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INCIDENCE AND CAUSES OF OSTEOSYNTHESIS TITANIUM MINIPLATE REMOVAL FOLLOWING ORTHOGNATHIC SURGERY
ORTOGNATİK CERRAHİ SONRASI OSTEOSENTEZ TİTANYUM MİNİPLAKLARIN ÇIKARILMA NEDENLERİ VE İNSİDANSI*

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ABSTRACT

This paper investigated the incidenceand causes of osteosynthesis plate removal after orthognathic surgery. The sample consisted of 250 patients (141 women and 109 men) who underwent orthognathic surgery between April 2011 and February 2017 at the Oral and Maxillofacial Surgery Hospital of the Faculty of Dentistry of Erciyes University. Follow-up files, operation notes, and radiographic images were reviewed retrospectively. Operation dates, age, sex, malocclusion type, fixation methods, and orthognathic surgery methods were classified. The incidence and causes of osteosynthesis titanium miniplate removal and the average time between placement and removal were determined. Patients had a mean age of 22.9 ± 6.5 [min: 17; max: 55]. Fourteen patients (5.6%) developed fixation-related complications. They underwent plate removal due to plate-infections (nine cases- 3.6%) or plate exposure (five cases- 2.0%). The total number of plates used was 1242 [800 (64%) in the maxilla and 442 (36%) in the mandible]. Twenty-three plates were removed from the maxilla [11 (1.3%)] or mandible [12 (2.7%)] due to fixation material-related complications. The mean plate removal time was 11.21± 8.21 months (min:3- max:34 months). Osteosynthesis plates should be removed due to infections and plate exposure after orthognathic surgery. There should be left in place unless complications arise.

Keywords: Infection, orthognathic surgery, osteosynthesis plate removal,plate exposure, titanium miniplate.

ÖZ

Bu çalışma ile ortognatik cerrahi sonrası osteosentez plağının çıkarılmasının insidansı ve nedenleri araştırıldı. Çalışmaya Erciyes Üniversitesi Diş Hekimliği Fakültesi Ağız, Diş ve Çene Cerrahisi Hastanesi'nde Nisan 2011-Şubat 2017 tarihleri arasında ortognatik cerrahi geçiren 250 hasta (141 kadın ve 109 erkek) dahil edilmiştir. Hastaların takip dosyaları, operasyon notları ve radyografik görüntüleri geriye dönük olarak incelendi. Ameliyat tarihleri, yaş, cinsiyet, maloklüzyon tipi, fiksasyon ve ortognatik cerrahi teknikleri sınıflandırıldı. Osteosentez titanyum mini plağın çıkarılma insidansı ve nedenleri, yerleştirme ile çıkarma arasındaki ortalama süre belirlendi. Hastaların ortalama yaşı 22.9 ± 6.5 [en küçük: 17; en büyük: 55]. Ondört hastada (%5.6) fiksasyona bağlı komplikasyonlar gelişti. Plak enfeksiyonu (dokuz vaka- %3.6) ve plağın açığa çıkması (beş vaka- %2,0) nedeniyle plaklar çıkarıldı. Kullanılan toplam plak sayısı 1242'dir [800 (%64)'ü maksillada ve 442 (%36)'si mandibulada]. Fiksasyon materyali ile ilgili komplikasyonlar nedeniyle maksilla [11 (%1.3)] ve mandibuladan [12 (%2.7)] yirmi üç plak çıkarıldı. Ortalama plak çıkarma süresi 11.21± 8.21ay (en düşük:3- en yüksek:34ay)'dı. Osteosentez plakları ortognatik cerrahi sonrası enfeksiyon ve plağın açığa çıkması nedeniyle çıkarılmalıdır. Komplikasyon ortaya çıkmadıkça yerinde bırakılmalıdır.

Anahtar kelimeler: Enfeksiyon, ortognatik cerrahi, osteosentez plaklarının çıkarılması, plağın açığa çıkması, titanyum miniplak.

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INTRODUCTION

Orthognathic surgery is used to treat congenital or acquired jaw-face deformities. Either Le Fort I or sagittal split ramus osteotomy (SSRO), or both,can be performed to correct jaw deformities (1,2). Orthognathic surgery aligns the upper and lower jaws (occlusion), restores jaw functions, and provides jaw-face integrity.

Screws and plates are used to fix the jaws in their final position after osteotomy. Miniplates are used for rigid fixation in maxillofacial injuries and orthognathic surgery (3-6). Physicians used to wait for a while after internal fixation and perform follow-up operation to remove osteosynthesis materials. Today, surgeons remove plaque with re-operate when a fixation material-related complications such as infection, exposure of the wound area (plate exposure), pain, patient complaints, irritation occur (3,5,7-14). Research on this topic shows that about two out of ten plates in the maxilla and three out of ten plates in the mandible are removed for various reasons. Overall, approximately 16 out of 100 screws and plates are removed postoperatively (15-17).

This paper investigated the incidence and causesof osteosynthesis plate removal following orthognathic surgery. This is the first study on the Turkish population.

