The effects of two methods of Class III malocclusion treatment on temporomandibular disorders

Hanefi Kurt*, Ceylan Alioğlu**, Banu Karayazgan***, Necat Tuncer* and Hülya Kılıçoğlu**
Departments of *Prosthodontics and **Orthodontics, Faculty of Dentistry, Istanbul University and ***Department of Prosthodontics, Faculty of Dentistry, Başkent University, Istanbul, Turkey

Correspondence to: Hanefi KURT, İstanbul Üniversitesi Diş Hekimliği Fakültesi, Total Parsiyel Protez Bilim Dalı Kat 2, 34093 Çapa, İstanbul, Turkey. E-mail: hkurt@istanbul.edu.tr

SUMMARY
The aim of this research was to evaluate, within a controlled clinical study, the effects of a Delaire-type facemask or a modified Jasper Jumper (JJ) used in the treatment of children with Class III malocclusions due to maxillary retrognathia on temporomandibular disorders (TMDs).

Forty-six patients with Class III malocclusions referred for orthodontic treatment were divided into two groups, a test and a control. The test group comprised 33 randomly chosen patients (15 females, 18 males) aged 8–11 years. The control group included 13 patients (eight females, five males) with similar features. TMD assessment was performed before and after treatment using a two-axis questionnaire, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMDs). Qualitative data were evaluated using chi-square and McNemar tests.

No statistically significant differences related to the presence of TMD were observed pre- or post-treatment (P > 0.05). The most commonly encountered diagnosis was arthralgia in the JJ group both before and after treatment. Evaluation of joint and muscle regions showed decreased symptoms, apart from the diagnosed discomforts, in the JJ group (P < 0.05). Reduced symptoms were observed in the Delaire group; however, this reduction was not statistically significant. An increase, not considered to be statistically significant, was observed in the control group. The Delaire-type facemask and modified JJ used in the early phase of Class III malocclusion treatment did not result in TMD.

Introduction
Temporomandibular disorders (TMDs) are a common condition that involves problems related to the temporomandibular joint (TMJ), masticatory muscles, and associated structures. Epidemiologic research has shown that TMD occurs in children as well as in adults, and several studies have investigated the prevalence of TMD in children. TMD in various populations has been reported to be between 17 and 90 per cent (Egermark-Eriksson et al., 1981, 1983; Nilner and Lassing, 1981; Lieberman et al., 1985; Kirveskari et al., 1992; Kritsinelli and Shin, 1992; Keeling et al., 1994; Deng et al., 1995; Sönmez et al., 2001; Thilander et al., 2002). TMD prevalence varies according to age, number, diagnostic method, and diagnostic criteria of the investigated individuals (Deng et al., 1995; Thilander et al., 2002).

It is difficult to isolate a single factor or to evaluate individual factors in the aetiology of TMD. Accordingly, TMD is considered to be a disorder with a multifactorial and complex aetiology (Greene, 2006; Okeson, 2008).

A diagnosis of TMD can be established via clinical examination and imaging. The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD; Dworkin and LeResche, 1992) is an index frequently used in epidemiologic studies (Haiter-Neto et al., 2002; Lindroth et al., 2002; Yap et al., 2002, 2003, 2004; Pergamalian et al., 2003; Ferrando et al., 2004; Schmitter et al., 2005) and clinical (Emshoff and Bertram, 1998; Pettengill et al., 1998; Carlson et al., 2001; Dworkin et al., 2002a,b; Ekberg et al., 2003; Wig et al., 2004) and is accepted as a reliable diagnostic criterion for the most frequently seen types of TMD. In addition to its use in adults, it has also been utilized in the evaluation of adolescents (Wahlund et al., 1998).

Although the factors that constitute TMD aetiology in children are classified by age, malocclusions, parafunctional movements, traumatic injuries, and orthodontic treatment, psychological factors are also thought to play a role (Hirata et al., 1992; Luther, 2007; Mohlin et al., 2007). Among these contributing factors, morphological and functional occlusions have been discussed, and their influence on natural muscle function is accepted.

