

Long-term follow-up of clinical symptoms in TMD patients who underwent occlusal reconstruction by orthodontic treatment

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SUMMARY Fifty-eight patients (mean age 18.4 years) who had received splint therapy for internal derangement of the temporomandibular joint (TMJ) were examined retrospectively to investigate the efficacy of occlusal reconstruction by orthodontic treatment. The subjects were divided into three groups: 18 patients (mean age 18.6 years) who underwent orthodontic treatment combined with the use of splints (ST group); 27 patients (mean age 18.2 years) who underwent orthodontic treatment without the use of splints (NST group); and 13 patients (mean age 17.9 years) who received only splint therapy for temporomandibular joint disorders (TMD; control group). TMJ sound, pain on movement and restriction of mandibular movement were examined at the initial examination (T1), at the end of the splint therapy for TMD or beginning of orthodontic treatment (T2), at the end of orthodontic treatment (T3), and at recall or 1 year after orthodontic treatment (T4).

The following results were found. (1) The percentage of patients with no joint sound at T2 was 20–30 per cent. The percentage of such patients in both the ST and NST groups increased to over 50 per cent at T3, but slightly decreased to 39–50 per cent at T4. There were no significant inter-group differences at any time point. (2) The number of patients who had no pain on movement at T2 was 60–80 per cent. The percentage of such patients in both the ST and NST groups increased to over 90 per cent at T3, but then slightly decreased to 80 per cent at T4. There were no significant inter-group differences at any time point. (3) None of the patients showed restriction of movement of the TMJ at T2 or T4. One patient in the ST group was found to have restriction at T3. There were no significant inter-group differences at any time point. (4) The most frequent type of malocclusion in both ST and NST groups was anterior open bite.

These results suggest that TMD symptoms that have been eliminated by splint therapy are not likely to recur due to subsequent orthodontic treatment, but it cannot be concluded that orthodontic treatment itself had a positive effect on TMD symptoms. The results also indicate that there is a relationship between anterior open bite and TMD.

Introduction

The relationship between the macropathology and clinical symptoms of temporomandibular joint disorders (TMD) have been clarified due to the recent developments in radiological and magnetic resonance image examinations (Tallents *et al.*, 1996; Tasaki *et al.*, 1996). There have been many long-term follow-up studies on the post-

treatment of TMD patients (Hansson *et al.*, 1984; Lundh and Westesson, 1989; Kai *et al.*, 1990; Le Bell and Kirveskari, 1990; Kurita *et al.*, 1992; Leeuw *et al.*, 1995) and on the natural course of clinical symptoms of TMD (Yoda *et al.*, 1996; Sato *et al.*, 1997; Kurita *et al.*, 1998). The results of these studies have led to changes in the methods of treating TMD.

The recent findings of some aspects of the pathology and time course of TMD signs and symptoms has indicated that TMD can, in most cases, be effectively managed by conservative treatment using splints, and does not require occlusal reconstruction or surgical therapy. On the other hand, there have also been several case reports showing good results from occlusal reconstruction by orthodontic treatment for TMD patients (Williamson and Sheffield, 1987; Yokoe *et al.*, 1992; Tanaka *et al.*, 1994; Endo *et al.*, 1995). However, many issues remain concerning the efficacy of occlusal therapy for TMD patients (Wajima *et al.*, 1990; Kurita *et al.*, 1992; Yatani *et al.*, 1998). Therefore, at the present time, the decision to use occlusal therapy for TMD patients depends on each practitioner's philosophy.

A multidisciplinary team approach, involving oral and maxillofacial surgeons, prosthodontists, and orthodontists, has been used for treating TMD patients in the Hokkaido University Dental Hospital. Conservative or surgical treatment is first used to improve clinical symptoms, and occlusal reconstruction to stabilize stomatognathic systems is performed on patients with morphological symptoms and/or functional occlusal abnormalities, and on those whose mandibular position has changed as a result of previous therapy. The purpose of the present study was to investigate retrospectively the efficacy of occlusal reconstruction performed on TMD patients who have been followed for more than 1 year after orthodontic treatment.

Subjects and methods

The subjects were 58 TMD patients (11 males, 47 females; mean age 18.4 years), who attended the Hokkaido University Dental Hospital during the period from February 1986 to December 1993, and received splint therapy for TMD. The subjects were divided into three groups:

- (1) 18 patients (four males, 14 females; mean age 18.6 years) who underwent orthodontic treatment combined with the use of splints (ST group);

- (2) 27 patients (three males, 24 females; mean age 18.2 years) who underwent orthodontic treatment without the use of splints (NST group);
- (3) 13 patients (four males, nine females; mean age 17.9 years) who received only splint therapy for TMD (control group; Table 1).

