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In-Ru Lin

National Cheng Kung University

Meng-Yen Chen

National Cheng Kung University

Tung-Yiu Wong

National Cheng Kung University

Chen-Jung Chang

National Cheng Kung University

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Abstract

Condylar resorption can be challenging to orthodontist when encountered during treatment. The clinical characteristics and cephalometric findings of a patient who experienced postoperative skeletal relapse caused by progressive condylar resorption (CR) are presented in this case report. The predisposing factors and treatment protocols of condylar resorption are also discussed. A 17-year-old female patient came to our hospital with chief complaint of no contact of anterior teeth. Cephalometric analysis shows that she is a patient with skeletal Class II hyper-divergent pattern caused by mandibular retrognathism. Flattened left condylar head was found on panoramic film suggesting possible condylar erosion in the past. Before starting her treatment, the superimposition of serial cephalometric films was done, and no active resorption of condyles were found. After four months of pre-surgical orthodontic treatment, a two-jaw surgery was performed. However, an increase in overjet was noticed nine months after that. Cephalometric superimposition revealed a decrease in ramus height indicating a skeletal relapse due to CR. Inter-arch elastics was stopped to eliminate the loading on temporomandibular joint (TMJ), and vitamin D plus calcium supplementation was prescribed. Condyle remained stable throughout the rest of the treatment. Total treatment time is 36 months, and satisfactory facial profile and occlusion have been achieved. CR is attributable to young female, Class II hyperdivergent skeletal pattern, posteriorly inclined condylar neck, estrogen deficiency, and pre-existing TMJ disorder. Mandibular advancement over 10 mm, posteriorly displaced condyles, and counterclockwise rotation of the proximal and distal segment are high-risk surgical factors. Impact of CR can be minimized by making the correct diagnosis, optimal orthodontic or orthodontic-surgical planning, and periodic check up on condylar condition.

Keywords

Malocclusion; Orthognathic surgery; Temporomandibular joint; Vitamin D; Cephalometry

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CASE REPORT

Treatment of a Class II Hyperdivergent Case with Progressive Condylar Resorption

In-Ru Lin ^a, Meng-Yen Chen ^b, Tung-Yiu Wong ^b, Chen-Jung Chang ^{a,*}

^a Division of Orthodontics, Department of Stomatology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan

^b Division of Oral Maxillofacial Surgery, Department of Stomatology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan

ABSTRACT

Condylar resorption can be challenging to orthodontist when encountered during treatment. The clinical characteristics and cephalometric findings of a patient who experienced postoperative skeletal relapse caused by progressive condylar resorption (CR) are presented in this case report. The predisposing factors and treatment protocols of condylar resorption are also discussed. A 17-year-old female patient came to our hospital with chief complaint of no contact of anterior teeth. Cephalometric analysis shows that she is a patient with skeletal Class II hyper-divergent pattern caused by mandibular retrognathism. Flattened left condylar head was found on panoramic film suggesting possible condylar erosion in the past. Before starting her treatment, the superimposition of serial cephalometric films was done, and no active resorption of condyles were found. After four months of pre-surgical orthodontic treatment, a two-jaw surgery was performed. However, an increase in overjet was noticed nine months after that. Cephalometric superimposition revealed a decrease in ramus height indicating a skeletal relapse due to CR. Inter-arch elastics was stopped to eliminate the loading on temporomandibular joint (TMJ), and vitamin D plus calcium supplementation was prescribed. Condyle remained stable throughout the rest of the treatment. Total treatment time is 36 months, and satisfactory facial profile and occlusion have been achieved. CR is attributable to young female, Class II hyperdivergent skeletal pattern, posteriorly inclined condylar neck, estrogen deficiency, and pre-existing TMJ disorder. Mandibular advancement over 10 mm, posteriorly displaced condyles, and counterclockwise rotation of the proximal and distal segment are high-risk surgical factors. Impact of CR can be minimized by making the correct diagnosis, optimal orthodontic or orthodontic-surgical planning, and periodic check up on condylar condition. *Taiwanese Journal of Orthodontics* 2021;33(4):188–197

Keywords: Malocclusion; Orthognathic surgery; Temporomandibular joint; Vitamin D; Cephalometry

