This study compares temporomandibular joint dysfunction (TMD) symptoms before and after bilateral sagittal split ramus osteotomy, and identifies predictive factors for the postoperative TMD symptoms by assessing the adjusted odds ratio using multiple logistic regression analysis. A consecutive series of 37 cases treated only with bilateral sagittal split ramus osteotomy were evaluated. New postoperative TMD symptoms appeared in 9 cases, preoperative TMD symptoms disappeared in 6 cases, and TMD symptoms were unchanged in 5 cases. The median period until the interincisal opening range attained 40 mm was 5 months (range, from 2 to 15 months). Age was a positive factor in patients with postoperative TMD symptoms, with an odds ratio of 1.43 (95 percent confidence interval, from 1.05 to 1.93). In addition, the maximum value of the bilateral setback distance of more than 9 mm was a positive factor of 6.95 (95 percent confidence interval, from 1.06 to 45.42). We concluded that surgical correction in skeletal malocclusion may affect temporomandibular joint dysfunction symptoms.

Key words: temporomandibular joint, Orthognathic surgery, Multiple logistic regression analysis

Introduction

Abnormalities in skeletal malocclusion may change the relationship between occlusion and the temporomandibular joint (TMJ) and may affect the morphology and function of TMJ. There is a proven relationship between TMJ and jaw deformities. Many articles have discussed the surgical and postoperative evaluation of the results of orthognathic surgery, showing various degrees of improvement, deterioration, or no change in TMJ dysfunction (TMD) symptoms after orthognathic surgery. However, the relationship has not yet been fully clarified. It is presumed that the factors influencing the TMD symptoms after orthognathic surgery relate mutually. In the univariate analysis used in the previous reports, the results were affected by various factors for each other. Westermark et al. illustrated the correlation between age and preoperative TMD symptoms. In their report, however, they confused the TMD symptoms after orthognathic surgery with TMD-like multifunctional disorder. Therefore, it is necessary to rectify the influence of confounding variables. In this study, we examined the changes in the TMD symptoms before and after sagittal split ramus osteotomy (SSRO). In addition, certain risks were adjusted...
simultaneously by multiple logistic regression analysis to obtain results that are more reliable. Multivariate analysis is more appropriate than univariate analysis in analyzing a multifunctional disorder such as TMD. To our knowledge, this analysis method has not been used for the simultaneous assessment of factors relating to postoperative TMD symptoms. Here, we discuss the predictive factors for postoperative TMD symptoms in patients with skeletal malocclusion before surgery by assessing the adjusted odds ratio resulting from multiple logistic regression analysis.

Materials and Methods

Cases

The study was based on a consecutive series of 37 cases only with bilateral sagittal split ramus osteotomy (SSRO) out of 105 patients operated on for jaw deformity in our oral and maxillofacial surgery clinic from January 1998 to October 1999. Of these 37 cases, 21 were female and 16 were male with a median age of 24 (range, from 19 to 35). Surgery comprised SSRO as described by Obwegeser and Dal Pont with a positioning device used to maintain the preoperative proximal segment position. Rigid fixation with two or three bicortical screws for each side of the mandible, and postoperative maxillo-mandibular fixation for 4 weeks and elastic traction was used in these cases. Elastic was used for the occlusion to lead into the inter-cuspal position. Preoperative and postoperative orthodontic treatment was carried out in all cases in this study.

Evaluation

All cases were examined before and 1 year after surgery by a TMJ specialist who had at least 6 years of clinical experience. We recorded the sex, age at surgery, TMJ pain, TMJ sounds (clicking, popping, or crepitus), masticatory muscle pain, range of maximal mouth opening before and after surgery, over-bite distance, difference and maximum value of bilateral setback distance, duration of postoperative maxillo-mandibular elastic traction and period until the interincisal opening range attained 40 mm. TMD symptoms were considered present if a patient had at least one TMD symptom (TMJ pain, TMJ sounds, masticatory muscle pain or restriction of mouth opening).

