ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Evaluation of Postoperative Accuracy and Relapse Extent in Orthognathic Surgery Patients: A Case Control Study

Ortognatik Cerrahi Hastalarında Postoperatif Doğruluğun ve Nüks Miktarının Değerlendirilmesi: Olgu Kontrol Araştırması

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ABSTRACT Objective: The success of orthognatic surgery depends on careful physical examination, correct diagnosis and good treatment planning. The aim of this study was to determine the accuracy of presurgical orthognatic planning and postoperative outcomes in single jaw or double jaw orthognathic surgery cases operated on in the Tokat Gaziosmanpaşa University Dentistry Faculty Department of Oral and Maxillofacial Surgery. **Material and Methods:** A total of 34 Class III patients were grouped in the form of bimaxillary osteotomy (Group 1), single jaw mandibular osteotomy with mandibular set-back (Group 2) and single jaw maxillary osteotomy with maxillary advancement (Group 3). Orthodontic analysis and measurements were performed on preoperative (T0), immediate postoperative (T1), 6 months (T2) and 12 months (T3) lateral cephalometric radiographs. **Results:** Based on multivariate analyses, there was no statistically significant difference in any of the groups between our T1-T0 values (p>0.05), with the exception of the distance of the ANS point from the vertical reference point (p=0.004). To evaluate the recurrence rates, the values between the T2-T1 and the T3-T1 periods were examined, and were not found to be statistically significant. However in Group 1, T3-T1 differences with regard to VR-ANS (p=0.003) and VR-L1 (p=0.033) showed a statistically significant recurrence. **Conclusion:** This study showed that the orthognathic surgical plan resulting from the methods we used were transferred to the surgery correctly. In addition, besides the postoperative orthodontic treatment, our techniques for fixation and osteotomy were effective in reducing the potential for relapse.

Keywords: Orthognathic surgery; recurrence; orthodontics

ÖZET Amaç: Ortognatik cerrahinin başarısı dikkatli fizik muayene, doğru teşhis ve iyi bir tedavi planlamasına bağlıdır. Bu çalışmanın amacı, Tokat Gaziosmanpaşa Üniversitesi Diş Hekimliği Fakültesi Ağız, Diş ve Çene Cerrahisi Anabilim Dalında opere edilen tek çene veya çift çene ortognatik cerrahi olgularında ameliyat öncesi ortognatik planlamanın ve ameliyat sonrası sonuçların doğruluğunu belirlemektir. **Gereç ve Yöntemler:** Toplam 34 Sınıf III hasta, çift çene osteotomi yapılanlar (Grup 1), tek çene mandibular geriletme yapılanlar (Grup 2) ve tek çene maksiller ilerletme yapılanlar (Grup 3) olarak gruplandırılmıştır. Operasyon öncesinde (T0), operasyonun hemen sonrasında (T1), 6. ay (T2) ve 12. aylarda ortodontik analiz ve ölçümler yapılmıştır. **Bulgular:** Çoklu değişken analizlerine göre ANS noktasının dikey referans noktasına olan mesafesi (p=0,004) dışında, T1-T0 değerlerimiz arasında (p>0,05) grupların hiçbirinde istatistiksel olarak anlamlı bir fark yoktu. Nüks oranlarını değerlendirmek için T2-T1 ve T3-T1 dönemleri arasındaki değerlere bakılmış ve istatistiksel olarak anlamlı bulunmamıştır. Ancak Grup 1'de VR-ANS (p=0,003) ve VR-L1 (p=0,033) açısından T3-T1 farklılıkları istatistiksel olarak anlamlı bir nüks görülmüştür. **Sonuç:** Bu çalışma, kullandığımız yöntemlerle oluşturulan ortognatik cerrahi planın operasyona başarıyla aktarıldığını göstermektedir. Ayrıca postoperatif ortodontik tedavinin yanı sıra osteotomi ve fiksasyon yöntemlerimizin de nüksü önlemede etkili olduğu görülmektedir.

Anahtar Kelimeler: Ortognatik cerrahi; nüks; ortodonti

During growth and development, maxillofacial structures develop depending on a number of genetic and environmental factors. If the growth of these structures occurs disproportionately and abnormally, a dentofacial deformity occurs.[1] Mild and moderate anomalies can be treated with orthodontic treatment alone, while severe disorders require surgery with regard to the mandible and/or maxilla, in addition to orthodontic treatment.[2]

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Orthognatic surgery aims to correct these deformations with various osteotomies/ostectomies. The success of orthognatic surgery depends on careful physical examination, correct diagnosis and correct treatment planning. In conventional orthognathic surgery planning, 2D cephalometric analysis, photographs, dental models mounted on the articulator with facebow transfer and model surgery, are used. After facial and cephalometric analysis, the conventional procedure implements a two-dimensional treatment plan based on this analysis.[3] Subsequently, with the use of surgical occlusal splints, orthognatic surgery planning is transferred to the operational procedure.