Class III malocclusions are less frequently seen compared with other malocclusions, with a frequency of 1–14 per cent. Class III malocclusions comprise various skeletal and dental components, such as an insufficient (retrusive) maxilla or excessive (protrusive) mandible (Campbell, 1983; Guyer et al., 1986). Several treatment options for Class III malocclusions with a skeletal component are
classified as orthodontic treatment [facemask, modified Jasper Jumper (JJ), chin cap, etc.] when performed during the growth and developmental period and as orthodontic treatment together with surgery when performed post-adolescence.

Treatment aims to orthopaedically correct the disharmony between the jaws in skeletal Class III malocclusions. In this way, the protractive effects of the forces are directed to the mandible via bones. The presence of a Class III malocclusion has been emphasized as an aetiologic factor in TMD (Mohlin, 1983; Heikinheimo et al., 1989; Egermark-Eriksson et al., 1990); while other authors have not supported this point of view (Pilley et al., 1992). A further controversial issue with respect to Class III malocclusions is whether TMD begins due to the forces that occur in the joint area as a result of treatment (Ricketts, 1966; Riolo et al., 1987; Wyatt, 1987; Tanne et al., 1996; Deguchi et al., 1998) or not (Jansen and Bluher, 1965; Dibbets and van der Weele, 1991; Gavakos and Witt, 1991; Baik, 1995; Deguchi et al., 1998; Gökalp et al., 2000; Arat et al., 2003; Gökalp and Kurt, 2005).

The aim of this preliminary investigation was to evaluate the effect of a Delaire-type facemask or a modified JJ in children with a Class III malocclusion related to maxillary retrognathia on TMD in a controlled clinical study.

Subjects and methods

The protocol of this project (number: 2007/2936) was reviewed by the Ethics Committee of Istanbul University. Each subject’s parent or guardian signed an informed consent form prior to treatment. Forty-six patients with functional Class III malocclusions referred to the Department of Orthodontics, Istanbul University, were included in the study. The treatment group comprised 33 (15 females, 18 males) patients aged 8–11 years and the control group 13 patients (eight females, five males) with the same features and in the same age range. All patients were chosen via single randomization and distributed to a treatment groups in accordance with their order of arrival at the clinic. The treatment group was further divided into two groups: a modified JJ appliance was used in one group (16 patients) and a Delaire-type facemask in the second group (17 patients). Selection was made on the basis of the following criteria:

1. Skeletal relationship: skeletal Class III with maxillary retrognathism (SNA ≤ 79 degrees), ANB angle less than −1 degree, and a horizontal growth pattern (S–N/Go–Me: 30–32 degrees).
2. Dental relationship: Angle Class III with an anterior crossbite. The patients could achieve an edge-to-edge incisor position.

No subjects had a history of any other craniofacial anomalies and none had undergone prior orthodontic treatment.

The gender distributions and chronological and skeletal mean ages at the beginning of treatment are shown in Table 1. Hand–wrist radiographs taken for determining growth potential and bone age before treatment were evaluated according to Greulich and Pyle (1959).

TMD was evaluated with the RDC/TMD in the study group prior to appliance placement and removal. This evaluation was also performed in the control group before and after 6 months. In the two-axis questionnaire used for examination and diagnosis, some elements, such as evaluation of depression and somatization, occupation, marital status, monthly income, and educational status, were excluded to create an easier protocol through elimination of demographic information and data not related to TMD diagnosis. A prosthodontist (HK) trained in RDC/TMD examined the patients without the appliance in situ, with no knowledge to which of the groups the patients were assigned. Diagnoses were performed in accordance with the proposed criteria of RDC/TMD. Ten right and 10 left intra–extraoral muscles

Table 1  Age, gender and investigation period of the study population.