INTRODUCTION

Condylar resorption (CR) after orthognathic surgery causing post-operative relapse can be frustrating to surgeons and orthodontists. It not only affects patients' esthetics and function, but is also related to long term stability. CR is a term used to describe the irreversible loss of condylar volume and mass. When the etiology of the resorption is unknown, it is called primary CR or idiopathic CR. Secondary CR may happen due to known causes that can be specified into

intrinsic or extrinsic factors. Intrinsic factors include rheumatic immune disease, hormone imbalance, and steroid use. Extrinsic factors such as orthodontic treatment, orthognathic surgery or even trauma, may produce forces that can trigger progressive resorption of the condyle.^{1–3}

Studies indicate that orthognathic surgery changes the load distribution on condyles or the position of condyles. These changes can trigger condylar remodeling or even condylar resorption once the force exceeds natural capacity of the condyles.^{1,4} Incidence of CR after orthognathic surgery ranges from 2% to 5%, and is found to be

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* Corresponding author at: Division of Orthodontics, Department of Stomatology, National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, 138 Sheng-Li Road, Tainan 704, Taiwan.
E-mail address: zoechang0405@gmail.com (C.-J. Chang).

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up to 19%–31% in skeletal Class II combined with high mandibular plane angle patients.^{1,5} Thus, for those with predisposing factors of CR in need of surgical correction, it is important to give proper surgical and orthodontic treatment plans. Several studies show that CR may occur 6 months after surgery, or even up to 2 years postoperatively.^{4,6} Clinical findings of CR include progressive open bite, mandibular retrusion, increase of overjet, increase of mandibular plane angle, and decrease of mandibular ramus height.⁴ Conservative treatments or surgical interventions can be carried out depending on the severity of the CR.⁷ In this case report, treatment of a Class II malocclusion with mandibular retrognathism and hyperdivergent facial pattern afflicted by postoperative CR is presented.

CASE REPORT

Clinical examination and diagnosis

A 17-year-old female came to our hospital with her parents with chief complaints of upper jaw protrusion and no contact in anterior teeth. She has no systemic diseases and no family history of retrusive mandible or open bite. In extra-oral examination, longer middle and lower facial height, lip incompetence, and 5 mm of gum display during smiling were noted. Convex profile and recessive chin were shown in lateral view with upper and lower lips protrusive to E-line (Figure 1). Intraoral examination revealed large overjet of 8 mm with bilateral Class II canine and Class II molar relationship. Arch forms were both tapered V shape without crowding (Figure 2). From functional examination, neither CO-CR discrepancy nor

symptom of temporomandibular disorder (TMD) was found. Symptoms regarding sleep apnea or snoring at night was denied as well. Cephalometric analysis (Table 1 and Figure 3) revealed large ANB angle and high mandibular plane with SN-MP up to 51° . Also, narrow airway measuring 5 mm at lower oropharynx was shown. The narrowest part of the airway was measured 4 mm at middle oropharyngeal area. From posteroanterior (PA) cephalometric film, no facial asymmetry was noted (Figure 4). Slightly flattened left condylar head was seen on panoramic film (Figure 5). However, from the pre-operative reconstructed computed tomography (CT) images, the condylar head was flattened on both sides. The configuration of right and left condyle was different can be seen as well (Figure 6A). Though ascending ramus height is measured slightly shorter on left side (Figure 6A), chin was not deviated to the left side (Figure 6B). This might be caused by the different morphology of right and left glenoid fossa (Figure 6C and D). Based on the clinical and radiographic findings, it is concluded that she is a skeletal Class II malocclusion patient with mandibular retrognathism and hyperdivergent facial pattern. It is suspected to be caused by idiopathic condylar resorption that might have happened before her visit to our department.

Treatment plan and progress

The treatment plan was first to follow up on her condylar status and occlusal condition to make sure that there was no progressive change of the condyles for at least six months before treatment. Second, to combine the orthodontic treatment and orthognathic surgery to achieve good occlusion and facial profile. From the superimposition of serial



Figure 1. Initial extraoral photographs: frontal view, smile view and lateral view.



Figure 2. Initial intraoral photographs: frontal view, lateral view, upper and lower occlusal view.

cephalometric films, no condylar resorption nor occlusal change has happened six months after her first visit (Figure 7). Thus, we started her treatment.

