The prevalence of temporomandibular disorders (TMDs) has recently increased in general and orthodontic populations. For orthodontic patients, the nature of TMDs is articular disk problem or TMJ-internal derangement (ID) in most cases. Among various types of TMJ-ID, osteoarthrosis (OA) of the TMJ has been focused on in the field of orthodontics, because of the association with occlusal development and craniofacial growth, and the long-term stability. Possible explanations for the causes have been documented in the literature indicating that mechanical stress may be assumed as an initial factor for a series of degenerative changes that result in condylar resorption if host remodeling capacity is reduced.

Given this assumption, we have been struggling to explore a certain therapeutic system for orthodontic patients with TMJ-ID, TMJ-OA in particular. The system would include the correction of condylar dislocation, if any, and the subsequent occlusal reconstruction with an orthodontic approach to achieve an optimal environment in the TMJ space with biomechanical equilibrium for various TMJ components. With these considerations, orthodontic treatment will also be of great significance for such cases that require occlusal reconstruction at the newly induced condylar position after splint therapy.

The purpose of this article is to present the treatment of an adult patient with TMJ-OA who exhibited adaptive remodeling of the condyles after orthodontic treatment and to discuss the association with the relevant factors to occlusal reconstruction.

**CASE REPORT**

This article reports treatment for a 21-year 11-month old female patient with severe osteoarthrosis of the TMJ with a special reference to adaptive changes of the condyle during the treatment. She had severe open bite with a Class II molar relationship; she had limited mouth opening, TMJ sounds, pain, and tinnitus. Lateral tomograms showed flattening and deep erosion on the left condyle, and an MRI revealed anterior disk displacement without reduction. By manipulation and splint therapy, TMJ pain and tinnitus were eliminated, then orthodontic treatment was initiated, maintaining the splint-induced position of the condyles. After 2 years of orthodontic treatment with a multibracket appliance, an acceptable occlusion was achieved with a Class I molar relationship. On lateral tomograms after treatment, bony deformation of the left condyle disappeared and adaptive remodeling was recognized with a uniform joint space in the left TMJ. However, repositioning of the disk was not achieved. Adaptive changes or functional remodeling experienced in this patient may be due to stable occlusion, uniform joint space, and the consequent biomechanical equilibrium in the TMJ. (Am J Orthod Dentofacial Orthop 2000;118:566-71)
muscle exhibited tenderness on palpation. No psychological problems were found.

Cephalometric analysis indicated a tendency for skeletal Class II malocclusion with a slightly retruded mandible (Fig 2). The mandibular plane and gonial angles and Y axis were within the normal range, although the ramus plane angle was larger and the ramus height was smaller than the controls. Labio-lingual inclinations of the maxillary and mandibular incisors were almost normal.

Lateral tomograms revealed flattening and deep erosion on the left condyle, of which the cortical bone almost disappeared (Fig 3). Both condyles presented an anterior position relative to the glenoid fossa. Magnetic resonance imaging (MRI) showed anterior disk displacement without reduction in both TMJs. The degree of disk displacement was grade 2 according to the criteria of Helms et al.\textsuperscript{10} Disk deformation was also found (Fig 4).

From these findings, this case was diagnosed as a stage IV TMJ-ID with severe condylar resorption according to the Wilkes criteria.\textsuperscript{11} Disk repositioning was considered very difficult and was not included in the following treatment plans.

1. Splint therapy and manipulation for condylar repositioning and for elimination of limited mouth opening
2. Occlusal reconstruction by use of a multibracket appliance with the splint in use, when TMD symptoms are improved or disappeared

Fig 5 shows a schematic illustration for a series of orthodontic treatment procedures combined with splint therapy to correct the condylar position.

Four months after initiating the splint therapy and manipulation, TMD symptoms such as tinnitus, TMJ pain, and crepitus disappeared. Then, orthodontic treatment with a multibracket appliance was initiated (Figs
The splint was modified to a separate type and placed on the right and left sides to make it available to allow orthodontic alignment of the dentitions (Figs 5 and 7). After leveling of both dentitions, a stabilizing arch wire of 0.017 × 0.025 inch stainless steel with tip back bends and 0.016 × 0.022 inch multiloop edgewise arch wire (MEAW) were used for the upper and lower dentitions, respectively. Both arch wires were used
simultaneously with the splint and vertical elastics to prevent anterior intrusion (Figs 5 and 8). The splint was reduced in size gradually according to the progress in orthodontic treatment.

