Long-term follow-up after occlusal treatment to correct abnormal temporomandibular joint disk position

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Fifteen patients with temporomandibular joint disk displacement in whom a normal condyle-disk relationship could be established were treated with occlusal changes to maintain the disk in a recaptured position. Occlusal changes were achieved by prosthodontics in 11 patients and by orthodontics in four patients. Follow-up after about 3 years showed that joint function was improved, intensity of pain was reduced, and joint and muscle tenderness were less frequent than before treatment. Intermittent locking, use of analgesics, sleep disturbances, and absence from work because of temporomandibular joint symptoms were also less frequent. Radiographic examination performed in 11 patients at follow-up demonstrated anteroinferior condylar position in the majority of the patients, but only minor hard tissue changes. Arthrography showed the disk to be in a correct position relative to the condyle in 82% (9 of 11) of the patients. These results suggest that permanent change of the occlusion with the objective of eliminating abnormal disk position may be effective treatment for disk displacement when conventional methods of treatment have failed to alleviate the symptoms. The extent of dental treatment needed to maintain the disk in a correct position should, however, be considered relative to the severity of the symptoms.
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Recapturing a displaced temporomandibular joint disk and positioning the mandible anteriorly and inferiorly to maintain the correct relationship between the disk and the condyle has been suggested to treat anterior disk displacement with reduction.[1] Short-term success with this treatment has been encouraging,[2-8] but the long-term outcome is not clear. One study[3] reported an 86% success rate with a follow-up questionnaire obtained after 2 years; another study[9] reported only a 50% success rate with 3 years follow-up.

We assessed clinical and arthrographic findings in 15 patients who 1 to 7 years earlier had been treated with prosthodontics or orthodontics to maintain a correct relationship between the disk and the condyle.

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MATERIALS AND METHODS

We retrospectively evaluated 15 patients (13 women, two men; Table I) with temporomandibular joint disk displacement who were treated in one author's (H.L.) routine clinical practice over several years. When first seen, the patients had severe symptoms associated with disk displacement that could be eliminated with temporary disk repositioning devices. All but one patient had been unsuccessfully treated by more conventional methods routinely used for temporomandibular joint symptoms, including counseling (14 patients), occlusal adjustment (11), medication (10), flat occlusal splints (9), and physiotherapy (3).

Ten patients had unilateral symptoms, five had bilateral symptoms. In the patients with bilateral symptoms the findings from the more painful side were tabulated. Twelve patients had reciprocal clicking, suggesting disk displacement with reduction.[10-17] The remaining three patients previously had reciprocal clicking that had recently progressed to limitation of jaw opening and deviation to the affected side

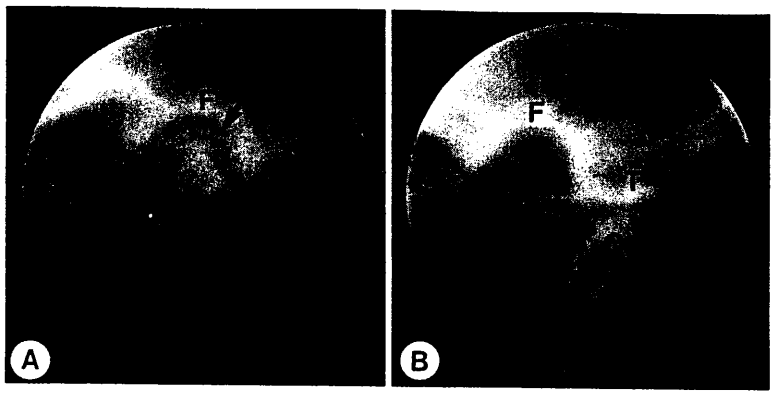

Fig. 1. Double-contrast arthrotomogram obtained at rest position (A) and at maximal mouth opening (B) showing normal disk position. Posterior band of disk *(arrow)* is lying between condyle *(C)* and fossa *(F)*. *T*, tubercle.

at maximal opening and protrusion, suggesting progression to disk displacement without reduction.[10-17] The clinical diagnoses were confirmed by arthrography in six patients (three with disk displacement with reduction and three with disk displacement without reduction). Arthrography was not performed in the remaining patients because of limited capacity for this examination at the time these patients were initially seen.