In order to eliminate interferences that may inhibit mandibular advancement, the patient underwent pre-surgical orthodontic treatment for four months. Full mouth banding and bonding were performed with .018 × .025-inch standard edgewise

brackets. Starting from 0.016 nickel titanium wire to .016 × .022-inch stainless steel wire, initial alignment, leveling and upper arch expansion was done. With the help of 3D surgical planning system, bimaxillary surgery was planned (Figure 8). For the maxilla, Le Fort I osteotomy with 4 mm superior impaction was designed to correct her gummy smile. After autorotation of the mandible, bilateral

Table 1. Cephalometric analysis.

	Initial	Finish	Norm
Skeletal factor			
SNA	80.5°	80.5°	84.0 ± 3.7
SNB	69.5°	73.5°	81.5 ± 3.7
ANB	11.0°	7.0°	2.5 ± 2.2
NAPg	25.5°	12.5°	4.5 ± 5.0
SN-FH	7.5°	7.5°	7.0 ± 2.6
SN-MP	51.0°	43.0°	29.1 ± 5.0
A-Nv	-2.5 mm	-2.0 mm	-1.0 ± 3.5
Pg-Nv	-31.0 mm	-16.0 mm	-2.3 ± 6.7
UFH/LFH	40.7%/59.3%	40.0%/60%	45%/55%
Dental factor			
U1-SN	95.5°	87°	109.9 ± 8.0
U1-L1	120.5°	129.0°	121.9 ± 10.5
U1-NP	21.5 mm	9.5 mm	6.4 ± 2.7 mm
L1-OP	61.0°	61°	61.8 ± 5.4
L1-MP	93.0°	100.5°	99.2 ± 6.8
Soft tissue analysis			
FCA	26°	16°	9.4 ± 3.5
UL-N'Pg'	4 mm	0 mm	0.67 ± 1.8 mm
LL-N'Pg'	5 mm	1 mm	0.93 ± 2.16 mm



Figure 3. Initial lateral cephalometric film.

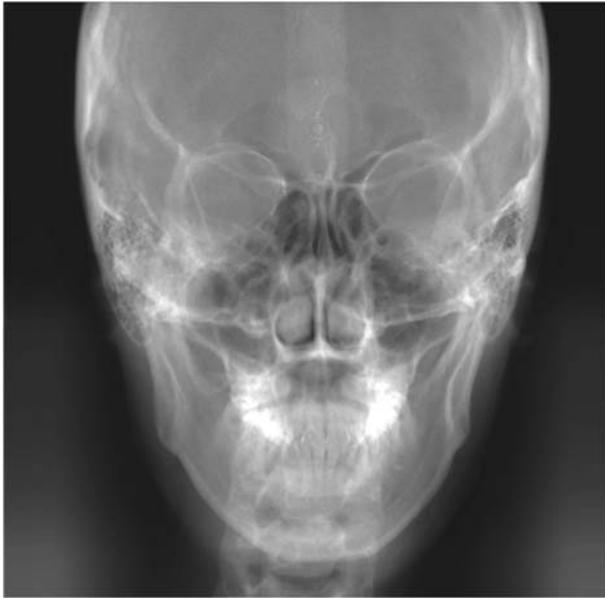


Figure 4. Initial PA cephalometric film.

sagittal ramus split osteotomy for the mandible with point B 7.5 mm advancement (plus 2.5 mm autorotation of the mandible in point B, total 10 mm forward movement of point B) was planned. Furthermore, 6 mm advancement genioplasty was added for better esthetics. The upper and lower incisors were set in edge to edge to compensate for possible post-operative relapse. Also, we limited the downward movement of the gonion to prevent elongation of pterygoid-masseteric sling for better post-operative stability.

However, we started to notice an increase in overjet after surgery. Cone beam computed tomography (CBCT) image was suggested for further diagnosis, but the patient refused due to radiation concern. Therefore, only lateral cephalometric films and panoramic films were taken. Compared with the immediate postoperative panoramic film



Figure 5. Initial panoramic film. Slightly flattened left condylar head was noted.