The aim of this study was to determine the accuracy of pre-surgical orthognatic planning and postoperative outcomes in single jaw or double jaw orthognatic surgery cases undertaken by an experienced surgeon in the Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Tokat Gaziosmanpaşa University.

MATERIAL AND METHODS

The study protocol was approved by Tokat Gaziosmanpaşa University Faculty of Medicine Clinical Research Ethics Committee (17-KAEK-185, 09.01.2018). This study included 34 patients who had skeletal Class III deformity and were operated on by an experienced surgeon in the department of oral and maxillofacial surgery. The patients were classified according to the surgical procedure used: Group 1 bimaxillary osteotomy (mandibular set-back+maxillary advancement), Group 2 mandibular osteotomy (mandibular set-back) and Group 3 maxillary osteotomy (maxillary advancement).

Patients with Class III deformities, who had completed their skeletal growth and development and had no additional congenital anomalies or any defects origined by a trauma, were included in the study. For all patients, presurgical orthodontic treatment and orthognathic planning had been arranged. Those with congenital defects, deformities other than Class III, and missing follow-up data, were excluded. This study followed the Declaration of Helsinki on medical protocol and ethics. Written informed consent was obtained from all patients included in the study.

After final orthognathic plans had been settled, plaster casts of the patients were mounted on professional articulators by using facebows, and model surgeries were performed. The intermediate and final occlusal splints to be used for the repositioning of the jaws during the surgery were produced as determined by the model surgery.

All surgeries were performed under general anesthesia with nasotracheal intubation. We used Le Fort I osteotomy for the maxilla, and bilateral sagittal split osteotomy (BSSO) for the mandible. We prefered the use of stepped Le Fort I osteotomy instead of a straight bone cut (Figure 1). After the completion of the osteotomies, maxillary downfracture and mandible split operations were performed, and the jaws were brought to their new positions with the help of the intermediate and final occlusal splints prepared by the orthodontic team, and the internal fixation procedures were then started. 'L' miniplates with 4 holes and 16 miniscrews were used for maxillary fixation. Mandibular fixations involved the use of a total of two bicortical screws, two straight miniplates with 4 holes, and 8 miniscrews (Figure 2). Following the fixation procedures, the surgical sites were closed, primarily using 3.0 silk sutures, and an extraoral elastic bandage was applied to reduce postoperative edema.

All patients were hospitalized for 6 days postoperatively and antibiotics (ampisilin 1 g IV) and anti-inflammatory analgesic (dexketoprofen trometamol 50 mg/2 mL IV) drugs were administered during this period. At the postoperative sixth hour, patients started oral feeding with a liquid food-rich diet.

In addition to preoperative radiographs (T0), lateral cephalometric radiographs were taken immediate postoperatively (T1), at 6 months (T2) and at 12 months (T3) after the operation, and analysis and measurements were performed (Figure 3, Figure 4, Figure 5, Figure 6). Initially, a horizontal reference plane (H) was created which passes over the sella-nasion plane at an angle of 7°. A vertical reference (VR) plane was then drawn from the nasion point, descending at right angles from this plane. Three points in the maxilla (ANS, A, U1) and 3 points in the mandible (B, Pg, L1) were determined, and the distances of these 6 skeletal points to the VR in the sagittal plane were measured. In addition, the amount of overjet was measured, and angular changes between the palatal and mandibular planes and the sella-nasion were evaluated.

The accuracy of orthognathic surgery planning was determined by an evaluation of the difference between T0 and T1. The amount of relapse was determined by an evaluation of the differences between T1-T2 and T1-T3.

Descriptive analyzes were conducted to give information about the general characteristics of the study groups. Data in the form of continuous variables were expressed as mean±standard deviation; categorical variables were given as n (%). When comparing the means of the quantitative variables between the groups, the significance test of the difference between two means and one-way variance analysis were used. For the dependent groups, the significance test of the difference between 2 spouses was used. p values less than 0.05 were considered to be statistically significant. Readily available statistics software was used in the calculations (IBM SPSS Statistics 19, SPSS inc., an IBM Co., Somers, NY).

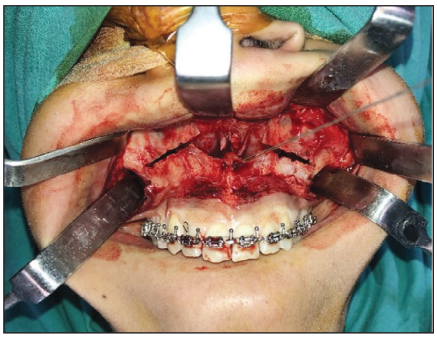

FIGURE 1: Stepped Le Fort I osteotomy in maxilla (intraoperative image).