Detailed clinical examinations were performed and tabulated by one of us (H.L.) before treatment and at follow-up. The median follow-up time after recapture of the disk was 41 months (range 15 to 86 months).

Pain at rest, during chewing, and during protrusion was scored by the patients on 10 cm visual analog scales ranging from 0 to 10. The distance from 0 to the patient's mark was measured to the nearest centimeter. Jaw locking, the use of analgesics, sleep disturbances, and absence from work because of temporomandibular joint symptoms were tabulated.

Reciprocal clicking was recorded using a stethoscope or by palpation. Palpatory tenderness of the temporomandibular joint and masticatory muscles were recorded as described by Krogh-Poulsen.[18]

The horizontal overjet and the vertical overbite were measured on the upper and lower left central incisors before treatment, after insertion of onlays or splint, and at follow-up.

Radiography

Corrected sagittal tomography[19,20] and dual-space double-contrast arthrotomography[21-23] were performed as previously described, at follow-up in 11 of the 15 patients. Four patients were not examined arthrographically because of pregnancy in two, history of allergy to contrast medium in one, and refusal of one. The position of the disk was classified as normal superior (Fig. 1) or displaced according to previously described criteria.[10-12,24,25] All arthrographic examinations were performed by one clinician (P.L.W.).

Fig. 2. Temporary onlays *(arrows)* on lower premolars and molars used to maintain mandible in such position that disk was not displaced again.

Disk recapture

The displaced disk was recaptured by positioning the mandible anteriorly and inferiorly, resulting in a new intercuspal position. This was designated as the therapeutic position,[2,7] determined clinically in 11 patients and during arthrography[26,27] in four patients. In the clinical determination of the therapeutic position the disk was recaptured by having the patient open the mouth until the opening click occurred, and then close in such anterior and inferior

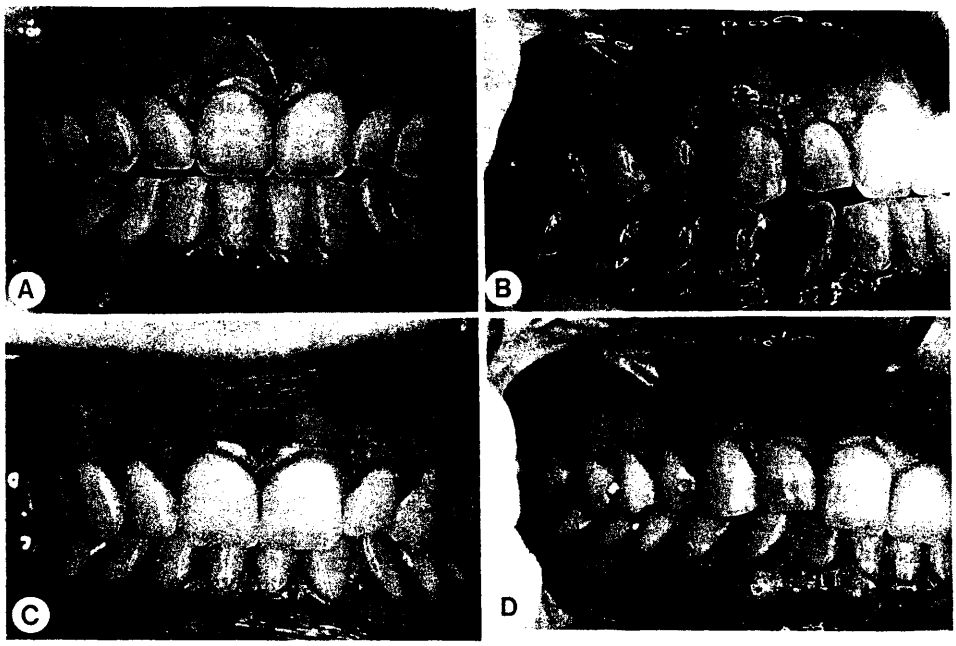

Fig. 3. **A,** Therapeutic position immediately after manipulation and recapturing of displaced disk. **B,** Acrylic onlays *(arrows)* for maintaining therapeutic position. Patient used onlays during 6 months and was treated with orthodontics. **C** and **D,** Position at follow-up after 15 months.