(Figure 9A), the panoramic film of postoperative 11 months (Figure 9B) showed slightly smaller and blurred condylar head on both sides. From the superimposition of post-operative 1 month and post-operative 10 months, rotational change of mandible, including increased ramus inclination and decreased PFH to AFH ratio was noted (Figure 10). Regional superimposition showed 4 mm change in Ar-Gn with no change in Go-Pg indicating condylar resorption (Figure 11). Therefore, we stopped elastics wearing to decrease TMJ loading, prescribed Vitamin D with calcium supplementation, and carefully monitored the overjet, signs and symptoms of TMJ for another six months. Tipping the upper incisors inward and flaring the lower incisors were done to compensate for the increased overjet caused by post-operative condylar resorption (Figure 12). The controlled tipping resulted in the extrusion of upper incisors. This is the reason why only slight intrusion of upper incisors was shown on the overall superimposition of initial and finishing lateral cephalometric films (Figure 13). From the comparison of the lateral cephalometric film of post-treatment and postoperative 10 months when we started to notice CR, we can see no further resorption of the mandible (Figure 12). The elimination of orthodontic elastic force, and vitamin D and calcium supplementation might have helped in ending condylar resorption. From cephalometric data of pre- and post-treatment (Table 1 and Figure 13). ANB angle has been decreased by 4° and mandibular plane has been decreased by 8°. Distance between pogonion to N-perpendicular line has improved from -31 mm to -16 mm, resulting in great improvement in facial contour angle which decreased from 26° to 16°. Upper and lower lips were both within E-line. Good root parallelism can be seen on finishing panoramic film (Figure 14). Moreover, the airway was measured 5 mm at lower oropharyngeal area and 4 mm at middle oropharyngeal area initially. After orthodontic treatment combined orthognathic surgery, the airway was measured 7 mm at lower oropharyngeal area with a total increase of 2 mm and was measured 6 mm with a total increase of 2 mm at the middle oropharyngeal area (Figure 15). The total treatment time was 2 years and 11 months. Satisfactory results were achieved regarding occlusion and facial esthetics (Figures 16 and 17).

DISCUSSION

Skeletal relapse after orthognathic surgery results from different mechanisms and may continue over a long period of time. According to a study by

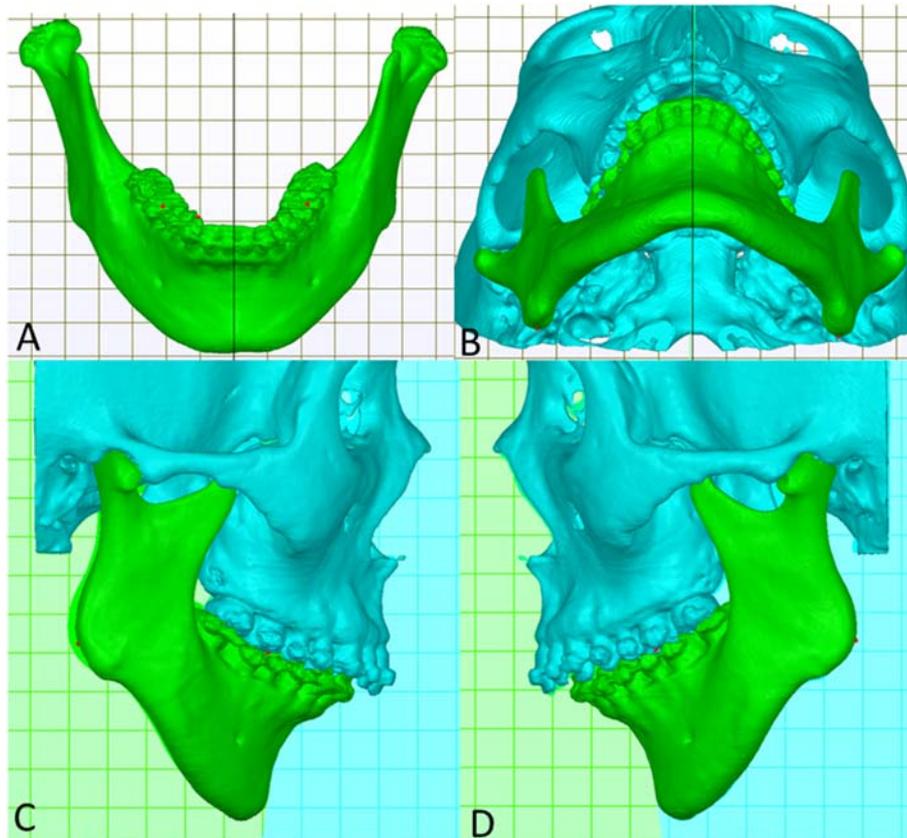


Figure 6. The 3D reconstructed CT images: A, the mandible in frontal view; B, the 3D CT skull in submental view, no chin deviation was showed; C & D, the 3D CT skull in the sagittal view. The different morphology of condyle and glenoid fossa in the right and left sides was showed.

