Complete Reoperation in Orthognathic Surgery

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Background: Complete reoperation is defined as undergoing reoperative/repeated jaw osteotomies, in a patient who previously underwent orthognathic surgery. The purpose of this study is to (1) describe jaw positions at three time-points (before primary and before and after reoperative surgery), (2) investigate factors necessitating reoperation, and (3) outline the technical challenges.
Methods: Repeated orthognathic surgery cases >1-year out were included. Demographic, radiologic, and perioperative data were compiled. Repeated osteotomies (Le-Fort and/or bilateral split sagittal osteotomy, with or without genioplasty), were compared to their respective primary procedures. Statistical analysis was performed using *t* tests and *z*-scores.
Results: Fifteen patients were included (28.1 years; 71 percent female). Reoperative/repeated surgery was most often needed to address iatrogenic bony malposition and asymmetry. Relapse was a less common indication. Time between reoperative and primary surgery was 14 months. Sagittal discrepancies ($p = 0.029$) were the most frequent reason for primary orthognathic surgery (e.g., mandibular hypoplasia ($p = 0.023$). Reoperative/repeated orthognathic was performed for asymmetry ($p = 0.014$). Repeated procedures used more 3-dimensional planning ($p < 0.001$), required all three osteotomies ($p = 0.034$), had longer operative times ($p = 0.078$), and all required hardware removal ($p < 0.001$). Anatomical outcomes were good with 100% patient satisfaction at long-term follow-up.
Conclusions: Reoperative/repeated orthognathic surgery is challenging and underreported in the literature. Whereas primary orthognathic typically addressed sagittal discrepancies, reoperative/repeated osteotomies were needed to correct iatrogenic bone malposition and asymmetries. Challenges include: re-planning, scar burden, need to remove integrated hardware, and repeated osteotomy/fixation. Despite these difficulties, outcomes and patient acceptance were good. (*Plast. Reconstr. Surg.* 143: 1053e, 2019.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Orthognathic surgery is performed to address facial balance and improve occlusion, airway, and speech.[1–7] Although three-dimensional planning has enhanced the operation, malposition, skeletal relapse, and asymmetries do still occur.[8,9] There is scant discussion of orthognathic reoperation in the literature, but rates may be as high as 12.2 percent.[10–12] Relapse is the reported cause, but the distinction between dental and skeletal relapse is not always clear. Errors in diagnosis, planning, or surgical execution may also contribute to the need for repeated surgery. A reoperation refers to when

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the entire maxillomandibular complex needs to be repositioned with new osteotomies, a new orthognathic plan, and orthodontic collaboration (Fig. 1). There is no literature to date focusing on complete orthognathic repeated procedures. The purpose of this article is to detail a series of repeated orthognathic surgery patients over three time points (i.e., before primary surgery and before and after repeated surgery), investigate causes for needing reoperation, and discuss technical challenges in performing repeated orthognathic surgery.

PATIENTS AND METHODS

All repeated orthognathic surgery patients, with a minimum 1-year follow-up, treated by the senior author (D.M.S.) between 2012 and 2016 were studied. Patients were included in the reoperation cohort if they underwent one-piece Le Fort I, bilateral sagittal split osteotomies with or without genioplasty, with a record of a previous orthognathic procedure with rigid internal fixation in the past. This study was performed in accordance with a protocol submitted to, and approved by, the Yale University Human Investigation Committee (no. 1101007932).

Demographic, perioperative, radiologic (radiographs, computed tomography, and three-dimensional planning), and postoperative data in the form of clinic follow-up notes were obtained. The repeated surgery cases were compared against their respective primary procedure. Statistical analysis was performed using paired *t* tests and *z*-scores. Values of $p < 0.05$ were considered significant.

RESULTS

Fifteen repeated operations were included (Table 1). The average age at repeated surgery was 28 years (71.4 percent female; 80 percent white). The average age at primary surgery was 24 years. New bony malposition was the most frequent indication requiring repeated orthognathic surgery (Table 2). Relapse was the cause of one-third of repeated operations, largely in the sagittal maxilla. Two patients had remote chronic condylar changes contributing to the need for reoperation.

