THE SIGNIFICANCE OF POSTERIOR OPEN BITE AFTER ANTERIOR REPOSITIONING SPLINT THERAPY FOR ANTERIORLY DISPLACED DISK OF THE TEMPOROMANDIBULAR JOINT


ABSTRACT: Spontaneous posterior open bite was observed in 15 patients after the application of anterior repositioning splints in the treatment of anteriorly displaced disk. Recapture of the disk after treatment was clinically diagnosed in five patients. Arthrography performed on 10 patients with open bite revealed a completely recaptured disk in four patients, an anteriorly displaced disk without reduction in four patients, and an anteriorly displaced disk with reduction in two patients. This suggests that recapture of the disk in the correct position at mouth closing should be a major cause of the posterior open bite in patients who have a relatively short duration of locking and successful mandibular manipulation. Although the cause of posterior open bite with the persistently displaced disk is still unclear, an increase in the posterosuperior joint space by the posterior open bite appears to eventually produce favorable effects to joints with anteriorly displaced disks.

Dr. Sadako Kai received her D.D.S. degree from Kyushu University in 1977 and her D.D.Sc. degree from the same institution in 1982. She has been working as an oral surgeon and an instructor in the First Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Kyushu University since 1981, and has actively treated and researched TMJ disorders since 1987. Dr. Kai has focused her professional interest on the relationship between occlusal problems and TMJ disorders.

Dr. Hiroyuki Kai received his D.D.S. degree from Kyushu University in 1983. He has been at First Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Kyushu University since 1983 and has actively treated and researched oral maxillofacial lesions. Dr. Kai is a member of the Japanese Society of Oral Maxillofacial Surgeons and the Japanese Society of TMJ.

The recognition of the concept of internal derangements of the temporomandibular joint (TMJ)\(^2\) has directed clinical attention toward the spatial relationship between the disk and the condyle. Thus, the anterior repositioning splint has recently become a common therapeutic appliance for internal derangements. It is generally applied to patients with anteriorly displaced disks with reduction in order to maintain a correct disk-condylar relationship during all phases of mouth movement. In patients with closed lock (anterior disk displacement without reduction), it is applied after successful mandibular manipulation.\(^3\) In the course of treatment with the anterior repositioning splint, we observed 15 patients whose posterior open bite persisted after removal of the splint. This report describes these cases and discusses the mechanical causes of the posterior open bite.

Case Reports

Case 1: A 31-year-old Woman

The patient visited our clinic complaining of limited mouth opening with pain in the left TMJ and the masseter muscles. She had reciprocal clicking in the left TMJ for three months, followed by a sudden limitation of her mouth opening for 10 days.

At the first visit, maximal interincisal distance was 20 mm and the mandible at mouth opening was remark-
deviated toward the left side. Mandibular manipulation after pumping and loading hydraulic pressure into the upper joint cavity of the left TMJ resulted in recapture of the displaced disk with palpable clicking of the TMJ. The interincisal distance increased to 43 mm and the bilateral condyles showed symmetrical translation. The patient wore an anterior repositioning splint to maintain the mandibular dental arch at an edge-to-edge incisal position, in order to maintain the recaptured disk in the correct position for 24 hours, even while eating. Three days after the manipulation, spontaneous posterior open bite in the premolar and molar region with intermaxillary contact on the bilateral second molars was confirmed after removal of the splint (Figure 1). The mandibular arch was located approximately 1.5 mm anterior to its position before the treatment and was slightly posterior to the position produced by the splint. The patient was able to smoothly open her mouth up to 46 mm without any pain or deviation of the mandible. Lateral transcranial radiography showed that the condyle was located centrally in the articular fossa after the treatment, whereas it was located posterosuperiorly before the treatment (Figure 2).

An arthrographic examination performed four weeks after the manipulation revealed that the disk was superior to the condyle even after removal of the splint (Figure 3). After a slight walk back procedure, the splint was replaced with a pair of silver splints cemented on the occlusal su-

**Figure 2**
Lateral transcranial radiograms of Case 1. A. The left condyle was located posterosuperiorly in the articular fossa before treatment. B. The condyle was located centrally in the articular fossa after development of the posterior open bite.