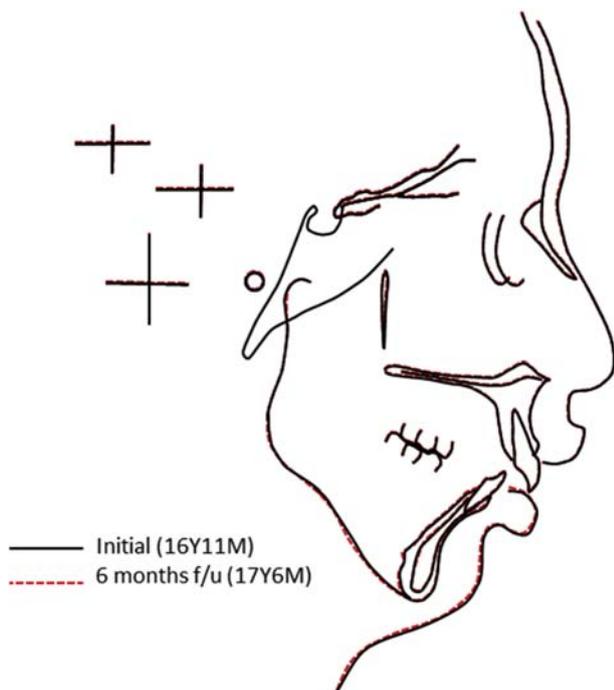


Figure 7. Superimposition of lateral cephalometric films (first visit and 6 month follow-up).

Eggensperger et al., skeletal relapse of the mandible after orthognathic surgery may be related to condylar displacement with rotation of the proximal segment, osteotomy slippage or condylar resorption. These three factors can be differentiated by measurement of changes in length or angle of the mandible body or ramus.⁸ First, the osteotomy slippage is shown with Go-Pg shortening. Second, the mesial displacement of condylar head during orthognathic surgery will only show rotational change in gonion angle but no change in ramus length. Third, condylar remodeling or resorption will lead to changes in ramus length shortening as shown in Ar-Gn shortening. With the aid of regional cephalometric superimpositions, mandibular body length shortening by 4 mm measuring from Ar-Gn was noted in our patient. However, Go-Gn remained the same, it meant that the length shortening was caused by mandibular ramus height shortening (Figure 11). Thus, we confirmed that the patient was suffering from CR after surgery.

There are several factors that can contribute to post-operative condylar resorption. In terms of non-surgical risk factors, females between 15 and 35

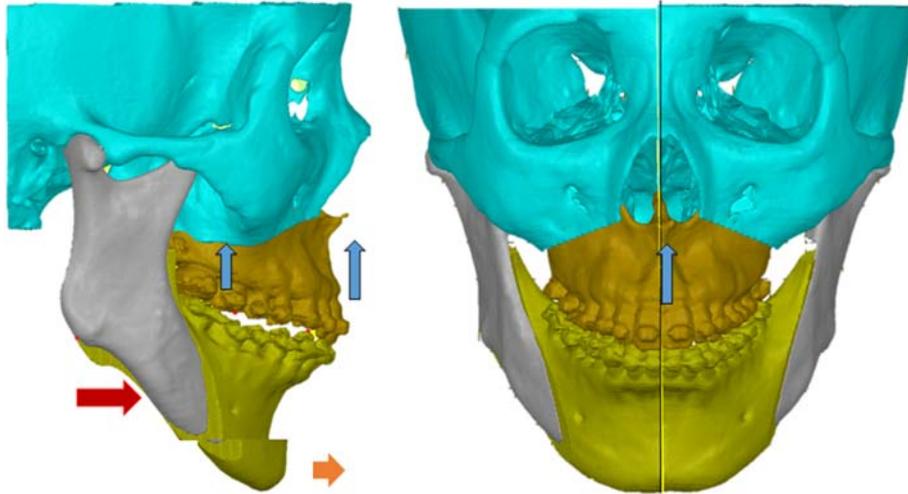


Figure 8. Three-dimensional virtual surgical plan. Maxilla: Le Fort I osteotomy with 4 mm superior impaction. Mandible: autorotation (point B 2.5 mm advancement), BSSO advancement (point B 7.5 mm forward movement), and genioplasty with 6 mm advancement and 3 mm reduction in vertical dimension.