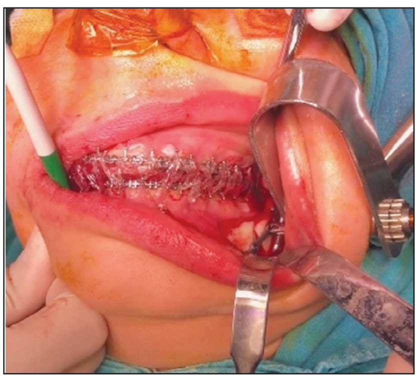

FIGURE 2: Fixation of mandibular segments by using hybrid fixation system (bilateral 1 miniplate+1 bicortical screw).

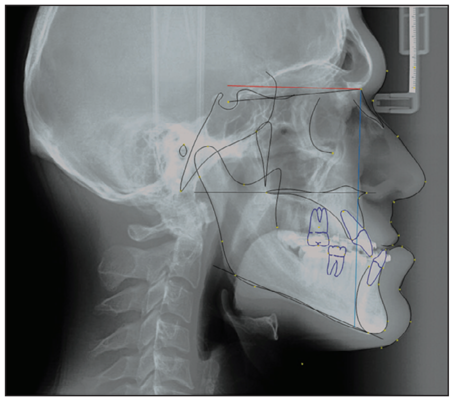

FIGURE 3: Preoperative cephalometry digitized with Dolphin Imaging software. Red line: Horizontal reference line; Blue line: Vertical reference line.

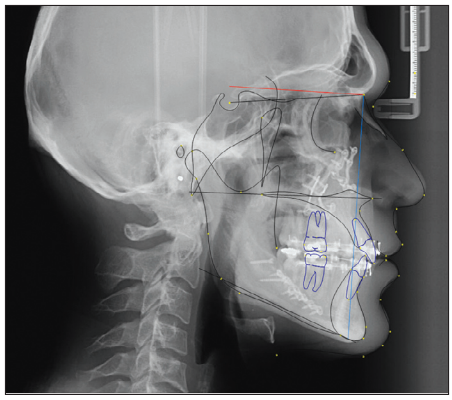

FIGURE 4: Postoperative cephalometry digitized with Dolphin Imaging software.

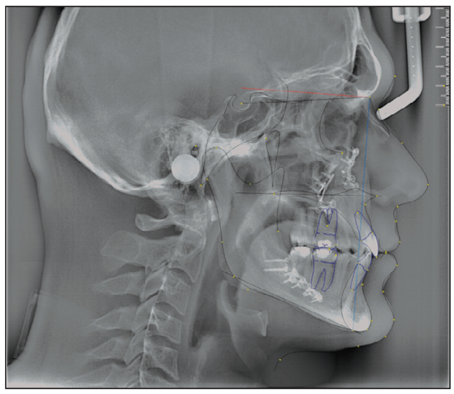

FIGURE 5: Postoperative 6th month cephalometry digitized with Dolphin Imaging software.

RESULTS

A total of 34 patients with a mean age of 21.47±4.75 years were included in the study. The distribution of patients by gender and type of surgery is given in Figure 7.

In addition, the planned mandibular and maxillary movement amounts in each of the three groups, are as shown in Table 1.

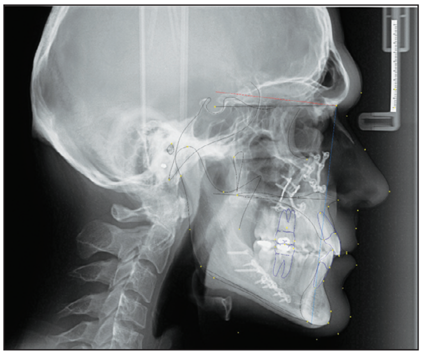

FIGURE 6: Postoperative 12th month cephalometry digitized with Dolphin Imaging software.

It is expected that the difference between the total amount of movement performed in the lower and upper jaws after orthognatic surgery operations, and the amount of overjet between preoperative (T0) and immediately after surgery (T1), will be the same. In the present study, when the T1-T0 overjet difference was compared with the total amount of movement planned, no statistically significant difference was found in each of Group 1 ($p=0.154$), Group 2 ($p=0.380$) and Group 3 ($p=0.141$) (Table 2).

In this study, it was observed that there was no statistically significant difference between the values of the angular parameters SN-PP and SN-MP between T0 and T1 according to the type of surgery and sex ($p>0.05$).