METHODS AND MATERIALS

The sample consisted of 250 patients who underwent orthognathic surgery between April 2011 and February 2017 at the Oral and Maxillofacial Surgery Hospital of the Faculty of Dentistry of Erciyes University. This study was approved by the ethics committee of the faculty of medicine of Erciyes University (2017/98).

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 (%), mean ± standard deviation and median (Q1-Q3) values. The Shapiro Wilk's test and Q-Q graphs were used for normality testing. Mann Whitney U test was used to examine the difference between the age of patients with and without plaque removal. $P< 0.05$ was accepted as significant.

The same surgical team performed the operations and used the same type of local anesthesia, incision, and osteotomies. Reciprocal saws, piezo saws and Lindemann burs were used to bone osteotomy. They performed standard Le Fort I osteotomy in the maxilla and Hunsuck modification (1968) of sagittal split ramus osteotomy (SSRO) in the mandible.

Osteosynthesis was performed using four L-shaped miniplates with four holes and monocortical self-tapping screws in the maxilla (Matrix ORTHOGNATHIC and Compact Lock, DePuy Synthes, Zuchwil, Switzerland; KLS Martin, Tuttlingen, Germany; Walter Lorenz Surgical Fixation systems, Zimmer Biomet Jacksonville, FL, USA) and one straight miniplate with four holes on each side and monocortical self-tapping screws in the mandible. Drills with a diameter of 1.5 mm were used in the drilling protocol. The miniplates were placed in the apertura piriformis and zygomatic buttress regions in the maxilla. The miniplates placed in the maxilla ranged from 0.8 to 1 mm in thickness, while those placed in the mandible were 1 mm in thickness. The monocortical screws were 5-6 mm in length and 2.0 mm in thickness, while the emergency screws were 2.3 mm in thickness.

Follow-up files, operation notes, and radiographic images were retrospectively analyzed. Operation dates, age, sex, malocclusion type, and fixation, and orthognathic surgery methods were classified. The incidence and causes of titanium plate removal and the average time between placement and removal were determined. The incidence of titanium plate removal from the maxilla and mandible was separately evaluated. Patients with plate-related infections and plate exposure and those who underwent plate removal due to other reasons (secondary surgical operation, patient request, etc.) were examined and analyzed.

RESULTS

The sample consisted of 250 patients who underwent orthognathic surgery. Table I shows the patients' demographic characteristics and the types of deformity and surgery. Patients (141 women and 109 men) had a mean age of 22.9 ± 6.5 (min: 17- max: 55). Almost all

Table I. Summary of variables

Sample size *(n=250)*	**n (%)**
Demographic characteristics	
Age (Mean ± SD), years	22.9 ± 6.5
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)

patients (98%) underwent fixation on the upper and lower jaws with miniplate and monocortical screws. Only five patients (2%) underwent fixation on the lower jaw with bicortical screws. Fourteen patients (5.6%) developed postoperative complications due to fixation materials (screws and plates) (Table II).

Eight patients (3.2%) developed plate-related local infections, while one patient (0.4%) developed plate-related maxillary sinusitis. Fixation materials were removed from five patients (2%) due to plate exposure without any sign of infection. Screws and miniplates were removed from one patient (0.4%) at his/her request without any complications, from four patients (1.6%) because of secondary surgery, and from one patient (0.4%) due to the screw-plate-related dental pathology.

A total of 1242 plates were used (800 in the maxilla and 442 in the mandible) (Table III).

Twenty-one plates were removed from the maxilla due to infections (n=4), plate exposure (n=7), perialar implantation (n=6), or at the patients' request (n=4). Fifteen plates were removed from the mandible due to infections (n=9), plate exposure (n=3), or secondary surgery, screw-plate-related dental pathology, etc. (n=3) (Table IV).

A total of 23 plates (1.85%) were removed due to fixation material-related complications, whereas 13 (1.0%) were removed without screw-plate-related complications. The average time between plate placement and removal was 11.21± 8.21 months (min:3- max:34 months). The average time between plate placement and removal due to infection was 10.4±10.26 months (min:3-max:34 months).The median (Q1-Q3) age of those who had plaque removed was 20.0(19.0-22.5), and the median (Q1-Q3) age of those who did not have plaque removal was 21.0(19.0-25.0).There is no statistically significant difference between the age of patients with and without plaque removal(p=0.348).

Table II. Fixation material-related complications

Fixation Material-Related Complications	n	%
Plate infection	9	3.6
Plate exposure	5	2.0
Total	***14***	***5.6***

Table III. The number of plates removed from the maxilla and mandible

	Maxilla	Mandible	Total
Plates removal	21 (1.69%)	15 (1.2%)	**36 (2.89%)**
Non-removal plates	779 (62.71%)	427 (34.3%)	**1206 (97.1%)**
Total	**800 (64.4%)**	**442 (35.5%)**	**1242 (100%)**