years old,¹ skeletal Class II caused by mandibular retrognathism, high mandibular plane exceeding 40°,^{9,10} posteriorly inclined condylar neck,¹¹ estrogen deficiency,¹² pre-existing temporomandibular

joint disorder (TMD)¹³ and systemic disorders (autoimmune diseases) are shown in studies. Thus, it is important to identify high risk patients in initial diagnosis. In addition, for those who have

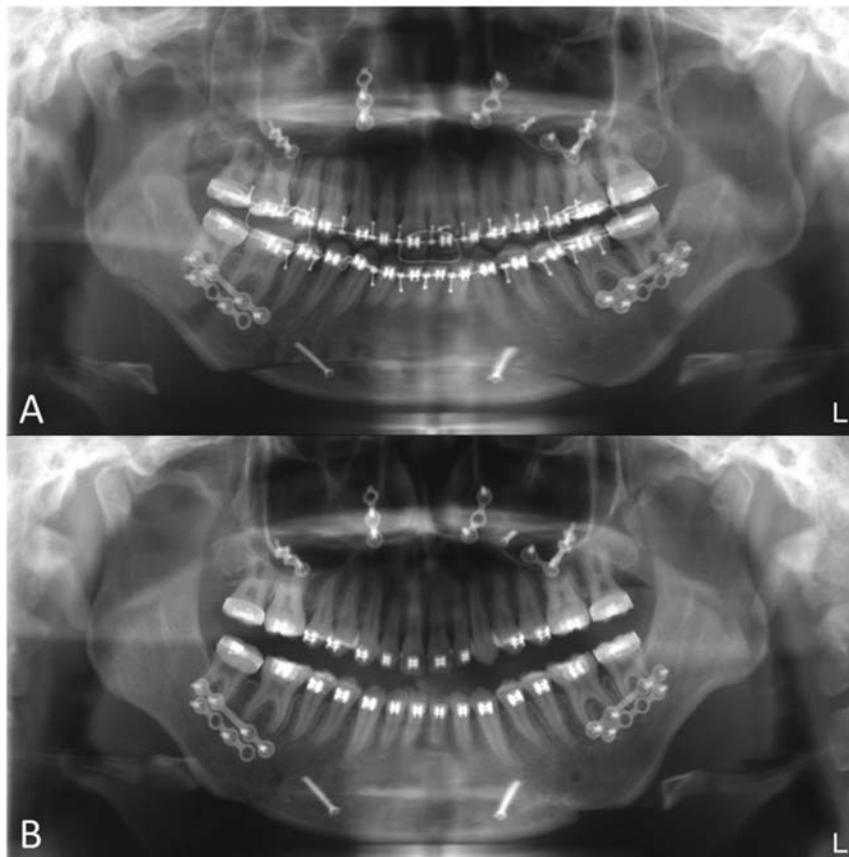


Figure 9. The post-operative panoramic films. A, post-operative 3 days; B, post-operative 10 months.

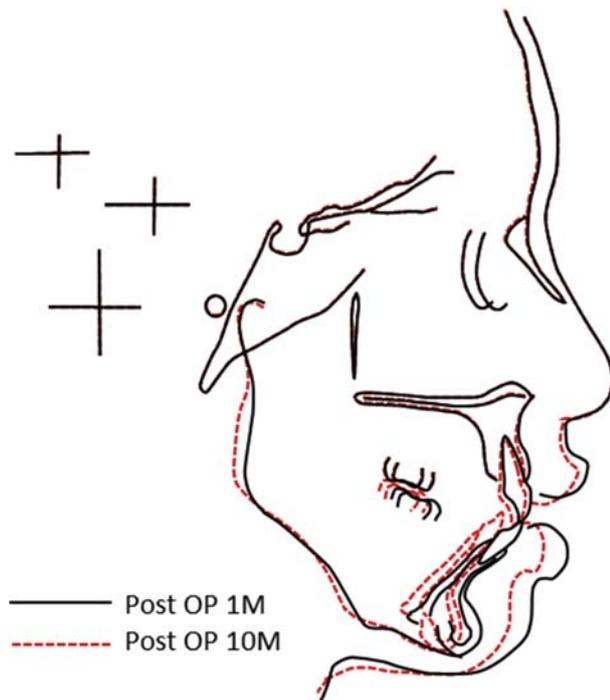


Figure 10. Overall superimposition of lateral cephalometric films (post-op 1 month and post-op 10 months).