position that the closing click did not occur. The mandibular position was selected to be as posterior as possible without producing a closing click, and was recorded by an interocclusal record.[28] Joint function was then tested to confirm that mandibular movements could be performed from the therapeutic position without reciprocal clicking. In the arthrographic determination of the therapeutic position[26, 27] the disk was recaptured during arthrographic visualization by having the patient open the mouth and then close in a protruded position to a point just before the displacement phase. In the three patients with limitation of opening and disk displacement without reduction, the disk was manipulated during arthrography as previously described[29] to obtain a correct relationship between the disk and the condyle. The therapeutic position was selected to be as posterior as possible without displacement of the disk. The therapeutic position was recorded with a rapidly polymerizing bite registration material (Ramitec, Espe GmbH, Seefeld/Oberbay, West Germany) that was injected between the occlusal surfaces of the teeth of the upper and lower jaws.[26, 27] Joint function was tested during arthrography to make sure that mandibular movements could be performed from the therapeutic position without displacement of the disk.

The interocclusal record and the Ramitec index were used to mount casts of the teeth of the upper and lower jaws in an articulator. Onlays (Figs. 2 to 4) in 12 patients or a maxillary anterior repositioning splint (Fig. 4) in two patients were constructed as previously described.[1, 6, 29] The onlays were cemented on the unprepared lower molars and premolars bilaterally. The anterior repositioning splint was used 24 hours a day. Guidance of the mandible into the therapeutic position was achieved through incorporation of a distinct occlusal anatomy on the onlays and on the splints that provided maximal occlusal stability in the therapeutic position only.[30] The therapeutic position in one patient was maintained by adding a light-cured composite material (Durafill, Kultzer & Co GmbH, Wehrheim/Ts, West Germany) to the occlusal surfaces of the premolars and molars bilaterally. The temporary devices to maintain the therapeutic position were used for 6 to 32 months (median 10 months) before permanent reconstruction of the occlusion to the therapeutic position was performed.

Occlusal therapy

In patients free of clicking, intermittent locking, pain, and other symptoms during the observation period with the temporary devices, a permanent change of occlusion to the therapeutic position was performed by prosthodontic methods in 11 patients

