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Camouflage Orthodontic Treatment on Skeletal Class II Malocclusion with Idiopathic Condylar Resorption

Hsin-Yi Lo  
*Division of Orthodontics, Department of Dentistry, Veterans General Hospital, Taichung*  
syluo@vghtc.gov.tw

Liang-Ru Chen  
*Division of Orthodontics, Department of Dentistry, Veterans General Hospital, Taichung*

Kwong-Wa Li  
*Division of Orthodontics, Department of Dentistry, Veterans General Hospital, Taichung*

Ming-Lun Hong  
*Division of Orthodontics, Department of Dentistry, Veterans General Hospital, Taichung*

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INTRODUCTION

Idiopathic condylar resorption (ICR), or condylysis, can be defined as acquired localized noninflammatory aggressive degenerative disorder of temporomandibular joints (TMJs) with progressive alteration in shape and reduction in mass of condylar head. It is characterized by lysis and repair of articular fibrocartilage and underlying subchondral bone. The etiology is not completely understood, but it is considered as multifactorial with both genetic and environmental factors involved. The basic concept is that the destruction of the TMJ structures occur when adaptive capacity is exceeded by the functional demands. Chemical and mechano-transduction can play a role in either reducing or exceeding the adaptive capacity threshold. The resorption of condylar head results in a progressive worsening of occlusion and esthetics with or without TMJ symptoms and associated pain. When it takes place during childhood or adolescent, it may affect the condylar growth; therefore, these teenagers are at risk of unfavorable long-term outcomes from the associated joint damage. Therefore, most of them with bilateral ICR manifest a dolichofacial growth pattern with severe mandibular retrognathism, high mandibular plane angle, and progressive condylar resorption (PCR), is a poorly understood progressive disease that affects the temporomandibular joint (TMJ) with multifactorial factors leading to severe mandibular retrognathism and anterior open bite. It is difficult to distinguish the exact causes for each individual. Different diagnostic methods and different treatment options can be chosen for different phases. In this report, we present a camouflage treatment with temporary anchorage devices (TADs) for a skeletal Class II open bite with ICR. The goal of improving facial profile and reconstructing of occlusion was achieved. Comprehensive review of ICR was presented in this case report. (Taiwanese Journal of Orthodontics. 32(1): 25-40, 2019, 2020)

Keywords: idiopathic condylar resorption (ICR); progressive condylar resorption; Class II anterior open bite; temporary anchorage devices (TADs).
class II basal bone relationship and anterior open bite.\textsuperscript{1,2} Sometimes, resorption of single condylar head developed a facial asymmetry. There is a tendency for a reduction in airway dimensions secondary to small mandibular growth, and posteroinferiorly repositioning of the mandibular symphysis.\textsuperscript{3}

**Etiology**

The ICR occurrence at the age range from 10 to 35 years, with a strong predominance for teenage girls during pubertal growth spur. Generally ICR results in bilateral and symmetric condylar resorption. The ratio of the disease occurring in girls to boys is 9:1.\textsuperscript{1-3,6,7,11}

The TMJ is a load-bearing joint which is capable of adapting to stress concentrations to maintain morphological, functional and occlusal balance. The basic concept is that if the biomechanical stress is overloaded or when the adaptive capacity of TMJ has been reduced, the dysfunctional remodeling like lysis of hard and soft tissue of condylar head will occur.\textsuperscript{1,2,11}

Although the exact causes are unknown, a number of possibilities have been proposed, such as age, gender, hormonal changes, systemic factors and increased mechanical loading from parafunctional habits, trauma, internal joint derangement, orthodontics, orthognathic surgery and occlusal therapy in the literature review.\textsuperscript{1,2,11} Garza et al. indicated that four main categories of etiological factors that trigger the ICR: (1) teenage to young adult female on average 20 years; (2) systemic factors, especially autoimmune diseases that can influence the metabolism of fibrocartilage and affect the adaptive capacity of the temporomandibular joint; (3) hormonal factors such as estrogen, prolactin and corticosteroids that can directly influence condylar resorption; (4) TMJ dysfunction occur after orthognathic surgery.\textsuperscript{11} It was reported as sporadically with pain, functional limitations, condylar resorption; Therefore, skeletal recurrence and surgical relapse occurs.\textsuperscript{3,12} An incidence of 1 to 31% has been reported by non-surgical and surgical factors.\textsuperscript{13}