<table>
<thead>
<tr>
<th></th>
<th>Jasper Jumper (n = 16)</th>
<th>Delaire facemask (n = 17)</th>
<th>Control (n = 13)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>9.67 ± 0.95</td>
<td>9.55 ± 0.97</td>
<td>9.14 ± 0.40</td>
<td>0.209</td>
</tr>
<tr>
<td>1Chronological age (years)</td>
<td>9.63 ± 1.09</td>
<td>9.88 ± 1.04</td>
<td>9.36 ± 0.88</td>
<td>0.332</td>
</tr>
<tr>
<td>1Skeletal age (years)</td>
<td>4.90 ± 0.37</td>
<td>6.41 ± 0.50</td>
<td>6.00 ± 0.00</td>
<td>**</td>
</tr>
<tr>
<td>1Investigation period (months)</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>0.543</td>
</tr>
<tr>
<td>1Gender</td>
<td>Female</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>8</td>
<td>5</td>
<td></td>
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</tbody>
</table>

1Kruskal–Wallis test. 1Chi-square test. **P < 0.01.
and the lateral and posterior poles of the TMJ were palpated in both treatment groups for evaluation of changes in symptoms. The means of these values were obtained and the number of joints and muscles with pain was determined.

Treatment protocols and periodic follow-ups were performed by the same orthodontist (CA) for each subject. The patients were instructed to wear the facemask for 14 hours per day. The amount of force selected was 400 g on each side. In the modified JJ group, the amount of force was 200 g on each side. All treatment was discontinued once the Class III molar relationship and the anterior crossbites were satisfactorily corrected. As the patients were in the mixed dentition period, other treatment mechanics were not utilized. The patients were recommended to use a sleeping chin cap for 8 hours and monthly controls were conducted during the retention period. Clinical investigations were performed 1 day after appliance removal.

The NCSS (Number Cruncher Statistical System) 2007 and PASS 2008 Statistical Software packages (NCSS, Kaysville, Utah, USA) were used for analyses. For evaluation of the study data, along with descriptive statistical methods, parameters that were not normally distributed were evaluated using Kruskal–Wallis, Mann–Whitney U, and Wilcoxon signed rank tests. Qualitative data were evaluated using chi-square and McNemar tests. The results are given at the 95 per cent confidence interval and significance was accepted at the $P < 0.05$ level.

Results

TMD was observed in four subjects in the modified JJ group both before and after treatment. In the Delaire-type facemask group, TMD was observed in two subjects before treatment, but in three patients (including the two subjects before treatment) after treatment ($P > 0.05$). In the control group, the same two patients had TMD ($P > 0.05$; Table 2).

The distribution of the TMD types and the appliances provided before and after treatment are shown in Table 3.

Table 2 Evaluation of the presence of temporomandibular disorders (TMDs).

<table>
<thead>
<tr>
<th>Type</th>
<th>Group</th>
<th>$n$ (%)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMDs</td>
<td>Jasper facemask</td>
<td>4 (25.0)</td>
<td>0.590</td>
</tr>
<tr>
<td></td>
<td>Jumper</td>
<td>2 (11.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delaire</td>
<td>2 (15.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2 (15.4)</td>
<td></td>
</tr>
</tbody>
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*Chi-square test. †McNemar test.

The most widely diagnosed disorder was arthralgia. The predicted occurrence of disc displacements due to applied forces was seen in only one patient. Evaluation of TMD symptoms revealed a statistically significant decrease in the mean number of painful muscles after treatment in the modified JJ group ($P < 0.05$).

Statistically significant differences were found between the two groups with respect to the number of painful TMJs before treatment ($P < 0.05$). The mean in the modified JJ group before treatment was found to be higher than in the control group ($P < 0.05$). A statistically significant reduction was observed in the number of painful TMJs post-treatment compared with pre-treatment ($P < 0.001$; Table 4).