underwent idiopathic CR, stable occlusion for at least 6 months or longer clinically and radiographically is required before any treatment was to be started.^{2,9,14}

Surgical risk factors have been discussed in numerous studies. CR can happen in all kinds of patients treated with orthognathic surgery. However, it is more likely to occur in the patients treated with bimaxillary surgery than those with Le Fort I osteotomy alone.^{2,15} Mandibular advancement over

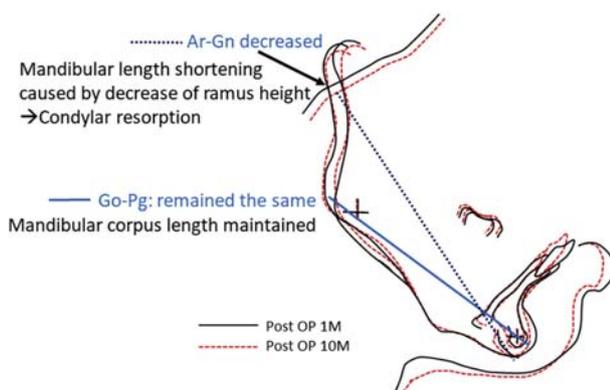


Figure 11. Regional superimposition of mandible (post-op 1 months and post-op 10 months). The mandibular body length shortening by 4 mm measuring from Ar-Gn were noted. However, the Go-Pg remained the same, meaning that the length shortening was caused by mandibular ramus height shortening.

10 mm tends to show higher risks.¹⁶ Posteriorly displaced condyles and counterclockwise rotation of the proximal and distal segments are also high-risk surgical procedures.^{6,17} However, it was concluded in a meta-analysis that counterclockwise rotation of the maxillomandibular complex could be a stable procedure for patients with healthy TMJs, and patients undergoing concomitant TMJ disc repositioning with Mitek anchors. This coincided with that pre-existing TMD can be a patient risk factor of CR after orthognathic surgery as previously mentioned.¹⁸ As for fixation, previous studies indicated that higher risk may be noted in intermaxillary fixation (IMF) cases.^{6,19} Studies have also shown that bi-cortical screws may cause torque on condyle during fixation. Therefore, the use of mono-cortical screws with titanium bone plates was advised.^{1,7}

Within the scope of our search, there is no standardized treatment protocol for treating post-operative CR. However, some guidelines are mentioned in literatures. The main treatment goals are (1) control the etiologic factors, (2) stabilization of the unstable occlusion and TMJ, and (3) correction of the resultant occlusal deformity.²⁰ The treatment methods for post-operative CR are different depending on the severity and progression of the resorption. Conservative treatments include occlusal splint, medication consisting of antioxidant diet, anti-inflammatory medication and vitamin D

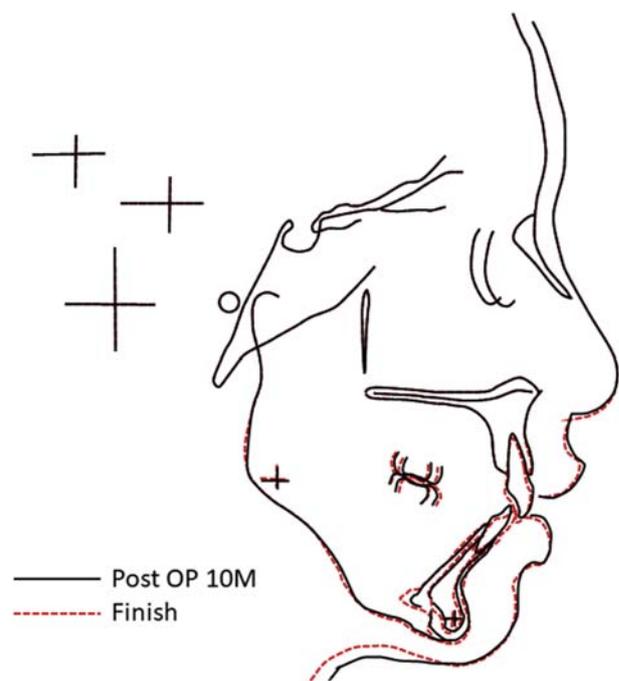


Figure 12. Overall superimposition of lateral cephalometric films (finish and post-op 10 months when we started to notice condylar resorption).