Only 27 percent had virtual surgical planning before their original surgery compared to operations required (87 percent; $p < 0.001$). [**See Table, Supplemental Digital Content 1**, which shows perioperative and intraoperative values for primary and repeated operations. All values present in proportions of a 15-patient cohort. *$p < 0.05$ (statistically significant), ***http://links.lww.com/PRS/D436***.] The median time between primary and repeated surgery was 14 months. The average operative time for reoperation cases was approximately 1 hour longer than primary operations (227 minutes versus 326 minutes; $p = 0.077$). More reoperations required all three osteotomies compared to their original/primary operation (67 percent versus 33 percent; $p = 0.034$) and 100 percent of repeated operations required hardware removal compared to 27 percent of primary operations ($p < 0.001$).

In the primary cases, sagittal deformities were the most frequent reason ($p = 0.029$) for operation (Table 3). All repeated surgery was performed for asymmetry, both uncorrected and newly created ($p = 0.014$). Asymmetry in the repeated surgery cohort consisted more often of the maxilla, mandible, and chin ($p = 0.015$) and arose more frequently from condylar change ($p = 0.034$).

Average follow-up was 607 days after repeated surgery. One patient complained of a palpable screw, which was routinely removed in the operating room. One other patient had a mandible infection 6 weeks postoperatively. "Good outcomes" long-term were defined as (1) lack of patient complaints and/or subjective patient satisfaction during clinic visits, (2) routine progression of postsurgical orthodontics to completion, and (3) no relapse or change in occlusion/morphology at longest (>1-year) follow-up. All reoperation patients, up to the latest visit (>1-year follow-up), reported good outcomes according to all three criteria. Physical examination revealed to-date unchanged, stable correction of deformities in all patients.

DISCUSSION

The potential need for reoperation may include errors/omissions in initial evaluation, presurgical orthodontics, surgical planning, technique, and postoperative orthodontics. Relapse toward the original deformity surprisingly accounted for only one-third of repeated surgery cases, whereas most cases presented new iatrogenic malpositions. Skeletal relapse is well-recognized following orthognathic surgery but is less prevalent since the advent of the use of rigid fixation.[13] In our cohort, we deemed any reversion toward the presurgical deformity to be relapse. We included incomplete correction, as it cannot be elucidated whether the discrepancy was attributable to relapse versus