Discussion

In order to evaluate the effects of forces on the TMJ, the effect of chin cap application has been assessed (Deguchi et al., 1998; Gökalp et al., 2000; Gökalp and Kurt, 2005). However, there are only a limited number of studies that have investigated the effect of a facemask on the TMJ, even though it has an effect similar to that of the chin cap. It is known that a facemask that applies force to the maxilla obtains its support from the tip of the chin. It is demonstrated that the pressure of the mandibular condyle on the nerve and vessel mesh in the bilaminar zone could cause clinical signs of TMD (Wyatt 1987; Drace and Enzmann, 1990).

It is therefore important that clinicians understand the effect of orthopaedic facemask application in Class III malocclusions related to maxillary retrognathia. JJ appliances used in a modified manner are regarded as an alternative to extraoral appliances in order to eliminate problems of cooperation in the early period of treatment of Class III malocclusions with maxillary retrognathia. In this study, no effect on TMD was found for either appliance.

In the present study, the RDC/TMD was utilized in the diagnosis of TMD (Dworkin and LeResche, 1992). It has been reported that RDC/TMD can be used in multicentre research, is appropriate in multicultural comparisons, and is extremely reliable in children and adolescents (Wahlund et al., 1998). The present study used only RDC/TMD, rather than magnetic resonance imaging (MRI) or the Helkimo Index, as previously reported research focused on the effect of the appliances chosen for Class III malocclusion treatment (Gökalp et al., 2000; Arat et al., 2003; Gökalp and Kurt, 2005). The factors underlying this decision were the cost, the likelihood that children would not be
cooperative during MRI, the fact that the Helkimo Index has only superficial relevance for TMD, and the characteristic of the RDC/TMD as a diagnostic method that includes standardized criteria that provides separate diagnoses of a patient with multiple TMDs, and can diagnose subgroups. These factors are important in the evaluation of disc displacement resulting from Class III malocclusions. Additionally, the reliability and validity of RDC/TMD have been tested and can be safely used in children.

No correlation between orthodontic treatment and TMDs has been shown in several epidemiologic and long-term studies. However, the effects from occlusal discrepancies and orthodontic treatment have been shown to affect TMD development (Egermark et al., 2003).

The current research showed no significant differences before or after treatment with respect to the presence of TMD. Between-group values also demonstrated no significant differences among the Delaire-type facemask, the modified JJ, and the control groups.

No similar studies using RDC/TMD were found in the literature. However, the finding, that treatment in Class III malocclusion subjects had no effect on TMD, supports previous results (Gavakos and Witt, 1991; Deguchi et al., 1998; Gökalp et al., 2000; Henrikson and Nilner, 2000; Arat et al., 2003; Valle-Corotti et al., 2007; Rey et al., 2008).

The appliances used in the treatment of Class III malocclusions exert posterior forces on the mandible and the condyle, and these are associated with TMD. Depending on the protraction of the facemask, some of the force is transmitted to the TMJ through the mandible. It is thought that chin cap application, which applies a force via the mandibular condyle, could cause TMJ internal derangement. The research consensus on this subject is that the reactive forces due to chin cap treatment cause no TMJ derangement (Gökalp et al., 2000; Arat et al., 2003; Gökalp and Kurt, 2005). However, there is contradictory research (Deguchi et al., 1998).

The number of painful muscles and joints was found to be lower in the treated groups and significantly higher in the untreated control group. From these results, it can be speculated that treatment has a positive effect on the musculature system. In parallel with these results, there is research demonstrating a reduction in TMD symptoms after orthodontic treatment (Egermark and Thilander, 1992;
Kremanak et al., 1992; Egermark and Rönnerman, 1995; Henrikson et al., 1997, 1999; Henrikson and Nilner, 2000).

Conclusions

Within the limitations of this study, it can be concluded that the Delaire-type facemask and the modified JJ, used early in the treatment of Class III malocclusions, have no effect on the occurrence of TMD. Due to the reduced observed in the study group and the increase found in the control group, it can be accepted that these two treatments have a positive effect on patient quality of life.

References

Greene C S 1982 Orthodontics and the temporomandibular joint. Angle Orthodontist 52: 166–182