The strong predilection of ICR for teenage girls supports a theory of hormonal mediation.\textsuperscript{2,14-16} The estrogen receptors have been identified in the TMJs of female primates.\textsuperscript{16} The metabolism of cartilage and bone of TMJ can be modulated by estrogen. It has also been reported that women with reduced serum levels of 17\(\beta\)-estradiol develop condylar resorption.\textsuperscript{15} Increased estrogen receptors may result in exaggerated response to the joint loading from parafunctional activities, trauma, orthodontics or orthognathic surgery. Serum 17\(\beta\)-estradiol has an osteoprotective effect due to enhancing osteoprotin (OPG) expression and decreasing osteoclast activity. Therefore, reduced estrogen may predispose to a bone degenerative process.\textsuperscript{15,16}

The progression of this disease is as followings: sex hormone mediates biochemical changes within the TMJ, leading to synovial tissue hyperplasia; this stimulates the production of destructive substrates, initiating the breakdown of ligamentous structures that normally support and stabilize the position of the articular disc.\textsuperscript{7} Structural breakdown allows the disc to move forward. The proliferative synovial tissue is then located around the head of condyle, further exposing the condylar head to the substrates and producing a resorptive phenomenon.

Many case reports provide significant evidence of condylar head resorption in skeletal class II patients after receiving orthognathic surgery. Crawford et al. reviewed seven patients with skeletal class II open bite.\textsuperscript{5} These patients had a history of condylar head resorption before orthognathic surgery with forward jaw movement. Five of these patients’ condyle head began to be resorbed postoperatively. Merkx et al.\textsuperscript{17} reported that 8 patients with skeletal class II pattern improved their profile after receiving bilateral sagittal split osteotomies.\textsuperscript{17} However, four of these patients had condylar head resorption after surgery. Arnett et al. also mentioned that patients with a history of condylar head resorption, may have an 80% recurrence rate after orthognathic surgery treatment.\textsuperscript{3,4}
Condylar resorption is one of the factors that related to the recurrence after orthognathic surgery. Preexisting clinically detectable TMJ sounds were recently implicated not to be a risk factor for post-operative TMJ resorption.\textsuperscript{1,6} The orthodontist must keep in mind that this condition can occur in patients during or after orthodontic treatment.\textsuperscript{11}

**Diagnosis**

Diagnosis of ICR is mainly from patient history, clinical examination and radiographic imaging. Clinical manifestations are progressive worsening of their occlusion and aesthetics, with or without TMJ symptoms and associated pain. Although TMJ symptoms can be present, oftentimes they are mild or nonexistent. In fact, 25\% of the patients had no TMJ symptoms. Generally, condylar heads usually resorbed during adolescence bilaterally.\textsuperscript{13} Bilateral ICR manifest a dolicho facial growth pattern with severe mandibular retrognathism, high mandibular plane angle, Class II molar relationship and anterior open bite. Unilateral disturbance of mandibular growth that usually caused by trauma may manifest pronounced facial asymmetry.\textsuperscript{18} Laboratory data could be a reference, especially when other joints are involved. It mainly detects the connective tissue or autoimmune diseases which cause condylar resorption. There are no laboratory tests specifically for ICR.

Five types of imaging findings can complement the clinical evaluation in diagnosis and determining the stability of ICR:

1. Panoramic radiographs are one of the most convenient imaging for screening and monitoring ICR. They can only reveal gross changes on the anterior-superior and posterior surfaces of the condyle.\textsuperscript{1,2} The medial and lateral resorption of TMJ could not be clearly detected. Image distortion and obscuring from overlapping structures prevents precise measurements of the condylar loss between serial images.