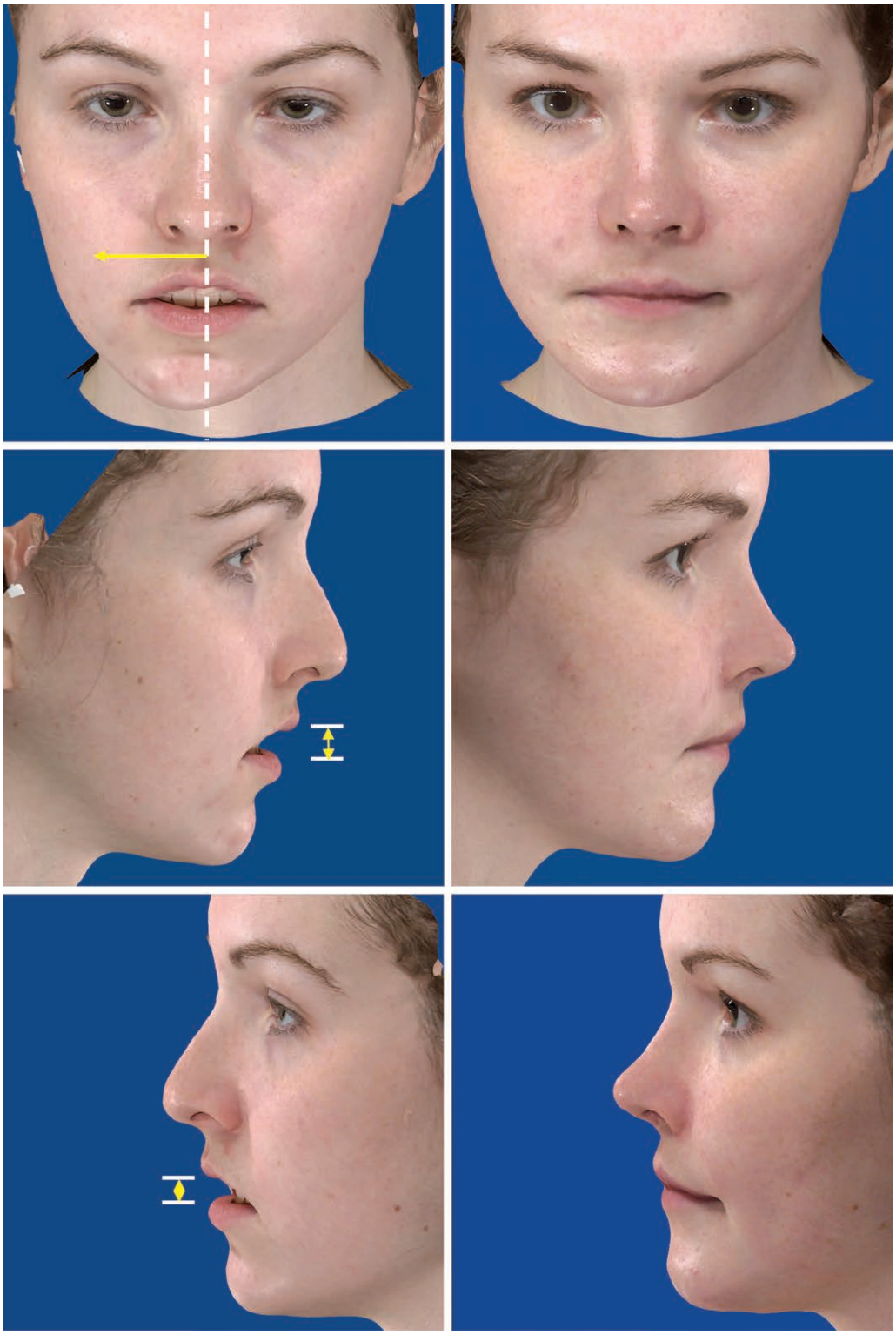

Fig. 1. Three-dimensional images of a patient before and after reoperative surgery. Before (*left*) and after (*right*) three-dimensional soft-tissue imaging of a patient following repeated orthognathic surgery, showing visible improvements in asymmetry and gingival show. (*Above*, *left*) Maxillary midline shift to the patient's right. (*Center* and *below*, *left*) Excess maxillary gingival show with greater vertical distance on the patient's right than left.

Table 1. Individual History of Repeated Orthognathic Surgery Patients*

Indications for Past Surgery†	Past Surgery‡	Past 3D Planning	Indications for Reoperation	Repeated Surgery	Angle Class	Malocclusion Indication	Repeated 3D Planning	Complications
Maxilla/mandible hypoplasia, underbite, malocclusion (class III, crossbite)	1. Genioplasty; 2. Le Fort I, BSSO, genioplasty	Yes	New bony malposition§, mandible/chin asymmetry, maxillary hypoplasia, malocclusion, airway obstruction	Le Fort I, BSSO, genioplasty	III	−2-mm overbite; −1-mm overjet; crossbite; procumbent maxillary incisors	Yes	—
Maxilla/mandible asymmetry, mandibular hypoplasia, malocclusion	1. Le Fort I, BSSO, genioplasty; 2. Le Fort I, BSSO, genioplasty	No	New bony malposition§, condylar malposition (CR-CO discrepancy), maxillary hypoplasia, malocclusion, maxilla/mandible asymmetry, airway obstruction	Le Fort I, BSSO, genioplasty	II	2-mm open bite; −2-mm overjet; 2-mm anterior crossbite on right first molar	Yes	—
Microgenia, mandibular retrognathia, mandibular asymmetry, malocclusion (class II; 6- to 8-mm overjet, 6-to 8-mm overbite, open bite)	Le Fort I, BSSO, genioplasty	Yes	New bony malposition§, postoperative shift, maxilla/mandible/chin asymmetry, residual microgenia, right nasal blockage, airway obstruction	Le Fort I, BSSO, genioplasty	I	None	Yes	—
Maxillary asymmetry, malocclusion (class III on left and class I on right)	Le Fort I, BSSO	No	New bony malposition§, chin/maxilla/mandibular asymmetry, and vertical maxillary excess, microgenia, implant failure, malocclusion, airway obstruction	Le Fort I, BSSO, genioplasty	I	2-mm overbite; 2-mm, 1-mm overjet	Yes	Late infection
Malocclusion (class II, open bite), maxilla/mandible hypoplasia	Le Fort I, BSSO	No	Condylar resorption§, maxilla/mandible hypoplasia, chin recession, malocclusion, airway obstruction	Le Fort I, BSSO, genioplasty	II	−5-mm overbite; 4-mm overjet; open bite	Yes	Palpable screw, removed in the operating room
Dentofacial deformities, malocclusion	Le Fort I, genioplasty	No	New bony malposition§, chin/maxilla/mandibular asymmetry, vertical maxillary excess, malocclusion, airway obstruction	Le Fort I, BSSO, genioplasty	III	Missing mandibular premolars, open bite	Yes	—
Maxilla/mandible hypoplasia, malocclusion (class III)	1. Le Fort III 2. Le Fort I	No	Relapse§, maxilla/mandible hypoplasia, narrow nasal cavity, malocclusion	Le Fort I, BSSO, genioplasty	III	Edge-to-edge anterior crossbite	Yes	—
Hemihypertrophy, mandible/chin asymmetry, malocclusion (mild open bite, class I on left, class III on right 2)	BSSO and genioplasty	No	Relapse§, mandible/chin asymmetry	Le Fort I, BSSO, genioplasty	Left, I; right, III	None	Yes	—
Maxillary hypoplasia, dentofacial asymmetry, malocclusion (class III)	Le Fort I	No	Relapse§, maxillary hypoplasia, chin/maxilla/mandible asymmetry, malocclusion, airway obstruction	Le Fort I, BSSO, genioplasty	III	6-mm anterior crossbite; open bite	No	—
Protuberant chin, malocclusion	BSSO	No	Condylar hyperplasia§, chin-mandibular asymmetry, lower face collapse, malocclusion	Le Fort I, BSSO, genioplasty	II	3- to 4-mm overjet; 2-mm overbite, right open bite	Yes	—
Maxilla/mandible hypoplasia, impacted tooth	1. Le Fort I, BSSO 2. Le Fort I, BSSO, genioplasty	No	New bony malposition§, chin/maxilla/mandible asymmetry, vertical shift, gingival show, airway obstruction	Le Fort I, BSSO	Left, II; right, III	None	Yes	—