**Figure 3**
Arthrograms of Case 1 with a posterior open bite shows the complete recapture of the disk, even after removal of the splint: A. At mouth closing; B. At mouth opening.

**Figure 4**
Left lateral view of a silver splint cemented on the bicuspid and molar region to fill the space of the open bite.
faces of the posterior mandibular teeth to fill the space of the open bite (Figure 4). Upon the confirmation of the suitability of the silver splints, the final prosthodontic treatment was performed (Figure 5). The patient was able to open her mouth smoothly up to 45 mm without pain or deviation of the mandible.

Case 2: A 15-year-old Woman

This patient had intermittent closed locking of the left TMJ for six months. At the first visit, she exhibited two different maximal interincisal distances. Upon first opening her mouth, she experienced the sensation that her jaw was caught and she was not able to open more than 40 mm. The second time she was able to open to 55 mm after an audible clicking sound. When she was able to open her mouth sufficiently, her posterior teeth were not in contact together except at the bilateral second molar regions and the incisal region (Figure 6A). When she clenched strongly, the teeth were in uniform contact with an audible clicking sound (Figure 6B), and then she was unable to smoothly open her mouth which required mandibular manipulation.

This patient was treated with an anterior repositioning splint for one month to stabilize the correct disk-condylar relationship. The treatment was followed by functional orthodontic treatment with a bionator, which allowed passive eruption of the posterior teeth and, thus, closed the posterior open bite (Figure 7). After the treatment, she had no signs of a displaced disk and was able to open her mouth up to 58 mm interincisally.

Case 3: A 25-year-old Woman

This patient had reciprocal clicking in the right TMJ,
followed by a sudden restriction of mouth opening for two weeks. At the first visit, the maximal interincisal distance on mouth opening was 22 mm, and the mandible was remarkably deviated to the right. Examination along with her history showed anterior disk displacement without reduction of the right TMJ.

Mandibular manipulation was performed to recapture the right disk. With an audible clicking sound, the maximal interincisal distance increased up to 42 mm and the mandibular deviation disappeared. We had the patient maintain the mandibular protrusive occlusion by wearing an anterior repositioning splint at all times.

At the second visit, bilateral posterior open bite was observed and the mandibular arch was located 2.5 mm anterior to its position before treatment (Figure 8). The patient complained of continuous pain in the right TMJ, the mandible deviated to the right on mouth opening, and there was reduction of maximal interincisal distance to 36 mm. Subsequent continuous use of the splint produced no improvement in these conditions. Bilateral arthrogram examination seven weeks after the mandibular manipulation revealed an anteriorly displaced disk without reduction of the affected splint (Figure 9).

Since several attempts of manipulation failed to recapture the disk, a flat occlusal splint was applied to maintain the open bite space. Lateral transcranial radiography with the mouth closed, splint in place, revealed adequate condylar position in the articular fossa, and several adjustments of the splint were performed. Further treatments with the splint and the subsequent prosthodontic treatments for six months resulted in resolution of the limited mouth opening and pain in the TMJ and masticatory muscles. She was able to open her mouth up to 45 mm without pain, although crepitation of the TMJ was palpated.

Table 1 shows 15 patients with posterior open bite after anterior repositioning splint therapy. Before treatment, 12 patients were diagnosed as having anterior disk displacements without reduction. Only two of them received an arthrographic examination before the treatment. The clinical diagnoses, however, for the remaining 10 patients were reliable because they had histories of previous clicking that disappeared immediately after a sudden onset of limitation of mouth opening, and they showed continuous deviated mouth opening to the symptomatic side. In these 12 patients, the duration of the locking appeared to be short, ranging from three days to two months. The mandibular manipulation produced a clicking sound and a subsequent remarkable increase in the maximal interincisal distance without deviation of the mandible upon mouth opening, indicating the successful recapture of the disk.

Two patients were diagnosed as having anterior disk displacements with reduction. Their obvious reciprocal clicking on mouth movement disappeared by mandibular protrusive repositioning. The remaining patient had apparent symptoms of intermittent closed lock (Case 2).

An arthrographic examination after development of the open bite was performed in 10 patients. Four patients showed complete recapture of the disks, even after removal of the splints. Four patients still had anteriorly displaced disks without reduction, and they had no improvement in clinical symptoms. In addition, the other two patients had anteriorly displaced disks with reduction, although one of them showed partial recapture of the disk at its medial position.