2. The lateral cephalometric radiographic films indicated skeletal class II deformity, anterior open bite, high occlusal plane angle, high mandibular plane angle, decreased vertical height of the ramus, proclination of the lower incisors and significant narrowing of the oropharyngeal airway in severe cases. It also revealed the dimension of airway to screen for the possible airway obstruction. Serial lateral cephalometric radiographs demonstrate slow but progressive retrusion of the mandible during the active resorption phase of ICR.

3. \textsuperscript{99m}Technetium methylene diphosphonate (\textsuperscript{99m}TC MDP) is a radionucleotide that is administered by injection. The aim is to detect whether the ICR is active around TMJ. The orthodontic, and/or orthognathic procedures should be deferred while if ICR is active. However, a major disadvantage with \textsuperscript{99m}TC MDP is the amount of radiation uptake, which is approximately 4–6 mSv. Bone scans are efficient to assess some medical conditions, but the specificity is not sufficient to determine the ICR stability. The bone scans may not be significantly beneficial to the diagnosis of ICR.\textsuperscript{1,11,13,18}

4. Cone beam computed tomography (CBCTs) can also a tool to determine active or inactive phase of ICR through serial imaging by evaluating the cortical bone integrity.\textsuperscript{1,6,11,18} ICR could manifest the changes of condylar volume in CBCT. It is considered as one of the most accurate imaging by evaluate the cortical bone integrity for diagnosing condylar head resorption.

5. MRI is mainly useful for soft tissue, and insufficient for osseous degenerative changes. Thus, it is difficult to diagnose TMJ problems by MRI at the initial stage of the disease.

Two main imaging strategies are suggested in clinical cases of ICR to determine stability. The first option uses nuclear medicine and provides immediate results. The second option reevaluates and compares anatomy after specific periods with CBCT.\textsuperscript{2}

**Differential diagnosis**

ICR can only be diagnosed when all pathologies of the TMJ have been ruled out,\textsuperscript{1,13} such as trauma,
rheumatoid arthritis and juvenile idiopathic arthritis. The clinical findings of ICR are similar with osteoarthritis, inflammatory arthritis, physiologic resorption/remodeling and congenital disorders affecting the mandible; image analysis, physical examination and history-taking are required for confirmation.

TMJ arthritic conditions can be classified as slow-inflammatory and high-inflammatory types. The high-inflammatory disease such as rheumatoid arthritis, scleroderma, systemic lupus erythematosus, Sjögren’s syndrome, ankylosing spondylitis and dermatomyositis manifest resorption of condylar heads and all other joints. The ICR is a localized noninflammatory degenerative disorder of TMJs. To distinguish juvenile idiopathic arthritis (JIA) and degenerative joint disease (DJD) with ICR is somewhat difficult.

JIA is the most common childhood rheumatic disease at age around 0-15 years. It is an autoimmune musculoskeletal inflammatory disease of childhood. All joints can be affected by JIA including TMJ and other large joints, such as spine, knees, wrists and ankles. Characteristic manifestation of JIA include fever, rash, chronic anterior uveitis, chronic synovitis, swelling of the joint, arthralgia and impaired joint mobility. JIA is bilateral and symmetrical involved in the TMJ and characterized by condyles resorption with a broad flat articular surface and a wide glenoid fossa.

DJD is a localized noninflammatory degenerative disease of synovial joints and also manifested by the resorption and repair of articular fibrocartilage and underlying subchondral bone. The clinical manifestation is resembled to ICR, the age of occurrence is much later and the extent of TMJ degeneration is slightly milder. The radiographic findings of DJD is more likely to see osteophytes and subchondral bone cysts.