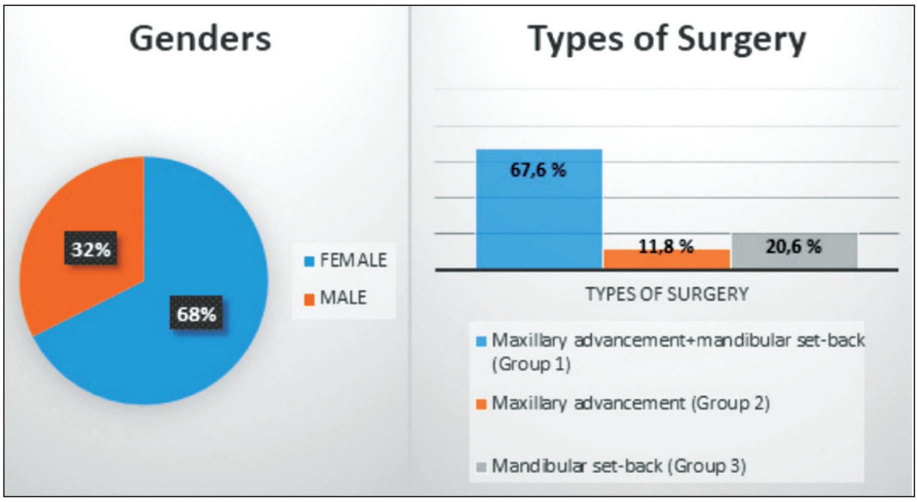

FIGURE 7: The distribution of patients by gender and type of surgery.

TABLE 1: Planned amounts of mandibular and maxillary movement.

	Mean	SD	Minimum value	Maximum value
Planned maxillary advancement (mm)	5.56	1.36	3.00	8.00
Planned mandibular set-back (mm)	-4.86	1.74	-9.00	-1.00
Planned total amount of movement (mm)	8.70	2.82	4.00	14.00

SD: Standard deviation.

TABLE 2: Comparation of planned total amount of movement and T1-T0 overjet.

	Group 1	Group 2	Group 3
Planned total amount of movement (mm)	10.17±1.96	5.88±1.65	5.5±1.71
Overjet (mm) (T1-T0)	9.67±2.3	5.15±1.34	4.57±2.69
p_2	0.154	0.380	0.141

When the difference of the VR-A values between T0 and T1 indicating the millimeter distance of the point A in the upper jaw to the vertical reference plane is compared with the planned maxillary movement amounts, there was an average difference of 0.403±2.431 mm between them, and this was not statistically significant (p=0.396). When the difference between the T0 and T1 distance of ANS in the upper jaw to the vertical reference plane, and the planned maxillary movement amount were compared, the difference between the mean 1.674±2.742 mm was found to be statistically significant (p=0.004). It was determined that the difference between the distance between T0 and T1 of the other maxillary point U1 to the vertical reference plane was 0.914±2.820 mm and the difference was not statistically significant (p=0.104).

The distance between T0 and T1 in terms of the distance between B, Pg and L1, which we base on the lower jaw, to the vertical reference plane was compared with the planned amount of mandibular movement. Accordingly, a mean difference of -0.800± 3.748 mm was found between VR-B (T1-T0) and the planned mandibular movement, which was shown to be statistically insignificant (p>0.05). Likewise, there was a difference of -1.290±4.556 mm and 0.396±3.590 mm between VR-Pg (T1-T0) and VR-L1 (T1-T0) and planned mandibular movement, respectively, which was found to be statistically insignificant (p=0.132, p=0.550). Table 3 shows a comparison between the changes in the distance between the points determined in the jaw to the vertical reference plane and the planned movement amounts.

In order to evaluate the recurrence rates at the 6th and 12th months, the changes in the distance between the points in the lower and upper jaws to the vertical reference plane were examined between the T2-T1 and T3-T1 periods. When T2-T1 differences in terms of VR-A, VR-ANS and VR-U1 values in the upper jaw were evaluated, no statistically significant difference was found in Group 1 and Group 3 (p>0.05). In addition, in Group 1 and Group 3, the T2-T1 differences with regard to VR-B, VR-Pg, VR-L1 values weren't statistically significant (p>0.05). When T3-T1 differences were observed in the 12-month period, no significant difference was found in terms of VR-A and VR-U1 values in Group 1, but there was a statistically significant difference in terms of the VR-ANS value (p=0.003). Besides, in Group 1, the T3-T1 differences in terms of the VR-B and VR-Pg values in the mandible did not show a statistically significant difference (p>0.05). However, there was a statistically significant difference in terms of the T3-T1 change of the VR-L1 value in terms of recurrence (p=0.033). No statistically significant difference was found between T3-T1 values in the lower and upper jaws in Groups 1 and 2 (p>0.05). The variations in terms of lower and upper jaw values between T2-T1 and T3-T1 according to the type of surgery, are shown in Table 4.

TABLE 3: Relationship between the skeletal points-VR distances and planned jaw movement amounts.