All patients were diagnosed as having internal derangement of the TMJs. Among these patients, those in the ST and NST groups agreed to receive occlusal reconstruction by orthodontic treatment after splint therapy for TMD. Fixed Edgewise appliances were used for orthodontic treatment. The reasons why the patients in the ST group received orthodontic treatment together with the use of splints were:

- (1) that it was difficult to continue the treatment because TMD symptoms occasionally recurred;
- (2) that mandibular position, which changed as a result of splint therapy for TMD, had to be maintained during the treatment.

The fixed appliances were removed after the amelioration of occlusal abnormalities, and retainers were fitted to ensure stability. Average orthodontic treatment time was 35.2 months (SD, 11.0 months) in the ST group and 35.6 months (SD, 13.0) in the NST group.

The following clinical findings were investigated:

- (1) TMJ sound (clicking sound on opening and closing of the mandible);
- (2) pain on movement of the TMJ;
- (3) restriction of movement (maximum opening of less than 35 mm);
- (4) types of malocclusion at the initial examination.

Two of the authors (TO and TK) examined the TMD symptoms of the patients. Malocclusion was classified into seven types: maxillary protrusion (mandibular deficiency), mandibular protrusion, anterior open bite, deep bite, crowding, posterior crossbite, and others (Kanazawa *et al.*, 1998).

Table 1 Characteristics of subjects and symptoms at the initial examination.

	ST	NST	Control
Sample size	18	27	13
Mean age (years)	18.6 ± 4.7	18.2 ± 4.6	17.9 ± 3.6
Gender ratio (M:F)	1:3.3	1:8	1:2.3
Joint sound (% sample)	13/18 (72.2)	22/27 (81.5)	10/13 (76.9)
Pain on movement of the TMJ (% sample)	15/18 (83.3)	20/27 (74.1)	10/13 (76.9)
Restriction of movement of the TMJ (% sample)	11/18 (66.7)*	6/27 (22.2)	4/13 (30.8)
Mean time T2–T4 (years)	4.9 ± 1.2	4.6 ± 1.1	4.4 ± 1.0

* $P < 0.05$.**Table 2** Number and percentage of patients who did not show each of the clinical symptoms after the initial examination.

	T2		T3		T4	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Joint sound						
ST (<i>n</i> = 13)	4 (1)	30.8	7	53.8	5 (2)	38.5
NST (<i>n</i> = 22)	8 (2)	36.4	13 (1)	59.0	11 (2)	50.0
Control (<i>n</i> = 10)	2	20.0	–	–	4	40.0
Pain on movement of the TMJ						
ST (<i>n</i> = 15)	9 (1)	60.0	14	93.3	13	86.7
NST (<i>n</i> = 20)	13	65.0	19 (1)	95.0	16 (1)	80.0
Control (<i>n</i> = 10)	8	80.0	–	–	9	90.0
Restriction of movement of the TMJ						
ST (<i>n</i> = 11)	11	100.0	10	90.9	11	100.0
NST (<i>n</i> = 6)	6	100.0	6	100.0	6	100.0
Control (<i>n</i> = 4)	4	100.0	–	–	4	100.0

Numbers in parentheses indicate patients who did not have that clinical symptom at the initial examination, but showed the symptom in subsequent examinations.

Clinical symptoms were examined at the initial examination (T1), at the end of the splint therapy for TMD or beginning of orthodontic treatment (T2), at the end of orthodontic treatment (T3), and at recall or 1 year after orthodontic treatment (T4).

The chi-square test was used to analyse differences in clinical symptoms between the three groups. A Student's *t*-test was used to compare mean ages and durations from T2 to T4 between groups.

Results

Table 1 shows the attributes of the subjects and symptoms at the initial examination. There were

no significant inter-group differences in mean age, gender, prevalence of joint sound, prevalence of pain on movement of TMJ, and duration from T2 to T4. However, the prevalence of restriction of movement of TMJ in the ST group was significantly higher than in the NST and control groups at the 5 per cent level.

Table 2 and Figure 1 show the number and percentage of patients who did not show each of the symptoms after the initial examination.

The percentage of patients with no joint sound at T2 was 30.8 per cent in the ST group, 36.4 per cent in the NST group, and 20 per cent in the control group. The percentage of patients without this symptom at T3 increased in the ST and NST groups. However, the percentage of