**Progress of ICR**

ICR can be classified into three phases based on its progression: destructive/active, reparative and remission. At the destructive/active phase, the breakdown of cortical bone of anterosuperior surface of condyle and then a cavitation defect extends into subchondral bone were noted. When the trabecular bone is exposed and vulnerable to excessive loads or functional demands, the irregularity of superior surface and reduction in mass were followed due to stress concentration over its adaptive capacity. As a result, ICR manifests significant loss of condylar volume. Clinical symptoms and signs of ICR may be associated with limited condylar motion and pain, but sometimes osteoarthritis is frequently asymptomatic. In the reparative phase, condylar flattening, congruent articulation with opposing surface and recortication were followed. In the remission phase, condylar resorptions stop, the degeneration of condyle with reduction in size was noted, and also the facial appearance and occlusion become worse.

**Treatment options of ICR**

Treatment options for ICR is decided by the phase of the disease. During active ICR, the treatment goal is to cease the progression disease and relieve the symptom of ICR. The managements include physiotherapy and oral appliance to reduce potential joint overload and provide relief of muscle pain. At the remission phase, it is time to rehabilitate the esthetics and occlusion. Nonsurgical orthodontic camouflage treatment, orthognathic surgery and TMJ surgery are mainly utilized for the correction of facial appearance of severe retruded mandible and open bite. Although, inflammation subsides in the remission phase, the excessive joint overloading will lead to resume the life cycle of ICR. Other treatment options range from no treatment to condylar replacement and osteotomy, but there are no sufficient data in the literature to make evidence based recommendations for the treatment. Treatments performed during destructive/active phase:

The methods to arrest ICR so far consisted of medications, physical therapy, occlusal splints, hyaluronic acid, corticosteroids, arthrocentesis, removable of
hyperplastic synovium, condylectomy, autologous costochondral graft or total alloplastic TMJ prosthesis. Nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxants and short-term oral corticosteroids and thermal physical therapy can be solely used for symptom relief. Occlusal splints are usually applied when pain and dysfunction in the joint is observed.

The hyaluronic acid (HA) was used to increase intra-articular lubricity and regenerate synovial fluid and has been shown to provide better improvement in body joints. Bertolami et al. indicated that HA did not seem to have better effect on localized TMJ osteoarthritis. Currently, HA has not been approved as a safe and effective medication for the management of arthritis of the TMJ by the US Food and Drug Administration. Intra-articular injections of corticosteroids is also an effective palliative method in the localized arthritis. Due to the risks for infection and the destruction of articular cartilage, and ligament attachments, it should be considered only for acute inflammation of the joint and limited use for no more than two injections within 6 months. Arthrocentesis was reported to decrease the subjective pain and dysfunction scores and increased objective mandibular range of motion significantly in osteoarthritic joints. But there are no studies about arthrocentesis in ICR.

It is prudent to delay definitive orthodontic and orthognathic treatment during the active/destructive phase of ICR. The aim of treatment in remission phase is to deal with the changes of patients’ appearance after condylar resorption. Orthodontic therapy, bilateral sagittal-split osteotomy or alloplastic reconstruction were suggested for occlusion and facial esthetics.

Orthodontic treatment with TADs may be used to solve the problems associated with anterior open, Class II occlusion and increased vertical dimension problem. It is usually assisted with bone plates or screws to intrude the posterior segments, causing counterclockwise rotation of the mandible to improve hyperdivergent facial profile. Compared to orthognathic sugery, orthodontic treatment with skeletal anchorage is an effective and inexpensive treatment modality.

Surgical treatment is the last treatment option. There are two types of treatment: (1) orthodontics treatment combine with orthognathic surgery; and (2) TMJ replacement. The condylar head resorption is the main reason for surgical relapse. Crawford et al. mentioned that if the patients could receive orthodontics treatment prior to orthognathic surgery, a more stable occlusion can be obtained after operation, it might reduce the probability of relapse. The movement of proximal segment should be minimized during mandibular forward surgery. If the maxilla surgery is performed only, the condyle resorption after surgery may be reduced. Woford et al. described one new treatment protocol of 14 cases that underwent open joint surgery with BSSO and maxillary osteotomies, in which the discs were stabilized by attachment to implants. There were no relapse after an average follow up of 16-68 months. TMJ can be totally replaced with autogenous or alloplastic graft. The prognosis is fairly good if the condyles were in the remission phase without tissue inflammation. On the contrary, it has more chance of condylar resorption in patients with high-inflammatory arthritis.