	Mean (mm)	n	SD	p value
PMxAd (mm)	5.563	27	1.355	0.396
VR-A (mm) (T1-T0)	5.159	27	2.186	
PMxAd (mm)	5.563	27	1.355	0.004
VR-ANS (mm) (T1-T0)	3.888	27	2.502	
PMxAd (mm)	5.563	27	1.355	0.104
VR-U1 (mm) (T1-T0)	4.648	27	2.615	
PMdS (mm)	4.856	30	1.737	0.252
VR-B (mm) (T1-T0)	4.056	30	4.548	
PMdS (mm)	4.856	30	1.737	0.132
VR-Pg (mm) (T1-T0)	3.566	30	5.401	
PMdS (mm)	4.856	30	1.737	0.550
VR-L1 (mm) (T1-T0)	5.253	30	4.075	

SD: Standard deviation; PMxAd: Planned maxillary advancement; VR: Vertical reference line; PMdS: Planned mandibular set-back.

DISCUSSION

Dentofacial deformities mainly affect the jaws and dentition, and can seriously affect the quality of life of individuals. Depending on the different types of malocclusion seen in individuals with dentofacial deformities, they suffer from problems such as chewing, biting, lip contact, swallowing and even breathing (obstructive sleep apnea).

Although the prevalence of skeletal and dental Class III relationships among patients with orthognathic surgery needs varies according to race, ethnic group and geographic region, studies have

TABLE 4: The variations of lower and upper jaw values between T2-T1 and T3-T1 according to the types of surgery.

		Mean difference	p value
Group 1	VR-A (T2-T1)	-0.535±0.328	0.678
	VR-A (T3-T1)	-0.661±0.374	0.524
	VR-ANS (T2-T1)	-0.861±0.336	0.093
	VR-ANS (T3-T1)	-1.065±0.272	0.003
	VR-U1 (T2-T1)	0.848±0.554	0.817
	VR-U1 (T3-T1)	1.035±0.465	0.200
	VR-B (T2-T1)	1.026±0.569	0.486
	VR-B (T3-T1)	0.991±0.690	0.967
	VR-Pg (T2-T1)	1.578±0.658	0.136
	VR-Pg (T3-T1)	1.539±0.779	0.343
	VR-L1 (T2-T1)	0.670±0.634	1.000
	VR-L1 (T3-T1)	1.474±0.493	0.033
Group 2	VR-A (T2-T1)	-0.975±0.786	1.000
	VR-A (T3-T1)	-2.000±0.898	0.200
	VR-ANS (T2-T1)	0.650±0.806	1.000
	VR-ANS (T3-T1)	-1.025±0.651	0.754
	VR-U1 (T2-T1)	0.025±1.329	1.000
	VR-U1 (T3-T1)	0.150±1.114	1.000
Group 3	VR-B (T2-T1)	0.286±1.031	1.000
	VR-B (T3-T1)	0.486±1.252	1.000
	VR-Pg (T2-T1)	0.429±1.192	1.000
	VR-Pg (T3-T1)	0.814±1.412	1.000
	VR-L1 (T2-T1)	1.129±1.149	1.000
	VR-L1 (T3-T1	0.629±0.894	1.000

VR: Vertical reference line.

shown that the prevalence is generally higher than Class I and Class II.[4-7] The current study also included only patients with Class III deformity, most of whom (76%) required bimaxillary orthognathic surgery.

In the present study, all maxillary advancements were performed using stepped Le Fort I osteotomy. In conventional Le Fort I osteotomy, the osteotomy line is inclined in the anteroposterior direction due to the length difference of the tooth roots and the zygomatic butress in position.[8] When the maxilla is brought forward due to this inclination, it also moves upwards, and anterior rotation is observed in the mandible that is positioned accordingly. As a result, vertical distances are changed.[9] Since no change in vertical distances was desired in the orthognathic surgery planning of the all cases considered in this study, stepped Le Fort I osteotomy was preferred.

In the past, and up to the present, many surgeons placed miniplates and screws bilaterally, both in the anterior piriform opening and in the posterior maxillary butress area for skeletal fixation after Le Fort I osteotomy. According to some authors, only 1 miniplate placed on either side of the anterior piriform opening is needed to prevent or reduce recurrence.[10] In the present study, 4 "L" shaped miniplate fixations were used bilaterally, which is the most common technique for fixation in patients undergoing Le Fort I osteotomy. In this way, the need for intermaxillary fixation was eliminated by providing a rigid fixation, and the possibility and rate of relapse was reduced. In one study, Ataç et al. found that using the 4-plate fixation method in the anterior piriform area and the zygomatic buttress area, the stress in the bone structures, and the von Mises stress that caused the deformation of the plates, were significantly lower than using the 2-plate method.[11] This shows that enormous mechanical advantages are achieved, especially when 4 ''L'' shaped plates are used in pure maxillary advancements without impaction.