In the five patients without arthrographic examination after the treatment, recapture of the disk was apparently observed from such clinical findings as no deviation of the mandible or clicking, symmetrical anterior translation of the condyles, relief of pain in the TMJ and/or masticatory muscles, and a sharp increase in the maximal interincisal distance. It took little time to confirm the posterior

Figure 8
Posterior open bite with the anterior repositioning splint in Case 3. The mandibular arch was located 2.5 mm anterior in comparison with that before treatment.

Figure 9
Arthrogram of Case 3 performed seven weeks after the mandibular manipulation with a posterior open bite shows the anteriorly displaced disk without reduction: A. At mouth closing; B. At mouth opening.
open bite after the manipulation, ranging from immediately after the manipulation to 30 days after. However, the exact time of onset of the open bite was unclear in the majority of patients. While open bite was bilaterally observed in some cases, all of the cases had the unilateral displaced disk.

**Discussion**

The anterior repositioning splint used in this study was applied to the maxillary arch and had a lingual ramp at its anterior portion to guide the anterior mandibular teeth anteriorly (Figure 10). This splint maintains the disks in the correct position by positioning the condyles forward, if effectively applied.68

Farrar and McCarty3 defined internal derangement of the TMJ as anterior displacement of the disk associated with posterosuperior displacement of the condyle when the teeth are closed in occlusion. Apart from the condylar position within the fossa before treatment, there must necessarily be spatial changes in the condyle if the disk has been recaptured completely. Since the patients in this study had a relatively short duration of locking, ranging from three days to two months, the disk is thought to have maintained its original shape, as shown in the arthroтомogram, (i.e. the posterior band of the disk was thicker than the other parts of the disk).

On the other hand, the posterior attachment consists of loose organized connective tissue which is not designed for loading. The posterior attachment is compressed between the condyle and the fossa when the disk is displaced anteriorly. If the disk is recaptured correctly, the posterior band is at the 12 o’clock position of the condyle at mouth closing. This change results in increased joint space dimension between the condyle and the fossa, especially in the posterosuperior portion of the joint.

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**Table 1**

Fifteen patients with posterior open bite after anterior repositioning splint therapy

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
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<td>1</td>
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<td>F</td>
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</tr>
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<td>F</td>
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<td>22</td>
<td>AD†</td>
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<tr>
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<td>26</td>
<td>F</td>
<td>ADR</td>
<td>–</td>
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<td>N†</td>
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<td>M</td>
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<tr>
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<td>F</td>
<td>AD</td>
<td>1 month</td>
<td>29</td>
<td>AD†</td>
</tr>
</tbody>
</table>

†: Arthrographically diagnosed.

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**Figure 10**

The anterior repositioning splint has a lingual ramp at its anterior portion to keep the mandibular arch in the forward position and to maintain the disk in the recaptured position.
other words, replacement of the posterior attachment with the posterior band should reposition the mandible anteroinferiorly.

There has been no report of posterior open bite after surgical correction of disk position (disk plication surgery). On the other hand, the postoperative arthrography or magnetic resonance imaging (MRI) shows frequent recurrence of anteriorly displaced disk after plication surgery. It seems that the recurrence depends on insufficiency in the joint space to maintain the recaptured disk in the correct position. Thus, the necessity of occlusal rehabilitation is suggested.

Most patients did not recognize the onset of the posterior open bite because we instructed them to not attempt to place the posterior teeth in contact after the removal of the splint. However, it is believed that the open bite occurred immediately after complete recapture of the disk in such cases. This conjecture was evidently demonstrated in Case 2 (a 15-year-old woman who had intermittent closed lock with two different occlusions). Accordingly, a posterior open bite is definitely not an undesirable side effect of splint therapy, but shows the occlusal disorders which causes the disk to slip from the condyle.

Lundh et al. stated that a favorable effect of the anterior repositioning splint is short duration. The majority of patients reported pain and clicking and demonstrated tenderness following removal of the splint after six weeks of treatment. More permanent devices were needed to stabilize the mandible in an anterior position, thereby maintaining the recaptured disk in a normal relation to the condyle. Generally, the tedious walk back procedure requires much time to select a position as far posteriorly as possible without displacing the disk anteriorly. The presence of the posterior open bite shortens the procedure because occlusion with an open bite closely represents the final anteroposterior position of the mandible after the occlusion is restored.