Until recently, predictable and stable treatment modalities for ICR in TMJ were still lacking.

**CASE REPORT**

A twenty-three-year-old female had chief complaints of lip incompetency and difficulty biting in her front teeth. She had lip incompetency approximately 6 mm with a negative overbite of 1.5 mm (Figure 1A). The midline of the upper and lower teeth was coincident with the midline of the face. There was symmetrical facial form without occlusal plane canting. She had a long face with anterior gummy exposure of 4 mm (Figure 1B). She had small chin as noted from lateral view (Figure 1C and 1D). In addition, the patient's facial profile was convex with protrusive upper and lower lips. There was an increased
overjet of 4.5 mm and slight open bite of 1.5 mm (Figure 2A, B, C). Maxilla and mandibular dentition were moderately crowded with an average curve of Spee (Figure 2D and 2E).

**X-ray finding**

Cephalometric analysis revealed that the patient had skeletal Class II relationship with ANB 6 degrees (Table 1). She had obvious mandibular retrusion and large mandibular plane angle due to the downward and backward rotation of the jaw (Figure 3). The panoramic radiography revealed that her condylar head were resorbed bilaterally (Figure 4).

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**Figure 1.** Initial extraoral photos. Patient presented lip incompetence with protrusive upper and lower lip. Her facial profile was convex.

**Figure 2.** Initial intraoral photos, indicated anterior open bite with upper and lower mild to moderate crowding.
Table 1. Conservative surgery for each obstruction site.

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Figure 3. Initial lateral cephalometric film.
Diagnosis

Skeletal Class II with high mandibular plane angle, dental Class I and ICR with anterior open bite were diagnosed. The patient was not uncomfortable and did not have any trauma history before. The open bite had maintained for many years. Therefore, we can conclude that the patient had idiopathic condylar head resorption in the remission phase.

Treatment plan

Based on her chief complaint and current situation, we decided to close anterior open bite by posterior dentition intrusion with temporary anchorage devices, followed by anterior retraction with the extraction of four bicuspids teeth to improve her soft tissue profile. The correction of her 4 mm gummy smile will be applied by upper anterior TAD.

Treatment progress

At the beginning, we used 0.018-inch slot preadjusted edgewise appliances and .014 NiTi wire for leveling and alignment. After 6 months of leveling and alignment, the anterior open bite was worse than before treatment (Figure 5). This is due to the anterior teeth flaring after crowding relief and uprighting of posterior teeth during the process of leveling. Few months later, four bicuspids teeth were removed and three were placed TADs at bilaterally infrasygomatic crests and upper
anterior area for whole dentition retraction and intrusion. After 4 months of intrusion and space closure, the mandible counterclockwise rotation was observed. The facial profile, gummy smile, lip posture and overbite were improved.

**Treatment result**

Lip incompetence was improved after treatment, and the gummy smile was reduced (Figure 6). The position of the chin was relatively forward. The convex profile was improved to a straighter facial profile (Figure 6). There were also significant improvements in dentition alignment and crowding (Figure 7). The 4 mm overjet was reduced to 2 mm. Overbite changed from a negative to a positive 2 mm overbite. The ANB was reduced from 6 degree to 5 degree. The mandibular plane angle was reduced by 2 degrees. The interincisal angle was improved from the initial 110 degrees to 120 degrees. The most obvious appearance change was the protrusive lower lip that changed from 5 mm to 2 mm relative to the E-line (Table 2, Figure 8). The prominence of upper and lower lip was reduced as indicated in the overall superimposition (Figure 9A). The mandible also rotated counterclockwise. The upper anterior teeth were retracted 6 mm with almost bodily movement and intruded 1.5 mm as indicated in maxilla superimposition (Figure 9B). The upper molars were uprighted and intruded 3 mm without mesial movement. The lower anterior teeth were retracted by 5.5 mm with controlled tipping as indicated in mandible superimposition (Figure 9C). The lower posterior teeth moved forward by 2.5 mm forward movement and uprighted about 1mm. No further bone resorption was detected at the mandibular condylar head as indicated in panoramic film (Figure 10). Neither pain in the TMJ nor open mouth limitation was reported from the patient.