(*Continued*)

Table 1. *Continued*

Indications for Past Surgery†	Past Surgery‡	Past 3D Planning	Indications for Reoperation	Repeated Surgery	Angle Class	Malocclusion Indication	Repeated 3D Planning	Complications
Maxillary hypoplasia, macrogenia, midface and perialar hollowing, lip incompetence, chin deformity, malocclusion (class III, anterior crossbite)	Le Fort I	No	Relapse§, maxillary hypoplasia, macrogenia, malocclusion	Le Fort I, genioplasty	III	6-cm anterior crossbite; posterior crossbite with transverse discrepancy	Yes	—
Vertical maxillary excess, malocclusion (class II, overjet)	1. Mandibular and maxillary expansion 2. Le Fort I, BSSO, genioplasty	Yes	New bony malposition§, shifting of upper jaw to the left, asymmetry, malocclusion, chin infection 1 mo after primary (unrelated to reoperation), airway obstruction	Le Fort I	I	Open bite; tripod occlusion	Yes	—
Maxillofacial deformities, malocclusion (class III, anterior/posterior crossbite), poor lip support	Le Fort I	Yes	Relapse§, maxilla deformities, hardware plate fracture	Le Fort I	I	None	Yes	—

3D, three-dimensional; BSSO, bilateral sagittal split osteotomy; CR, centric relation; CO, centric occlusion;
*Indications for primary and repeated surgery, primary and repeated procedures, and perioperatives listed for each of the 15 reoperation patients.
†Missing detailed patient data for past operations.
‡1, delineates the first operation of patients with multiple past operations; 2, delineates the second operation of patients with multiple past operations.
§Primary indication for reoperation.

Table 2. Reoperation Indications*

Indications for Reoperation	No. of Patients (%)
Relapse (or return to deformity)	5 (33)
Sagittal relapse	4
Maxilla	3
Maxilla/mandible/chin	1
Midline or relapse of asymmetry	1
Mandible/chin	1
New iatrogenic bony malposition	8 (53)
Presentation	
Asymmetry	8
Malocclusion	6
Vertical excess	3
Chronic condylar change (remote to osteotomy site)	2 (13)
Condylar hyperplasia	1
Condylar resorption	1

*Percentages are of a total of 15 reoperation patients.

undercorrection.[10] The maxilla was responsible for all cases of sagittal relapse in our cohort. Maxillary advancement is typically deemed less stable than impaction, with moderate relapse in up to 20 percent of patients.[9] Anteroposterior relapse can be attributable to incomplete mobilization of the maxilla, and/or muscle or scar-tissue forces pulling the maxilla back.