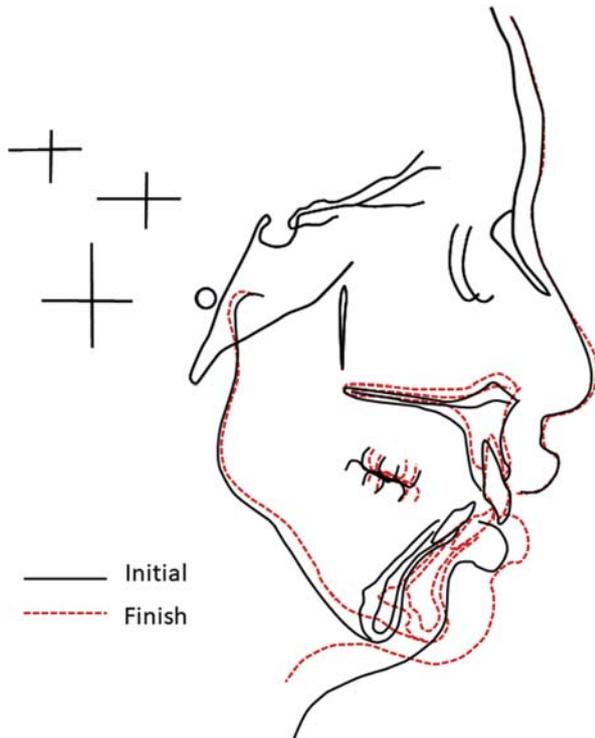


Figure 13. Overall superimposition of lateral cephalometric films (initial and finish).

with calcium supplementation and physiotherapy. Antioxidant diet is suggested to reduce free radicals that may exacerbate the bone erosions. Anti-inflammatory medications are used to block cytokines that are used in cellular pathways of bone resorption. Vitamin D and calcium are known not only for its role in increasing bone density, but also in controlling inflammation in arthritis.^{7,21} Post-operatively, close monitor and long term follow up is needed.⁹ However, re-operation or condyle



Figure 15. Finish lateral cephalometric film.

reconstruction of already worn condyles can be considered when facing severe resorption cases.^{1,22}

In our case, the patient had all the risk factors mentioned above, 15 to 35-year-old female, skeletal Class II hyperdivergent caused by mandibular retrognathism, high mandibular plane angle at 51° , posteriorly inclined condylar neck as seen on panoramic film, and possible idiopathic condylar resorption in the past. Thus, a certain amount of remodeling or even condylar resorption were expected after surgery. Therefore, we tried to limit the amount of advancement within 10 mm and placed the final occlusion in edge-to-edge position. In order to correct her gummy smile and lip incompetence, bimaxillary surgery with counter-clockwise rotation of the maxilla–mandible complex were inevitable.²³ Hence, the downward



Figure 14. Finish panoramic film.



Figure 16. Finish extra-oral photographs: frontal view, smile view and lateral view.

movement of the gonion were limited to prevent elongation of pterygoid-masseteric sling for a better stability. We also maximized the amount of advancement genioplasty for better esthetic results. However, CR did happen after surgery. Though CR was noted, the patient did not suffer from any symptoms regarding the TMJ or masticatory muscles. With the lack of muscle and joint tenderness, occlusal splint and physiotherapy weren't considered. Conservative treatments including antioxidant diet, anti-inflammatory medication and vitamin D with calcium

supplementation were suggested. However, patient did not want to take any medicine except vitamin. We tried prescribing vitamin D with calcium supplementation and elimination of elastic use. No further resorption was demonstrated since the managements were applied. Owing to the edge-to-edge occlusion we planned beforehand, we were able to finish the case with good overjet by tipping the upper incisors inward and flaring the lower incisors to compensate for the skeletal changes from CR. However, if the CR got worse, upper arch distalization with the aid of temporary



Figure 17. Finish intraoral photographs: frontal view, lateral view, upper and lower occlusal view.

anchorage devices might be required to finish and maintain the postoperative occlusion.

CONCLUSION

To prevent the postoperative CR, it is important to identify high risk patients. Progressive CR can be associated with young female, Class II division I malocclusion with hyperdivergent facial pattern. For patients who might had undergone condylar resorption before treatment, it is crucial to follow up on condylar status for at least six months, and to make proper surgical plan to avoid putting the condyles in risk. For patient suffering CR after orthognathic surgery, conservative treatment or surgical interventions can be carry out depending on the severity of the CR.

ETHICAL APPROVAL

None.

PATIENT CONSENT

Provided.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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