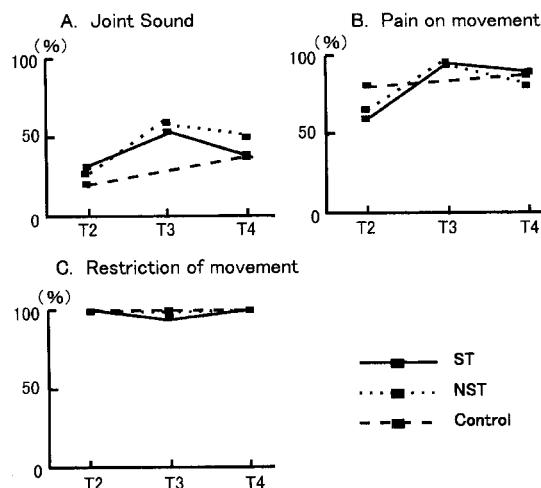


Figure 1 Temporal changes in symptoms of TMD. T2: end of conservative therapy for TMD or beginning of orthodontic treatment. T3: end of orthodontic treatment. T4: time of recall or 1 year after T3.

such patients at T4 decreased to 39–50 per cent. There were no significant inter-group differences at any time point. There were two patients in both the ST and NST groups who had joint sound at T2, T3, and T4, but not at T1.

The percentage of patients with no pain on movement of the TMJ at T2 was 60 per cent in the ST group, 65 per cent in the NST group, and 80 per cent in the control group. The percentage of such patients in both the ST and NST groups increased to over 90 per cent at T3, but then slightly decreased at T4. Approximately 80 per cent of the patients had no pain on movement of the TMJ at T4. There were no significant inter-group differences at any time point. One patient in the ST group and one in the NST group had pain at T2, T3, and T4, but not at T1.

None of the patients showed restriction of movement of the TMJ at T2. One patient in the ST group was found to have restriction at T3, but, again, no patient had restriction of movement at T4.

Table 3 shows the frequencies of types of malocclusion in the ST and NST groups. The most frequently observed type of malocclusion in the ST group was anterior open bite (44.4 per cent), followed by crowding (33.3 per cent), and

Table 3 Types of malocclusion in the ST and NST groups.

	ST	NST
Anterior open bite	44.4 (8)	37.0 (10)
Crowding	33.3 (6)	29.6 (8)
Posterior crossbite	11.8 (2)	3.7 (1)
Maxillary protrusion	0 (0)	18.5 (5)
Mandibular protrusion	0 (0)	11.1 (3)
Deep bite	5.9 (1)	3.7 (1)
Other types	5.9 (1)	3.7 (1)

Numbers in parentheses indicate patients who had the malocclusion at the initial examination.

posterior crossbite (11.8 per cent). In the NST group, the most frequently observed type of malocclusion was anterior open bite (37 per cent), followed by crowding (29.6 per cent), and maxillary protrusion (18.5 per cent). Thus, there was no noticeable difference between types of malocclusion in the ST and NST groups.

Discussion

The percentage of patients who had no joint sound increased from 31–36 per cent at T2 and to 54–59 per cent at T3, but decreased to 39–50 per cent approximately 5 years after the initial examination due to recurrence in some patients. Long-term follow-up studies of conservative treatment using splints for TMD patients show that satisfactory results were obtained in 57 per cent of patients 4 years after treatment (Le Bell and Kirveskari, 1990) and in 57 per cent of patients 6 years after treatment (Hansson *et al.*, 1984). Studies on joint sound in TMD patients (Hansson *et al.*, 1984; Le Bell and Kirveskari, 1990; Kurita *et al.*, 1992) show that in a small percentage of subjects with joint sound, who have been successfully treated, these symptoms may recur several years later. A small percentage of patients without joint sounds at the initial examination may exhibit joint sounds several years after the initial examination. The results of this study were similar to those of previous investigations.

Although there was no significant difference between the percentage of patients with no joint

sound in the ST and NST groups at T3, the percentage in the NST group was higher than that in the ST group at T4. The positional and morphological changes of the TMJ in ST patients were thought to have been more progressive than those in others patients because the prevalence of restriction of movement at the initial examination in the ST group was significantly higher than in the other two groups. As has been pointed out in previous studies (Hansson *et al.*, 1984; Miyazaki *et al.*, 1988; Lundh and Westesson, 1989; Le Bell and Kirveskari, 1990; Matsugi *et al.*, 1993; Endo *et al.*, 1995; Leeuw *et al.*, 1995), it is difficult to eliminate joint sound in TMD patients by conservative or even orthodontic treatment. Therefore, it has been suggested that the use of splints during orthodontic treatment is not very effective for eliminating joint sound.

Conservative treatment for pain on movement of the TMJ (Kai *et al.*, 1990; Matsugi *et al.*, 1993; Kashima *et al.*, 1994) produced satisfactory results in more than 60 per cent of patients, which is similar to that in this study. Moreover, the percentage of patients in both the ST and NST groups in whom pain was eliminated increased following orthodontic treatment. Although the mechanisms of improvement in clinical symptoms during orthodontic treatment are not clear, it is thought that pain on movement of the TMJ is alleviated or eliminated due to the therapeutic effect of the splint, and to the elimination of occlusal interferences caused by orthodontic tooth movement.