Among the osteosynthesis methods used in BSSO, the use of bicortical screws and miniplates has been documented in clinical and laboratory studies with reliable results.[12-14] In 2010, Rieberio-Junior et al. found higher strength with regard to displacement in hybrid system groups using a locked or conventional miniplate with a bicortical screw.[15] In a similar study, the stability of a 6 fixation system was evaluated, and it was found that the hybrid system (1 miniplate+1 bicortical screw) that we used for fixation of the mandibular segments, showed the highest stability.[16] In the present study, the aim was to combine the advantages of bicortical screws in fixation with the mechanical advantages of moncortical screws.

The first focus of the present study was to determine the accuracy of the planning, and the use of osteotomy and fixation techniques, by comparing the consistency between the results obtained after the operation and the amount of movement envisaged in orthognathic planning. First of all, orthognathic planning was undertaken by means of various measurements, analyzes and simulations on cephalometries, digitized using Dolphin Imaging (DI) software (Dolphin Imaging and Management Solutions, Chatsworth, Calif., USA). The plaster models obtained by measuring our patients were then transferred to a professional articulator using a facebow, and model surgery was performed. Intermediate and final splints were produced in this way. It can be thought that this process, which is a combination of digital and manual stages, can make it difficult to transfer the planned amounts of movement to the operation accurately. A wide range of commercial orthodontic planning software is available. Of these, DI is increasing in popularity. In a study by De Lira Ade et al., it was found that the surgery outcome prediction obtained by using the DI software showed a high correlation with the actual results.[17]

The use of a facebow in the transfer of the maxillary model to the articulator provided a reliable view when it comes to estimating the distance between the dentition and the intercondylar hinge axis. In this way, the sensitivity of the planning increases. In some studies, it has been found that some errors may occur during the transfer of the planned movement amount to the model surgery, but these errors caused no statistically significant difference between the plans and the results obtained preoperatively.[18]

In this study, the authors used a combination of DI software and traditional model surgery. When the results were examined, it was seen that the difference between the amount of planned movement of the jaws and the amount of movement obtained immediately after the operation, were compatible with each other. In the upper jaw, only the difference in terms of the ANS point was statistically significant, while in the mandible the same difference wasn't statistically significant for any points. In cases where the maxilla was moved forward after the Le Fort I osteotomy, nasal changes, such as an increased alar base width and the upward tip of the nose can be seen.[19-25] In the present study, contouring and reduction was performed in ANS in order not to cause any change in nasal aesthetics in some of the cases with maxillary advancement. Therefore, it is thought that the reason for the difference between the planned amount of maxillary movement at the ANS point, and the amount of surgical movement achieved, was statistically significant.

Many studies in the literature indicate that the postoperative recurrence rate is closely related to the size of the movement in the jaws. Especially when the amount of movement is performed within certain limits (<10 mm), the linear measurements in the skeletal structures remain stable, and this does not make a significant change in soft tissues.[26-30] However, Han et al. reported that the relapse seen in patients treated with BSSO for mandibular prognatism was not related to the amount of setback, but to the clockwise rotation of the proximal segment intraoperatively.[31] Accordingly, the difference in the vertical distance between the lower boundaries of the proximal and distal segments in the vertical osteotomy line is the most predictive factor for the intraoperative rotation of the proximal segment. In the present study, in order to prevent this effect in each mandibular setback patient, whether there was a step due to level difference between the lower edges of the proximal and distal segments, was manually checked pior to the fixation process. On the cephalometric radiographies, the angular changes due to rotation in the jaws were evaluated by analysing the change of SN-MP and SN-PP angular parameters. When the angle differences between T0-T1 were examined to evaluate the degree of intraoperative rotation and T2-T1 and T3-T1 to evaluate postoperative changes, it was concluded that the mean differences for the SN-PP and SN-MP parameters were <1° and were therefore not statistically significant. This is one of the findings explaining the high stability that the authors achieved in the postoperative period.

The main limitations of this study were the low number of samples and the fact that the number of patients does not show homogeneous distribution among the groups. It is thought that this problem can be overcome by including more cases in the study. In addition, since digitized 2D cephalometries were used in this study, the analysis covered only the vertical and sagittal planes. Asymetries, occlusal cant and midline deviations could not be evaluated due to the lack of 3D cephalometric images of the patients. When different amounts of surgical movements were performed between the right and left sides in the mandible or maxilla of the patient, the average value of the 2 sites was taken into consideration. Due to no changes being planned in vertical distances, the authors did not consider differences in the vertical plane.