DISCUSSION

Orthognathic surgery is a standard treatment for acquired or congenital dentofacial and maxillofacial deformities and maxillofacial asymmetries (2,18,19). Miniplates are commonly used in orthognathic operations to treat maxillofacial trauma and craniofacial disorders. Miniplates are strong and biocompatible devices made of titanium. They can bear loads and fulfill oro-facial functions as long as there are no screw-plate-related complications. Fixation materials should be removed in the event of symptomatic problems. However, there are different approaches in the literature. Some physicians remove plates on both sides even if there is a complication only on one side (15), increasing the incidence of plate removal. Some others remove plates at patients' request, even in the absence of complications. These different approaches and practices make the issue con-

Table IV. Reasons for removal of screws and plates

Reasons for Removal of Screws and Plates	Number of patients (n,%)	Number of Plates removed (n,%)	
		Maxilla	Mandible
Plate exposure	5 (2.0)	7 (0.56)	3 (0.24)
Plate-related local infections	8 (3.2)	2 (0.16)	9 (0.72)
Plate-related maxillary sinusitis	1 (0.4)	2 (0.16)	-
Patient request	1 (0.4)	4 (0.32)	-
Secondary surgery	4 (1.6)	6 (0.48)	1 (0.08)
Screw-plate-related dental pathology	1 (0.4)	-	2 (0.16)
TOTAL	**20 (8.0)**	**21 (1.69)**	**15 (1.2)**

troversial.

Patients sometimes experience fixation problems, such as wound dehiscence, loss of rigidity and screw stability, plate exposure or breakage, mobile bone fragments, necrosis, and infections (20). Research shows that postoperative plate removal ranges from 1 to 55% (7,14,16,17,20-23). Sukegawa et al. (2018) conducted a study on 240 patients and reported that 71 plates were removed due to infections and other reasons (n=24) or at patients' request (n=47) and that 24 screws and plates were removed due to early complications in the first year of surgery (n=10) or plate-related complications within five years after surgery (n=14) (17). In the present study, the average time between plate placement and removal was 11.21± 8.21 months (min:3-max:34 months), and the average time between plate placement and removal due to infections was 10.4±10.26 months (min:3-max:34 months). Friscia et al. (2017) reported that seven out of ten patients (N =423) developed fixation material-related complications, such as osteitis (n=25) and bone sequestration of the distal mandible fragment (n=5) (24). We detected sequestration formation due to osteitis in one patient (0.4%). Little et al. conducted a study on 202 patients who underwent orthognathic surgery and reported that 21 patients (10.4%) required plate removal due to various reasons (plate exposure, infection, pain and irritation without infection, sinusitis, etc.). They stated that a total of 27 out of 854 plates were removed from the maxilla (n=8) and mandible (n=19) (15). Chow et al. (25) conducted a study on 1294 patients who underwent orthognathic surgery (1070 bimaxillary; 102 maxillary; 122 mandibular surgery) and found that 46 (3.6%) patients required plate removal due to loose screws (n=19), plate exposure (n=16), plates felt during palpation (n=2), at patients' request (n=8), or infections (sinusitis) (n=1). Widar et al. (2017) determined that one in every 32 patients (n=323) required plate removal due to infections (16).

Gómez-Barrachina et al. (2020) found that the plate removal rate was 13.4% per patient (26). Verweij et al. (2016) calculated that rate as 11.2% (27). Research shows that the prevalence of plate removal ranges from 1% to 37.3%.This wide range is due to variations, such as follow-up times, tobacco addiction, and different criteria (22,28,29).The rate of removal per plate is 9.7%. Most physicians remove plates from the mandible unilaterally due to infections and patient discomfort but remove the plates on both the complication side and the other side of the maxilla (26).Falter et al. (2011) attributes the high incidence of plate removal after orthognathic surgery to the following reasons:

- ⇒ Physicians place two plates in the incision lines in lower jaw osteotomies,
- ⇒ Physicians decide to remove plates even in the case of minimal complaints.
- ⇒ Physicians do not perform intermaxillary fixation after surgery (14).

In our study, physicians did not perform intermaxillary fixation but placed a single plate on the osteotomy line and removed the screw-plates in the presence of symptomatic complaints. Therefore, the rate of plate removal may be low. We observed fixation material-related complications in 14 patients (5.6%), who required plate removal due to infections (3.6%) and plate exposure (2.0%). A total of 1242 plates were placed (800 in the maxilla and 442 in the mandible). Twenty-three plates (1.85%) were removed from the maxilla [11 (1.3%)] or mandible [12 (2.7%)] due to fixation material-related complications, while 13 (1.0%) plates were removed without screw-plate-related complications. Although practices vary across countries, it is recommended that screw plates not be removed unless there are complications. We found that 14 (5.6%) patients were plate removed due to infections and plate exposure. This rate is lower than those reported by earlier studies. Healthcare professionals should identify systemic predisposing factors (diabetes, etc.) and follow up patients closely. Inadequate cooling with saline during bone drilling for rigid fixation causes the bone around the screw to heat up, resulting in localized necrosis and fixation destabilization. Covering screws and plates with tension-free and stable soft-tissue flaps is one of the basic surgical principles that can prevent infections.

CONCLUSION

In conclusion, Osteosynthesis plates should be removed due to infections and plate exposure after orthognathic surgery. There should be left in place unless complications arise.

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