Dull pain and discomfort were not treated as pain in this investigation. Further studies are therefore needed to estimate the degree of disorders in daily life through evaluation of a wide range of pain and discomfort by using the Visual Analogue Scale for quantitative evaluation of pain and the McGill-Melzack pain questionnaire (Lynch, 1977) for subjective evaluation of pain.

Conservative treatment using splints is the first choice of therapy for restriction of TMJ movement (Kai *et al.*, 1990; Matsugi *et al.*, 1993; Kashima *et al.*, 1994). All of the subjects in this study received only conservative treatment, including manual reduction of the mandible, for restriction of TMJ movement. None of the

patients had restriction of TMJ movement after splint therapy. Many other authors have also reported satisfactory results using splint therapy in 80 per cent or more of patients (Kamegai *et al.*, 1990; Matsugi *et al.*, 1993; Kashima *et al.*, 1994).

Of the 11 patients in the ST group and the six patients in the NST group who had restriction of TMJ movement at the initial examination, only one patient in the ST group had a recurrence of this symptom during orthodontic treatment. Previously reported rates of recurrence of this symptom after conservative therapy are 17.2 per cent (Kashima *et al.*, 1994), 19.9 per cent (Matsugi *et al.*, 1993), and 11.4 per cent (Kamegai *et al.*, 1990). Thus, the results of this and previous studies show that, although the frequency is low, there is some recurrence of restriction of TMJ movement after conservative therapy. In the present series of patients, the prevalence of recurrence of restriction at T4 was 0 per cent in all groups. This indicates that the possibility of orthodontic treatment exacerbating or inducing recurrence of restriction of TMJ movement is very low. However, if considered necessary, a splint should be used during orthodontic treatment for TMD patients with a history of restriction of TMJ movement.

Several authors (Williamson and Sheffield, 1987; Miyazaki *et al.*, 1988; Terada *et al.*, 1994) report that anterior open bite is the most frequently observed type of malocclusion in TMD patients. Riolo *et al.* (1987), and Seligman and Pullinger (1989) also reported a relationship between open bite and TMD. Terada *et al.* (1994) proposed that biomechanical imbalance of the TMJ due to a steep mandibular plane and/or large gonial angle, which are morphological characteristics of the mandible in open bite cases, might induce abnormality of the articular disc. Therefore, there may indeed be a close relationship between open bite and TMD, and the improvement of open bite by orthodontic treatment is thought to be important from the standpoint of improving the orofacial function and prevention of recurrence of TMD symptoms, as well as facial morphology.

The results of this study show that orthodontic treatment for TMD patients does not cause recurrence or exacerbation of TMD symptoms.

Moreover, the results of many previous investigations have clearly shown that orthodontic treatment itself is not a cause of TMD (Luther, 1998). However, the differences between changes in the clinical symptoms of TMD patients who had undergone occlusal reconstruction by orthodontic treatment and those who had been treated by splint therapy could not be clarified. Recent studies on the natural time course of TMD symptoms have shown that severe symptoms in TMD patients who do not receive any treatment gradually disappear after several years (Yoda *et al.*, 1996; Sato *et al.*, 1997; Kurita *et al.*, 1998). The subjects in this study were followed for a period of 4 years after TMD therapy. Therefore, the reason why there were no differences in the changes in symptoms between the groups is thought to be due to the influence of the above specificity of this disease. A further reason was that the observation period after the end of orthodontic treatment was thought to be too short to estimate the efficacy of orthodontic treatment for TMD patients. Oral functions of orthodontic patients, such as mastication and pronunciation, gradually improve in the first 1–2 years after orthodontic treatment. Therefore, a further follow-up is needed to evaluate the efficacy of orthodontic treatment for TMD patients.

In this retrospective study, the TMD symptoms at the initial examination which altered during orthodontic treatment following splint therapy for TMD were investigated. Two of the authors examined the TMD symptoms of the patients. The criterion used in the selection of subjects for this study was that the patient's awareness of the symptoms was nearly consistent with the examiners' findings. It is therefore considered that the effects of orthodontic treatment on TMD symptoms based on this data is meaningful as the ages and gender of the subjects, and the duration of follow-up were almost the same in all three groups. However, for a more accurate evaluation of the efficacy of orthodontic treatment for TMD patients, a randomized, well-controlled clinical trial is required (Yuasa *et al.*, 1997).

Conclusions

The following conclusions were drawn from the results of this study:

- (1) The possibility of recurrence or exacerbation of TMD symptoms by orthodontic treatment performed on TMD patients after splint therapy for TMD is very low. However, it cannot be concluded that orthodontic treatment itself is a valid method for significantly improving TMD symptoms.
- (2) Orthodontic treatment combined with the use of a splint is effective for reducing pain and restriction of mandibular movement, but not for joint sound.
- (3) There seems to be a relationship between anterior open bite and TMD.

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