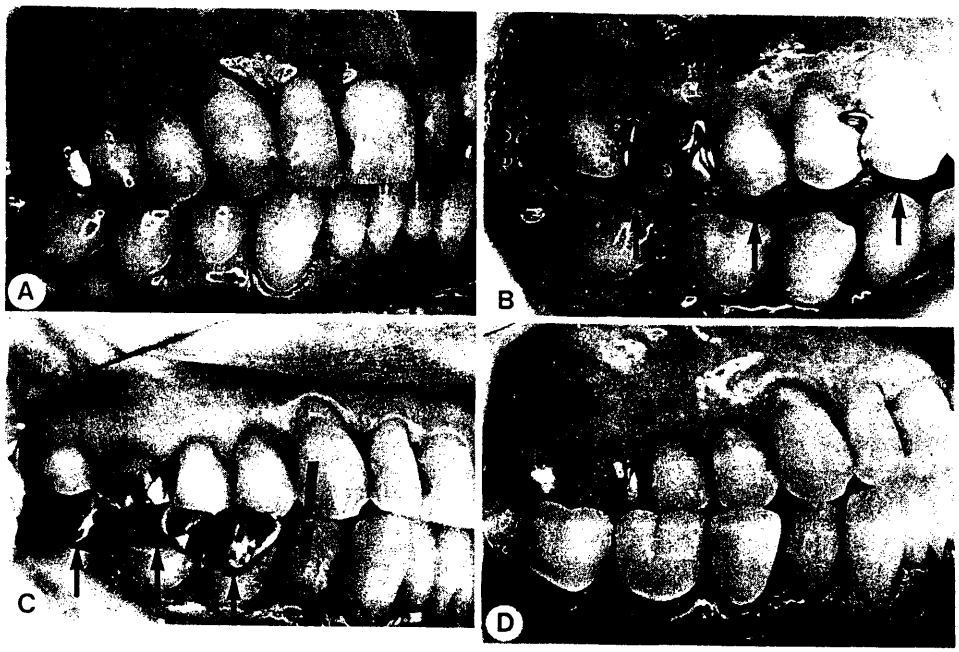

Fig. 4. Intraoral photos of disk repositioning before treatment (**A**), with anterior repositioning splint (**B**), with silver onlays (**C**), and after prosthodontic treatment (**D**).

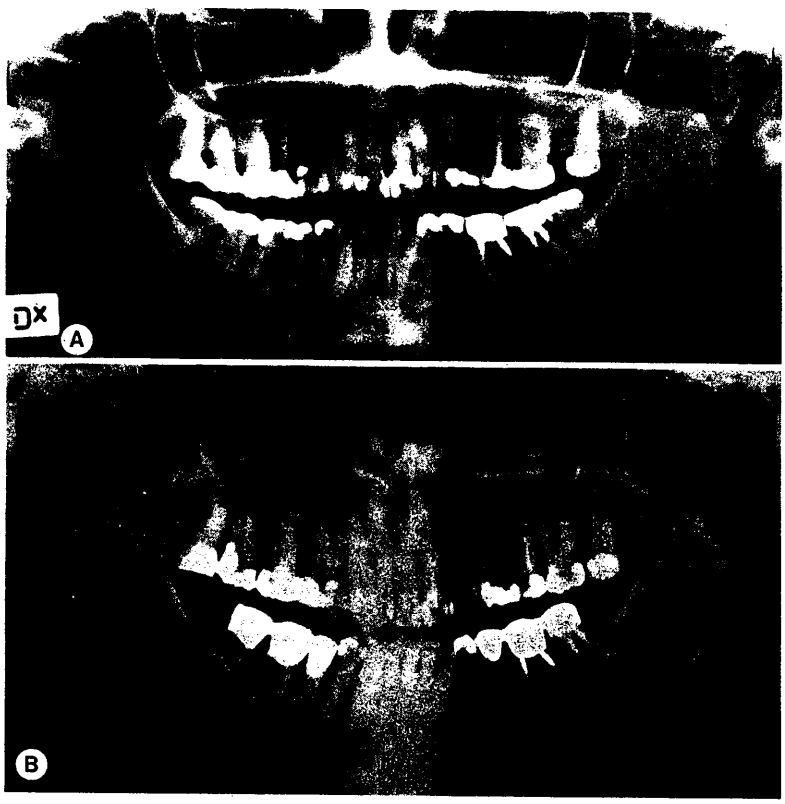

Fig. 5. Orthopantomograms before (**A**) and after (**B**) treatment with prosthodontics to maintain disk in recaptured position. Same patient as in Fig. 4.