![Figure 5. Lateral cephalometric film. A, after leveling and alignment; B, After space closure.](image-url)
Figure 6. Extraoral photos at completion of treatment.

Figure 7. Intraoral photos at completion of treatment.
Table 2. Initial and final cephalometric data

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Figure 8. Lateral cephalometric film at completion of treatment.
Figure 9. Cephalometric superimposition. A overall superimposition; B maxillary superimposition; C mandible superimposition; black line, before treatment; red line, after treatment.

Figure 10. Panoramic film at completion of treatment.
Follow up

In the one year follow up, we found that the facial profile was almost the same as debond (Figure 11). No change in angle and in the vertical direction were found in the superimposition of lateral cephalometric films (Figure 12). The mandibular plane angle and upper dentition were stable. No further changes in the mandibular condyles were observed (Figure 13). Patient did not report any TMD symptom and signs during this year.

Figure 11. Extraoral photographs in 1 year follow up.

Figure 12. The lateral cephalometric film and superimposition for 1 year follow up.
DISCUSSION

When patients have idiopathic condylar head resorption, it is necessary to determine which stage of the disease. It usually take half to one year to observe the changes of occlusion and the relative symptoms and signs of TMD. At the same time, the images of condylar head need to be monitored. If the patient continues to have symptoms, the application of medication and rehabilitation is required. If the patient is still in the active phase, orthodontics or orthognathic surgery should be deferred. Any additional force exerted on the TMJ is likely to make the resorption worse.

In this case, two treatment options were considered: camouflage or surgical-orthodontics. Patients with condylar head resorption history had an 80% chance of recurrence after surgical treatment. If the patient’s anterior open bite is relatively mild, TADs can be used to correct the open bite. Considering the cost and benefit, the orthodontic camouflage treatment plan was selected.

At the leveling stage, anterior teeth flaring after relieving crowding causes the anterior open bite to become more apparent. In the traditional orthodontic treatment, tools for posterior teeth intrusion are mainly posterior bite block with vertical chin cap. With MEAW and elastic, the anterior teeth can be extruded to resolve open bite. However, these methods also exert additional pressure on the joints while reactivating condylar head resorption. Another disadvantage of extrusion of anterior teeth is the relatively high probability of open bite relapse. Hence, Umemori et al. began to use screws to treat anterior open bite. Such treatment can cause absolute intrusion of posterior teeth and the prognosis is relatively stable. Our treatment goal was anterior bodily retraction intrusion to achieve a normal overjet and overbite. The TADs can be placed at both upper and lower posterior teeth to

Figure 13. Panoramic film in 1 year follow up.
correct open bite more efficiently, it provides more upward and forward rotation of mandible for a better facial profile improvement. In this case, only upper posterior TADs were applied to intrude the posterior molars. It may cause a slight extrusion of the lower posterior teeth. The result was still satisfactory in this case. The mandibular plane angle of the patient was reduced and remained stable after 1 year. The chin looks more prominent than before and the proportion of the face is more harmonious.

**CONCLUSION**

Patients with condylar reabsorption manifest with decreased condylar size, retruded mandible and progressive Class II with open bite. CBCT images is the best tool to observe the resorption and the interruptions areas of the bone cortex in the TMJ. Although the exact causes are unknown, several main etiological factors have been proposed, such as age, gender, hormonal changes, systemic factors and increased mechanical loading from parafunctional habits, trauma and orthognathic surgery. The force during treatment may cause harmful loads on the TMJ that trigger condylar resorption. The anterior open bite can could be successfully corrected with TADs by molar intrusion.

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