Statistical analysis

A chi-square test and Wilcoxon test were performed to investigate the influence of preoperative factors on the postoperative presence/absence of the TMD symptoms. Furthermore, a forward selection stepwise logistic regression model was used to simultaneously assess the relative odds of each of the 7 independent variables: sex, age at surgery, preoperative presence/absence of the TMD symptoms, over-bite distance, difference and maximum value of bilateral setback distance, and the duration of postoperative maxillo-mandibular elastic traction. These variables are useful in predicting the presence/absence of TMD symptoms postoperatively, are easy to control, with little correlation among the variables as a result of considering correlation. The endpoint was a binomial variable that depended on the presence of at least one TMD symptom (TMJ pain, TMJ sounds, masticatory muscle pain or restriction of mouth opening) 1 year after surgery. Continuous independent variables with a nonlinear relationship to the logarithm of the odds of the dependent variable were separated into binominal variables using appropriate cutoff values determined by plotting the log-odds against the values of the independent variable. After this procedure, the difference in the bilateral setback distance was divided into two groups of equal, or more than 5 mm or less than 5 mm, and the maximum value of the bilateral setback distance was equal, or more than 9 mm or less than 9 mm. Probabilities of less than 0.05 (two-tailed) were considered statistically significant. Data were analyzed using the software package SPSS for Windows, Version 11.5 (SPSS Japan Inc.).

Because this study was a retrospective analysis on the data set, written informed consent was not obtained from the participants, however the study was carried out in accordance with the guidelines of the Helsinki Declaration, as revised in 1996.

Results

The prevalence and variance of TMD symptoms before and after surgery are shown in Table 1. Of the 37 cases treated with SSRO, we observed preoperative TMD symptoms in 11 cases. TMJ pain was observed in...
1 case, TMD sounds in 5 cases, masticatory muscle pain in 5 cases and restriction of mouth opening in 1 case. We observed TMD symptoms postoperatively in 14 cases. TMJ pain was observed in 4 cases, TMJ sounds in 4 cases, masticatory muscle pain in 7 cases and restriction of mouth opening in 3 cases.

The variance in preoperative and postoperative TMD symptoms was classified using these descriptions: new postoperative TMD symptoms appeared, preoperative TMD symptoms disappeared, unchanged and no TMD symptoms before or after surgery. New postoperative TMD symptoms appeared in 9 cases, preoperative TMD symptoms disappeared in 5 cases, and were unchanged in 6 cases. The median period until the interincisal opening range attained 40 mm was 5 months (range, from 2 to 15). Thereafter, however, all TMD symptoms except for sounds that existed postoperatively improved or disappeared as a result of physical therapy, medication, or splint therapy.

In the univariate analysis to investigate relation of the preoperative factors to the postoperative presence/absence of TMD symptoms, no significant factor was extracted that was associated with the postoperative presence/absence of TMD symptoms. (Table 2)

Table 3 summarizes the significant contributing factors of the TMD symptoms revealed by a forward selection stepwise logistic regression model. Age was a positive factor for the postoperative TMD symptoms, with an odds ratio of 1.43 (95 percent confidence interval, 1.05 to 1.93). The maximum value of a bilateral setback distance of more than 9 mm was also a positive factor with an odds ratio of 6.95 (95 percent confidence interval, 1.06 to 45.42). No other factors were significantly associated with the postoperative presence of TMD symptoms.

Discussion

Several studies have reported a positive association between TMD symptoms and age in univariate analyses. However, there have been no reports associated with the progressive prediction of TMD symptoms after SSRO. In this study, progressive prediction was carried out with multiple logistic regression analysis. The analysis revealed two positive factors. If age at surgery is higher by 1 year, the probability of postoperative TMD symptoms increases 1.4-fold.

The positive predictor of age in our finding is inconsistent with the results of studies by Panula et al. and Westemark et al., which reported no association between age and symptoms. This inconsistency might be due to the differences in the evaluation
methods used. Panula et al. performed their calculations using the Wilcoxon matched pairs signed-ranks test. Westemark et al. compared the younger patients with the older patients using chi-square analysis. In the univariate analysis used in their reports, the results were affected by various factors each other, and the true TMD symptoms were confused with TMD-like multifunctional disorders. This problem is believed to be dissolved by using multiple logistic regression analysis applied in our present study. Solberg et al. showed that with increasing age there may be morphologic change in the TMJ associated with malocclusion. Since such morphologic changes effect similarly on patients with skeletal malocclusion after orthognathic surgery, correlation might be seen between age and postoperative TMD symptoms in our study. We observed no significant difference between sex and the improvement of TMD symptoms after orthognathic surgery, which is consistent with the findings of Westemark et al.