Table I. Patients and treatment

Patient	*Sex*	*Age* (yr)*	*Affected side†*	*Diagnostic method*	*Temporary treatment*	*Duration of temporary treatment (mo)*	*Permanent treatment*	*Follow-up (mo)*	*Follow-up arthrographic findings*
1	F	19	L, R	Arthrographic‡	Onlays	6	Orthodontics	15	Normal
2	F	36	L	Arthrographic‡	Onlays	10	Bridges 34-37, 44-47	17	Normal
3	F	49	R	Arthrographic‡	Onlays	10	Crowns 45, 46	20	Normal
4	F	18	L	Arthrographic‡	Onlays	6	Orthodontics	25	Normal
5	F	36	R	Arthrographic	Onlays	19	Crowns 16, 26, 27, 44-47 Bridge 34-37	29	Not performed
6	F	60	L	Clinical	Onlays	7	Crowns 34-36, 44-46	34	Normal
7	F	48	L	Clinical	Onlays	19	Crowns 35-37, 45, 46	39	Not performed
8	F	56	R	Clinical	Onlays	5	Crowns 35-37, 45-47	41	Normal
9	F	38	R, L	Clinical	Onlays	10	Crowns 14-17, 24-27, 44-47 Bridge 34-37	53	Normal
10	M	44	R, L	Clinical	Onlays	14	Bridges 34-37, 44-47	53	Normal
11	F	17	L	Clinical	Splint	5	Orthodontics	61	Not performed
12	F	44	R, L	Clinical	Composite	20	Crowns 16-14, 23-26 Bridge 43-45	63	Normal
13	F	22	R	Clinical	Splint	2	Orthodontics	64	Not performed
14	M	35	R, L	Clinical	Onlays	8	Bridges 34-36, 44-46	66	Disk displacement without reduction
15	F	64	R	Arthrographic	Onlays	32	Bridges 35-37, 45-48	86	Disk displacement with reduction

*At initial examination before treatment.
†Side that was most painful at initial examination is noted first in patients with bilateral symptoms.
‡Arthrographically determined therapeutic position.

(Figs. 4 and 5) and by orthodontic methods in four patients (Fig. 3). The extent of the prosthodontic reconstructions was individually determined based on the need to stabilize the occlusion to the therapeutic position (Table I). In the two patients in whom the most extensive prosthetic treatment was performed, the reconstruction was required not only to stabilize the occlusion in the therapeutic position but also for other reasons. Treatment was first performed on one side; on completion the onlays were removed from the other side and the prosthodontic treatment was completed. Thus one side always served as an accurate indicator to transfer the temporary therapeutic position to the permanent reconstructions.

The orthodontic technique to permanently change the occlusion to the therapeutic position aimed specially at closing the bilateral posterior open bites that occurred when the onlays or the anterior repositioning splint were removed. This was done by modifying the maxillary anterior repositioning splint to function like a Sved bite plate.[31,32] Thus the appliance covered the upper second molars, incisors, and cuspids, and the teeth in between were allowed to erupt. When stable occlusal contacts were established on these teeth the bite plate was removed, and the second molars erupted to occlusal contacts. Finally, minor occlusal adjustments were performed to create a stable occlusion. In two patients, closure of the posterior open bite was accelerated by the use of interocclusal elastic bands, as previously described.[33,34] The median time for orthodontic treatment was 4 months (range 2 to 12 months).

RESULTS

Intensity of pain at rest, during chewing, and during protrusion was reduced when examined at follow-up (Table II). Intermittent locking, use of analgesics, sleep disturbances, and absence from work because of temporomandibular joint symptoms

Table II. Median of subjective symptoms as evaluated by 15 patients by marking on 10 cm visual analog scales (range 0 to 10)

	Before treatment	*At follow-up*
Pain at rest	2	0
Pain during chewing	8	0
Pain during protrusion	5	0

Values represent median.

were more frequent before treatment than at follow-up (Table III).

Reciprocal clicking and palpatory tenderness of the temporomandibular joint and masticatory muscles were more frequent before treatment than at follow-up (Table IV). No patient had crepitation at the initial examination, but this finding was observed in one patient at follow-up.

The range of mandibular movement capacity before and after treatment are presented in Table V; no appreciable differences were found between median values before and after treatment. The three patients who initially had disk displacement without reduction had, however, significant improvement in mandibular movement capacity directly after manipulation.