A correct disk-condylar relationship failed to be maintained in patients with anteriorly displaced disks after the occurrence of posterior open bite. However, the open bite does not appear to be an undesirable condition, because it increases the joint space; especially in the postero-superior portion, where the stretched posterior attachment tissue exists under excessive loading from occlusal forces. Increased joint space may be favorable to prevent destructive changes of the disk and posterior attachment.

We followed the course of symptoms in 35 patients with persistent anteriorly displaced disks which failed to be ultimately recaptured by mandibular manipulation. These patients received conservative therapy with flat occlusal splints in order to: (a) eliminate hyperactivity of the masticatory muscles, and (b) achieve sufficient joint space in which the posterior attachment tissue might functionally adapt to the altered intracapsular conditions. Excellent results were obtained in 94% of the patients concerning the range of maximal mouth opening and pain in the TMJ and masticatory muscles: excluding the fact that crepititation gradually occurred during the treatment.

The development of an open bite may depend on the duration of splint wear. This is because a posterior open bite frequently occurred in patients with anteriorly displaced disks without reduction before treatment, who had to wear the splint at all times to stay unlocked and to avoid recurrent locking. The explanation for this may be that the continuous anterior position of the condyle may surpass the volumetric expanding capacity of the posterior disk attachment, and the deficit so created increases the volume of joint fluid in the upper joint cavity. There is also a possibility that long-standing application of the splint decreases or eliminates hyperactivity or hypertonicity of the elevator muscles, such as the masseter or temporal muscles resuspending the mandible beneath the cranial base, thereby causing the posterior open bite. These alterations may even enhance the degree of open bite in patients with completely recaptured disks and occurrence of open bite in the contralateral side.

The possibility that the open bite was due to intrusion of the posterior teeth was excluded in this study by comparing the models before and after treatment, and because the patients had such a short duration of splint therapy until the presence of a posterior open bite was confirmed.

Additionally, when the occlusion with posterior open bite had one or more intermaxillary contacts in the molar region, the stability appeared to be obtained more easily than when occlusion without contacts resulted. The stability resulting from this posterior contact may influence development of the posterior open bite on the contralateral side in which the disk has not been displaced. Indeed, most of the patients had unilateral or bilateral contacts at the second molar. It goes without saying that these contacts should not be equilibrated, as their removal may induce recurrent displacement of the disk or pain due to the loss of the occlusal stability they provide.

Conclusion

This study indicates that complete recapture of an anteriorly displaced disk changes the maxillomandibular relationship between the jaws, resulting in a posterior open bite in patients with a short duration of locking. This change shows the occlusal compensations causing or contributing to the displacement of the disk. The occlusion change occasionally occurs when the disk is not recaptured because the maxillomandibular relationship...
has been made more normal. Clinicians should pay attention to this resulting change in occlusion and symptoms of TMJ disorder in the course of treatment with the anterior repositioning splint in order to select the most suitable mandibular position (maxillomandibular relationship).

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Dr. Osamu Tabata received his D.D.S. degree from Kyushu University in 1981. He has been an instructor in the Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Kyushu University since 1981. He is a member of the Japanese Society of Oral Maxillofacial Radiology and the Japanese Society of TMJ. Dr. Tabata has focused his professional interest on TMJ disorders.

Dr. Hideo Tashiro graduated from the Medical Faculty of Kyushu University in 1955. He then received training in general surgery, neurosurgery, dentistry, and oral maxillofacial surgery at Kyushu University, plastic surgery at Tokyo Metropolitan Police Hospital, and oral and maxillofacial surgery at Düsseldorf University, Germany. Dr. Tashiro was a professor and chairman of the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry at Kyushu University in 1974 and served as the Director of the University Dental Hospital from 1979 to 1982. From 1985 to 1989, he was the Dean of the Dental Faculty at Kyushu University. Dr. Tashiro served as President of the Japan Society of Head and Neck Cancer in 1977, the Japanese Stomatological Society in 1986, and the Japanese Cleft Palate Association in 1988.