In addition, the authors left the final splints that they fixed intraoperatively to the upper jaw for 2 weeks in order to guide the occlusion during the early recovery period. As a result, in some of the T1 cephalometries, the teeth could not come to full occlusion due to splints in the mouth. In order to prevent this situation from causing differences and statistical errors in the same patients or between patients, the mandible was autorotated to provide contact between the incisors using the "autorotate" feature of the DI software in the T1 cephalometric drawings with the final splint. In a study bt Jakobsone et al., a similar situation was encountered, and standardization was attempted through the method of autorotation.[27]

CONCLUSION

In the present study, orthognathic surgery plans that were created as a result of orthodontic analyzes performed on 2D cephalometries digitized by DI software, were transferred to the operation correctly by using intermediate and final splints which were manually produced through the use of model surgery. In all cases, the planned movement amounts in the sagittal plane were achieved by using stepped Le Fort I osteotomy in the maxilla and BSSO in the mandible, with the exception of ANS points in the maxilla. No statistically significant relapse was seen during the 6 and 12 month follow-up periods. The authors believe that the hybrid fixation system in the mandible, and 4 miniplate fixations as used in the maxilla, have great effect in reducing recurrence. Other factors that are similarly effective are keeping the orthognathic movement size low, and preventing early recurrences with the use of postoperative orthodontic treatment.

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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