The median value of the vertical overbite before treatment was 5 mm (range 2 to 7 mm). Immediately after insertion of the onlays or splints it had decreased to 2 mm (range 0 to 5 mm). At follow-up the vertical overbite was 3 mm (range 2 to 6 mm). The median value of the horizontal overjet was 3 mm (range 2 to 11 mm) before treatment, 2 mm (range (1 to 7 mm) immediately after insertion of the onlays or splints, and 3 mm (range 1 to 11 mm) at follow-up. The change of the vertical overbite during treatment with onlays and subsequent orthodontics is illustrated in Fig. 3, *B* and *D*.

Tomography was performed in 11 patients at follow-up, and revealed inferoanterior condylar position in five patients, central position in four, and posterior condylar position in two patients. Structural hard tissue changes such as flattening, sclerosis, and osteophytosis were seen in three patients. Progressive remodeling with hard tissue formation was seen on the posterior surface of the condyle in two patients (Fig. 6).

Arthrography was performed in 11 patients at follow-up, and showed superior disk position in nine patients (Fig. 1), medial disk displacement with reduction in one, and disk displacement without reduction in one patient (Table I).

Table III. Anamnestic findings in 15 patients

	Before treatment	*At follow-up*
Intermittent locking	9	0
Use of analgesics	6	1
Sleep disturbances	6	0
Absence from work*	3	0

*During last 3 months.

Table IV. Distribution of clinical findings in 15 patients

	Before treatment	*At follow-up*
Reciprocal clicking	15	0
Palpatory tenderness		
Laterally over joint	8	0
Posteriorly over joint	6	0
At insertion of temporal muscle	10	2
Anterior portion of temporal muscle	8	0
Superficial masseter muscle	8	2
Medial pterygoid muscle	7	1

DISCUSSION

Our findings suggest that changing the occlusion for the purpose of maintaining a correct condyle-disk relationship is one way to treat disk displacement when more conventional treatment methods have failed. This observation is in accordance with a previous study based on questionnaires.[3] Our results, however, contradict findings by Moloney and Howard,[9] who reported an overall success rate of 36% at 3-year follow-up. Recurrence of disk displacement might explain the high failure rate in their patients; these authors also reported that the joint clicking suggesting disk displacement returned during or shortly after completion of the dental restorations.[9]

When evaluating our results it should be remembered that our 15 patients represent a highly select group of all patients treated for temporomandibular joint symptoms over several years. Our selection criteria were disk displacement where the disk could be recaptured and maintained in a normal relationship to the condyle and where this resulted in freedom from symptoms during the period with temporary disk repositioning devices. The patients were also selected with respect to the intensity of pain; those with mild or no pain were not considered for this extensive treatment. It should also be pointed out that all but one of our patients were treated unsuccessfully by more conventional treatment methods such as occlusal adjustment, medication,

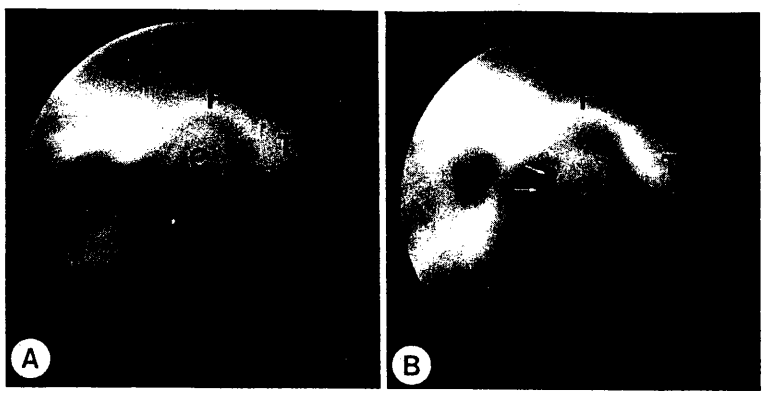

Fig. 6. Tomograms before (**A**) and at follow-up (**B**) after 19 months with disk repositioning onlays and orthodontic treatment. Double contour *(arrows)* is seen posteriorly on condyle after treatment. Same patient as in Fig. 3.