After 2 years of treatment, an acceptable occlusion was achieved without any TMD symptoms. Overjet and overbite were improved to +2.2 mm and +1.7 mm, respectively (Fig 9). The amount of maximum mouth opening became 42 mm. Cephalometric analyses indicated a counterclockwise rotation of the mandible (Fig 10). Lateral tomograms of the TMJ demonstrated that bony deformation of the left condyle observed before treatment had disappeared and adaptive remodeling was induced on the surface of left condyle. Furthermore, the TMJ spaces in the anterior and superior areas increased and uniform joint spaces were obtained (Fig 11). However, MRI showed that anterior disk displacement without reduction still existed, as was expected before treatment (Fig 12).

After 2-year retention, acceptable occlusion was maintained without recurrence of any TMD symptoms, indicating a long-term stability of occlusion and TMJ components.

**DISCUSSION**

This patient had severe deformation of the mandibular condyle and anterior disk displacement without reduction before treatment. After initial splint therapy, orthodontic treatment was conducted for occlusal reconstruction at the condylar position induced by splint. Meanwhile, disk repositioning was considered very difficult and was not included in the treatment plans. After orthodontic treatment, most TMD symptoms disappeared, and deformity of the mandibular condyle was improved. Substantial bone remodeling of the left condyle, recognized on the lateral tomograms after treatment, was regarded as adaptive change or functional remodeling, although such responses were not expected before treatment.

Dysfunctional remodeling of the condyle produces morphologic collapse of the TMJ component and the subsequent decrease in ramus height and progressive mandibular retrusion. These alterations are assumed because of an excessive or unbalanced mechanical stress on the articular cartilage layers, which is also affected by host remodeling capacity. Meanwhile, functional remodeling of the TMJ bony structures is characterized by morphologic adaptation, invariable ramus height, and stable occlusions. With these considerations, adaptive change of the condyle achieved in this case is speculated because of the elimination of excessive or unbalanced stresses on the mandibular condyle. In a clinical aspect, superimposition of cephalometric tracings before and after treatment indicated a counterclockwise rotation of the mandible. Because of the mandibular rotation, the occlusal plane and mandibular plane angles decreased by 2.0° and 1.5°, respectively. The mandibular condyles also exhibited a rotational repositioning in the inferior direction, and thus the joint space became almost uniform with the increases in the anterior and superior areas. It would be a reasonable assumption that these changes in condylar position, if accomplished simulta-
neously with optimal occlusal support, may achieve bio-
mechanical equilibrium in the TMJ and produce func-
tional remodeling of condyle. It is assumed that such
biomechanical equilibrium in the TMJ has been
achieved by the stable occlusion.

Splint therapy and the subsequent orthodontic treat-
ment were designed for this patient to reduce TMJ load-
ing. Such therapeutic system has recently been de-
veloped for the treatment of severe TMJ internal derange-
ment. A pair of miniature splints was designed for this
system to cover only the premolars and molars. During
orthodontic treatment, the splint was reduced in size and
gradually placed only on the molar regions. After level-
ing of both dentitions, a multilooop edgewise arch wire
was used for the lower dentition combined with vertical
elastics to alter the occlusal plane and to correct anti-
erior open bite. However, the posterior extrusion should be
performed carefully and gradually, because vertical
elastics may induce anterosuperior displacement of the
condyle, if posterior occlusal support is not well main-
tained. Thus, orthodontic treatment for occlusal con-
struction should be executed with special attention to
the condylar position induced by the splint.

In conclusion, an adult patient with open bite and
severe TMJ internal derangement was treated orthodon-
tically in order to achieve occlusal reconstruction at the
newly induced condylar position after splint therapy.
Although the anterior disk displacement without reduc-
tion still existed after treatment, TMD signs and symp-
toms disappeared. Furthermore, adaptive change or
functional remodeling of the condyle was induced after
treatment. It is assumed that such adaptive responses of
the condyle are resulted from optimal condylar position
and stable occlusion. During treatment for occlusal
reconstruction in patients with TMD, TMJ-OA in partic-
ular, it is prudent for orthodontists to obtain stable occlu-
sion without producing the recurrences of condylar dis-
location and TMD symptoms. It is hopefully anticipated
that the present case report would provide an insight into a new therapeutic approach to TMD patients.

REFERENCES