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REFERENCES

1. Lye KW. Effect of orthognathic surgery on the posterior airway space (PAS). Ann Acad Med Singap. 2008;37(8):677-82. [PubMed]
2. Adolphs N, Ernst N, Keeve E, Hoffmeister B. Contemporary correction of dentofacial anomalies: A clinical assessment. Dent J (Basel). 2016;4(2):11. [Crossref] [PubMed] [PMC]
3. Steinhuber T, Brunold S, Gärtner C, Offermanns V, Ulmer H, Ploder O. Is virtual surgical planning in orthognathic surgery faster than conventional planning? A time and workflow analysis of an office-based workflow for single- and double-jaw surgery. J Oral Maxillofac Surg. 2018;76(2):397-407. [Crossref] [PubMed]
4. Mendes de Paula Gomes A, Adas Saliba Garbin C, da Silva Ferraz FW, Adas Saliba T, Isper Garbin AJ. Dentofacial deformities and implications on quality of life: A presurgical multifactorial analysis in patients seeking orthognathic surgical treatment. J Oral Maxillofac Surg. 2019;77(2):409.e1-409.e9. [Crossref] [PubMed]
5. Olkun HK, Borzabadi-Farahani A, Uçkan S. Orthognathic surgery treatment need in a Turkish adult population: A retrospective study. Int J Environ Res Public Health. 2019;16(11): 1881. [Crossref] [PubMed] [PMC]
6. Ong MA. Spectrum of dentofacial deformities: a retrospective survey. Ann Acad Med Singap. 2004;33(2):239-42. [PubMed]
7. Zere E, Chaudhari PK, Sharan J, Dhingra K, Tiwari N. Developing class III malocclusions: challenges and solutions. Clin Cosmet Investig Dent. 2018;10:99-116. [Crossref] [PubMed] [PMC]
8. Buchanan EP, Hyman CH. LeFort I osteotomy. Semin Plast Surg. 2013;27(3):149-54. [Crossref] [PubMed] [PMC]
9. Bennett MA, Wolford LM. The maxillary step osteotomy and Steinmann pin stabilization. J Oral Maxillofac Surg. 1985;43(4):307-11. [Crossref] [PubMed]
10. Yoon HJ, Rebellato J, Keller EE. Stability of the Le Fort I osteotomy with anterior internal fixation alone: a case series. J Oral Maxillofac Surg. 2005;63(5):629-34. [Crossref] [PubMed]
11. Ataç MS, Erkmen E, Yücel E, Kurt A. Comparison of biomechanical behaviour of maxilla following Le Fort I osteotomy with 2- versus 4-plate fixation using 3D-FEA. Part 1: advancement surgery. Int J Oral Maxillofac Surg. 2008;37(12):1117-24. [Crossref] [PubMed]
12. Rubens BC, Stoelinga PJ, Blijdorp PA, Schoenaers JH, Politis C. Skeletal stability following sagittal split osteotomy using monocortical miniplate internal fixation. Int J Oral Maxillofac Surg. 1988;17(6):371-6. [Crossref] [PubMed]
13. Shetty V, Freymiller E, McBrearty D, Caputo AA. Experimental analysis of functional stability of sagittal split ramus osteotomies secured by miniplates and position screws. J Oral Maxillofac Surg. 1996;54(11):1317-24; discussion 1324-6. [Crossref] [PubMed]
14. Ulu M, Soylu E, Kelebek S, Dikici S, Oflaz H. Comparative study of biomechanical stability of resorbable and titanium fixation systems after sagittal split ramus osteotomy with a novel designed in-vitro testing unit. J Craniomaxillofac Surg. 2018;46(2):299-304. [Crossref] [PubMed]
15. Ribeiro-Junior PD, Magro-Filho O, Shastri KA, Papageorge MB. In vitro biomechanical evaluation of the use of conventional and locking miniplate/screw systems for sagittal split ramus osteotomy. J Oral Maxillofac Surg. 2010;68(4):724-30. [Crossref] [PubMed]
16. De Oliveira LB, Reis JM, Spin-Neto R, Gabrielli MA, Oguz Y, Pereira-Filho VA. Mechanical evaluation of six techniques for stable fixation of the sagittal split osteotomy after counterclockwise mandibular advancement. Br J Oral Maxillofac Surg. 2016;54(5):573-8. [Crossref] [PubMed]
17. de Lira Ade L, de Moura WL, de Barros Vieira JM, Nojima MG, Nojima LI. Surgical prediction of skeletal and soft tissue changes in Class III treatment. J Oral Maxillofac Surg. 2012;70(4): e290-7. [Crossref] [PubMed]
18. Sharifi A, Jones R, Ayoub A, Moos K, Walker F, Khambay B, et al. How accurate is model planning for orthognathic surgery? Int J Oral Maxillofac Surg. 2008;37(12):1089-93. [Crossref] [PubMed]
19. Altman JI, Oeltjen JC. Nasal deformities associated with orthognathic surgery: analysis, prevention, and correction. J Craniofac Surg. 2007;18(4):734-9. [Crossref] [PubMed]
20. Becelli R, Renzi G, Carboni A, Cerulli G, Perugini M. Evaluation of the esthetic results of a 40-patient group treated surgically for dentoskeletal class III malocclusion. Int J Adult Orthodon Orthognath Surg. 2002;17(3):171-9. [PubMed]
21. Bell WH. Le Forte I osteotomy for correction of maxillary deformities. J Oral Surg. 1975; 33(6):412-26. [PubMed]
22. Honrado CP, Lee S, Bloomquist DS, Larrabee WF Jr. Quantitative assessment of nasal changes after maxillomandibular surgery using a 3-dimensional digital imaging system. Arch Facial Plast Surg. 2006;8(1):26-35. [Crossref] [PubMed]
23. Misir AF, Manisali M, Egrioglu E, Naini FB. Retrospective analysis of nasal soft tissue profile changes with maxillary surgery. Journal of Oral and Maxillofacial Surgery. 2011;69(6): e190-e194. [Crossref] [PubMed]
24. Park SB, Yoon JK, Kim YI, Hwang DS, Cho BH, Son WS. The evaluation of the nasal morphologic changes after bimaxillary surgery in skeletal class III maloccusion by using the superimposition of cone-beam computed tomography (CBCT) volumes. J Craniomaxil lofac Surg. 2012;40(4):e87-92. [Crossref] [PubMed]
25. Metzler P, Geiger EJ, Chang CC, Sirisoontorn I, Steinbacher DM. Assessment of three-dimensional nasolabial response to Le Fort I advancement. J Plast Reconstr Aesthet Surg. 2014;67(6):756-63. [Crossref] [PubMed]
26. de Haan IF, Ciesielski R, Nitsche T, Koos B. Evaluation of relapse after orthodontic therapy combined with orthognathic surgery in the treatment of skeletal class III. J Orofac Orthop. 2013;74(5):362-9. [Crossref] [PubMed]
27. Jakobsone G, Stenvik A, Sandvik L, Espeland L. Three-year follow-up of bimaxillary surgery to correct skeletal Class III malocclusion: stability and risk factors for relapse. Am J Orthod Dentofacial Orthop. 2011;139(1):80-9. [Crossref] [PubMed]
28. Mucedero M, Coviello A, Baccetti T, Franchi L, Cozza P. Stability factors after double-jaw surgery in Class III malocclusion. A systematic review. Angle Orthod. 2008;78(6):1141-52. [Crossref] [PubMed]
29. Tabrizi R, Nili M, Aliabadi E, Pourdanesh F. Skeletal stability following mandibular advancement: is it influenced by the magnitude of advancement or changes of the mandibular plane angle? J Korean Assoc Oral Maxillofac Surg. 2017;43(3):152-9. [Crossref] [PubMed] [PMC]
30. de Lir Ade L, de Moura WL, Oliveira Ruellas AC, Gomes Souza MM, Nojima LI. Long-term skeletal and profile stability after surgical-orthodontic treatment of Class II and Class III malocclusion. J Craniomaxillofac Surg. 2013; 41(4):296-302. [Crossref] [PubMed]
31. Han JJ, Yang HJ, Lee SJ, Hwang SJ. Relapse after SSRO for mandibular setback movement in relation to the amount of mandibular setback and intraoperative clockwise rotation of the proximal segment. J Craniomaxillofac Surg. 2014;42(6):811-5. [Crossref] [PubMed]