Table V. Mandibular movement capacity in 15 patients

	Before treatment	*At follow-up*
Maximal opening	48	50
Protrusion	8	9
Laterotrusion		
To left	10	10
To right	10	10

Values represent median millimeters.

flat occlusal splints, and physiotherapy. The number of patients selected should, however, not be regarded as an indicator of the percentage who would require this type of treatment, because they were not systematically selected. Rather, our patients should be regarded as a pilot group used to study the long-term effect of disk repositioning therapy. Determination of the percentage of patients requiring this type of treatment must await further studies.

It would have been desirable to have had an initial arthrographic diagnosis for all patients, but this was not possible because of the retrospective nature of the study. Another drawback to the study was that the clinician who examined the patients also performed the treatment, and may unknowingly have upgraded the posttherapeutic results.[35] This possible bias should, however, not prevent us from making conclusions, because the difference before and after treatment was so pronounced and the registration of pain was performed by the patients themselves and should not be influenced by possible examiner bias.

All patients felt immediate relief from pain and functional disturbances after recapturing of the disk and insertion of the onlays or splint. These observations are similar to those previously presented in a case report in which the patient also felt immediate relief from his symptoms and considered his chewing ability much improved when a repositioning splint was inserted.[36] The favorable condition persisted in our patients during the period with the temporary disk repositioning devices, and this was one of our prerequisites for permanent reconstruction of the occlusion.

There may be a risk for neuromuscular complications with this type of change of the occlusion,[2, 37] but did not occur in our patients. This is in accordance with the findings of Hellsing et al.,[36] whose patient showed excellent neuromuscular and skeletal adaptation to anterior repositioning of the mandible.

Immediately after insertion of the splint or onlays the vertical overbite and the horizontal overjet were reduced, consistent with movement of the mandible inferiorly and anteriorly. At the follow-up examination after about 3 years the change in the horizontal plane was eliminated and only about half of the change in the vertical plane remained. These observations are in accordance with roentgen stereophotogrammetric findings in patients treated with disk repositioning onlays.[7] The relapse is probably caused by movements of the teeth and the mandible.[7] This gradual movement of the mandible toward its former position was not associated with relapse of disk displacement, as shown after abrupt removal of disk repositioning onlays.[38] This raises the question of whether it would be possible to gradually move the mandible toward its original position over a long time and still maintain the normal relationship between the disk and the condyle. If so, the need for prosthodontic and orthodontic rebuilding of the occlusion would be significantly reduced. Further clinical studies in this area are warranted.

Tomography at follow-up revealed that the condyle was located anteriorly and inferiorly in the fossa in the majority of the patients. A double contour was seen on the posterior aspect of the condyle in a few patients, and was interpreted as a sign of rebuilding and adjustment to the new position. A similar double contour posteriorly on the condyle has also been seen after orthognathic surgery with osteotomy of the mandibular rami,[39, 40] after condylar fracture,[41] and after permanent anterior repositioning of the mandible.[36]

Arthrography after treatment showed normal disk position in the majority of the patients, but two patients showed persistent disk displacement. In both patients the initial diagnosis was made clinically and the therapeutic position was established without arthrographic visualization. This might explain the failure of recapturing the disk, because all patients with arthrographically assisted disk recapturing had a normal disk-condyle relationship at follow-up. Persistent or recurrent disk displacement has also been a frequent finding in other studies in which arthrography was not used to establish the therapeutic position.[2, 9, 26, 42]

We found no appreciable differences in the clinical status of the two patients with abnormal disk position at follow-up compared with patients with a normal disk-condyle relationship. This raises the question of whether correction of the disk position actually is a prerequisite for symptoms relief or whether just a change in position of the condyle anteriorly and inferiorly in the fossa can reduce the symptoms. The number of patients in our study is too small to answer this question, and further investigations are warranted.

In conclusion, our study suggests that a permanent change of the occlusion to maintain a normal disk position is one way to treat disk displacement when more conventional treatment methods have failed to alleviate the symptoms. The extent of dental treatment needed to maintain the disk in the correct position should, however, be considered relative to the severity of the symptoms.

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