Asymmetry caused by new iatrogenic bony malposition was the most frequent reason for reoperation. Care should be taken at the primary

Table 3. Anatomical Diagnoses*

Anatomical Diagnosis	Primary Surgery†	Repeated Surgery	*p*
Sagittal problems	80.0	46.7	0.029‡
Maxillary hypoplasia	40.0	26.7	0.221
Mandibular hypoplasia/retrognathia	46.7	13.3	0.023‡
Microgenia/macrogenia	13.3	13.3	0.500
Asymmetry	33.3	73.3	0.014‡
Maxilla/mandible/chin	6.7	40.0	0.015‡
Maxilla/mandible	6.7	13.3	0.271
Maxilla only	6.7	6.7	0.500
Condylar change	0.0	20.0	0.034‡
Vertical problems			
Vertical excess	6.7	13.3	0.271
Malocclusion	86.7	73.3	0.181
Angle class			
III	46.7	66.7	0.267
II	20.0	13.3	0.624
I	0.0	13.3	0.067
Other	13.3 (L III, R I; L I, R III)	6.3 (R I, L II)	0.542
Open bite	20.0	46.7	0.060
Crossbite	20.0	40.0	0.115

L, left; R, right.
*Percentages of 15. Diagnoses divided into sagittal, vertical, asymmetry, and malocclusion. The *p* values were calculated from one-tailed *z*-scores.
†Missing detailed anatomical data for patients operated on at remote times/locations.
‡Statistically significant ($p < 0.05$).

surgery to avoid future asymmetry. Malposition could occur because of imprecise transference of the plan intraoperatively from technical issues or lack of three-dimensional planning. Even with premade splints, there is an element of subjectivity. Osseous contacts can be held with uneven pressure, and interferences or bony shifts can impart asymmetry. Sagittal mandibular deficiencies were less frequent in the repeated surgery group, likely because these vectors are easily addressed by traditional two-dimensional model surgery.

Another cause of asymmetry was remote condylar changes following primary orthognathic surgery. These changes developed gradually with time. In cases with preexisting resorption, reactivation following surgery can occur, leading to bony changes, asymmetry, and malocclusion.[14,15] Avoidance of excessive upward and backward pressure on the joints during fixation should be avoided intraoperatively.

Ultimately, repeated surgery was deemed more difficult/challenging compared with primary cases. Scarring, malposition, and altered bony anatomy contributed to operative difficulty. Tissue planes become anomalous by primary surgical modifications; structures may not be reliably located based on typical landmarks. Furthermore, concurrent hardware manipulation further increases time and complexity.[16] Once removed, new osteotomies on a scarred tissue bed with altered bony anatomy increase difficulty. Repeated fixation is difficult, as remaining bone stock may not be adequate and plates must be contoured to avoid past screw holes.[17] [**See Figure, Supplemental Digital Content 2,** which shows repeated fixation around screw holes after previous removal of hardware. Hardware may be difficult to remove and necessitate directly cutting through screws. *Arrows* indicate screw holes, which reduce bone stock and complicate replating, in the maxilla (*left* and *center*) and mandible (*right*). New plates must be repositioned to avoid screw holes and weakened bone, ***http://links.lww.com/PRS/D437***.] In a previous study by Raffaini et al., satisfactory aesthetic results were achieved with repeated orthognathic surgery in conjunction with facial lipofilling.[18] Despite potential complexities, this cohort experienced good outcomes with attention paid to the aforementioned intraoperative difficulties.

Limitations include its retrospective nature and sample size. Documentation at other institutions was not standardized; therefore, primary operative circumstances cannot be wholly appreciated. Future analysis of complete records of repeated orthognathic surgery patients will shed more light on this important area in patient care.

CONCLUSIONS

Repeated orthognathic surgery is challenging, and underreported in literature. In this study, patients underwent reoperation less for relapse, and most commonly needed to address new facial/jaw asymmetries. Challenges performing complete reoperation include the need for replanning, hardware presence/integration, repeated osteotomies and fixation, and more complex surgery. Despite these difficulties, outcomes and patient acceptance were good.

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PATIENT CONSENT

Patient provided written consent for the use of patient's images.

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