixation due to reduced screw stability, broken plates, increasingly mobile bone fragments, and necroses. Little et al. reported detached fixation in ten out of 100 OS cases due to exposed plates, infection, pain or irritation without infections, sinusitis, etc.[27] We observed fixation material-related postoperative complications in 14 (5.6%) patients due to local infections (n=8), maxillary sinusitis (n=1), and exposed plates (without no signs of infection) that were removed. Screws and mini plates were removed from patients at their request with no complications (n=1) and due to secondary (n=4) or genioplasty surgery due to the screws entering the anterior lower jaw teeth (n=1). To monitor or prevent screw-plate infections, healthcare professionals should take systemic predisposing factors (diabetes, use of immunosuppressive drugs, etc.) under control and follow up patients and make sure that patients take antibiotics and pay attention to oral hygiene in the postoperative period. Using too little saline solution to cool down a socket area that is being drilled to prepare a screw socket can cause overheating in the bone, resulting in local infections and necrosis that may cause fixation instability. Primary closure of soft tissue flaps should be achieved to prevent screws and plates from being exposed. This makes the flaps tight and stable, preventing infections.

Another complication was incompatibility in occlusal splints prepared in the preoperative period in 4 (1.6%) cases. Surgeons manually placed the jaws to their new positions in these patients and fixed them without using splints. Faulty face-bow transfer or errors in model surgery can cause this problem.

We observed foreign bodies in 2 (0.8%) cases. In one patient, the fissure bur broke during the bone osteotomy in the mandible and displace to the mouth floor. The patient is still being followed up because he has no symptomatic complaints. A tampon used for bleed-control was left at the wound site in the left SSRO region in the other patient. She developed an infection in the postoperative period, and therefore, was operated on again. Teltzrow et al. reported that healthcare professionals forget foreign objects inside 6 out of 1,000 OS patients. Broken instruments and orthodontic brackets can cause such complications. Teltzrow et al. also reported that the patients did not develop infections and were operated on for a second time to remove the osteosynthesis materials and foreign objects.[11]

OS can, albeit rare, cause eye-related complications, such as reduced visual acuity, extraocular muscle dysfunction, neuroparalytic keratitis, and epiphora due to occluded lacrimal canal.[28] Bendor-Samuel et al. talk about a case who developed left oculomotor paralysis (a rare complication) after Le Fort I osteotomy.[29] We detected eye diseases (stripped corneal epithelium and itching-inflammation) in 2 cases (0.8%).

Temporomandibular joint dysfunction is a severe complication of OS. Condylar resorption may develop, especially in the postoperative period. Condylar resorption is characterized by gradual changes in the shape of the condylar head after SSRO and is possibly caused by high pressure and stress in soft tissues after mandibular progression.[30] Systemic problems (hyperparathyroidism, autoimmune, etc.) increase post-OS condylar resorption risk in patients with Class II malocclusion and anterior open bite and high mandibular plane.[31] The prevalence of condylar resorption among women and older adults is 1% to 31%.[30,31] Condylar resorption is also caused by osteoarthrosis, temporomandibular joint disorders, mandibular hypoplasia, a posteriorly inclined condylar neck, mandible rotated in a counterclockwise direction, OS excessive, mandibular progression, and prolonged IMF. Friscia et al. reported condylar resorption in 2 (0.47%) out of 423 cases.[32] Park et al. reported condylar resorption in all 22 OS patients.[33] We detected only 1 (0.4%) patient with Class III malocclusion who developed condylar resorption and osteoarthritis 8 months after surgery. Another patient (0.4%) had heavy pain (visual analog scale score: 8)

in the temporomandibular joint and masticatory muscle region 2 weeks after surgery. It is critical in OS to position the condylar glenoid fossa atraumatically, naturally, and tension-free. To that end, the surgeon should target minimum stress on the condyle for rigid fixation of the jaws.

The incidence of post-OS infections is 1% to 33%.[34] Systemic pathologies (diabetes, immunosuppression, anorexia, etc.), poor oral hygiene, and pathogenic bacteria associated with tobacco use (*Bacteroides*, *Streptococcus*, *Enterobacteriaceae*, *Pseudomonas aeruginosa*, etc.) may contaminate the surgical site and increase the risk of post-OS infections.[26] We detected postoperative infections in 4 (1.6%) patients; an early systemic infection (n=1), late-term maxillary sinus infections (n=2), and infection due to a facial implant placed before (n=1). Friscia et al. observed 5 early-term (1.18%) and 5 late-term infections (n=5; 1.18%) in 423 patients.[32] Robl et al. detected infections in four (0.4%) out of 1,000 OS patients.[19]

The more experienced the surgeon, the less the likelihood of complications. However, research shows no significant difference in complication rates between young and experienced surgeons.[35] Advances in technology and surgical techniques have made maxillofacial surgeons' work easier. However, they should know the human anatomy well, plan surgery accurately, evaluate their patients thoroughly, mentally prepare them for surgery, and follow them up afterward for optimum success.

CONCLUSION

The results indicate that bad splits and severe bleeding are the most critical intraoperative complications, the management of which is critical for the success of the surgery. In conclusion, OS operations are generally safe operations that can be easily managed, although they may rarely cause serious life-threatening complications.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Ömer Ülker, Ahmet Emin Demirbaş;* ***Design:*** *Ömer Ülker, Ahmet Emin Demirbaş, Alper Alkan;* ***Control/Supervision:*** *Nükhet Kütük, Erdem Kılıç, Alper Alkan;* ***Data Collection and/or Processing:*** *Ömer Ülker, Ahmet Emin Demirbaş, Erdem Kılıç;* ***Analysis and/or Interpretation:*** *Ömer Ülker, Ahmet Emin Demirbaş, Nükhet Kütük;* ***Literature Review:*** *Ömer Ülker;* ***Writing the Article:*** *Ömer Ülker;* ***Critical Review:*** *Ahmet Emin Demirbaş, Nükhet Kütük, Erdem Kılıç, Aper Alkan.*

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