If the maximum value of the bilateral setback distance is more than 9 mm, the probability of postoperative symptoms increases 7-fold. Sakaki et al. reported that the greater the setback distance of the bone segment increases, the greater the changes in the average electric potential of the tem-

Table 2. Relation of the Preoperative Factors to the Presence/Absence of TMD Symptoms

<table>
<thead>
<tr>
<th>Sex</th>
<th>Male (n=16)</th>
<th>Female (n=21)</th>
<th>Postoperative absence of TMD symptoms</th>
<th>Postoperative presence of TMD symptoms</th>
<th>Significance of difference (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at surgery (year)</td>
<td>23 (1.8)</td>
<td>25 (2.5)</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative TMD symptoms</td>
<td>Absence (n=26)</td>
<td>17</td>
<td>9</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Over-bite distance (mm)</td>
<td>0 (0.3)</td>
<td>0 (0)</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference value in the bilateral setback distance (mm)</td>
<td>1 (1.5)</td>
<td>4.25 (3.9)</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum value of the bilateral setback distance (mm)</td>
<td>8 (1.5)</td>
<td>11.5 (1.9)</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of postoperative maxillo-mandibular elastic traction (month)</td>
<td>4 (1.9)</td>
<td>3.5 (1.5)</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The frequency of categorized factors are compared using Chi-square test. The continuous variables data are median (quartile deviation) value and compared using Wilcoxon test.

Table 3. Significant Contributing Factors of TMD Symptoms Present Postoperatively from Forward Stepwise Logistic Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Partial regression coefficient</th>
<th>Standard error</th>
<th>Odds ratio</th>
<th>95 percent confidence interval</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at surgery</td>
<td>0.35</td>
<td>0.16</td>
<td>1.43</td>
<td>1.05 ~ 1.93</td>
<td>0.02</td>
</tr>
<tr>
<td>Maximum value of the bilateral setback distance (more than 9 mm)</td>
<td>1.94</td>
<td>0.96</td>
<td>6.95</td>
<td>1.06 ~ 45.4</td>
<td>0.04</td>
</tr>
<tr>
<td>Constant</td>
<td>-9.95</td>
<td>4.22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
poral and masseter muscles over time at the mandibular rest position after SSRO increases on electromyography. In mastication, the central pattern generator, and the sensory feedback from the oral mucosa, masticatory muscles, and TMJ as well as periodontium, are reported to coordinate jaw elevator and depressor muscles and conduct rhythmic movements of mastication. Therefore, stable occlusion and anterior guidance at the incisors after surgery contributed to the postoperative stability of the masticatory rhythm. The extent of muscle activity in the masseter and temporalis muscles increased after surgery on electromyography or maximum occlusal force. Multiple factors such as occlusion and sensory feedback may cause this increase. Eckardt et al. reported that postoperative dicord in masseter excitation patterns is indicative of the risk of relapse and the prolonged phase of retention. This progression of mastication muscles activity might increase loading on the TMJ. However, diagnostic accuracy might be improved by adding the variance of operator or other factors.

Except for TMJ sounds, all other symptoms improved or disappeared with physical therapy or medication. These results suggest that the hyperactivity of the muscle decreases and the muscle adapts to the new position with postoperative treatment. The TMJ sounds, however, might remain because of the over-loading on the TMJ during the phase of muscle hyper-activity.

Changes in the TMD symptoms before and after orthognathic surgery have been reported, but the findings have varied. Kerstens et al. reported that 66% of the preoperatively symptomatic patients had improved; on the other hand 11.5% of preoperatively asymptomatic patients developed TMD symptoms after surgery, and showed no significant difference between the surgical techniques. White et al. reported that 89.1% of the symptomatic patients had improved TMJ function after orthognathic surgery, however, 2.7% were unchanged and 8.1% had increased symptoms; 7.9% of the patients asymptomatic prior to surgery developed TMD postoperatively. These studies evaluated various deformities using varied and combined surgical techniques. This wide disparity, therefore, might be explained by differences in race, skeletal morphology, surgical methods, and evaluation methods used. Multivariate analysis is more appropriate than univariate analysis in analyzing the multidimensional aspects of patients.

Several studies in the literature evaluate the position of the condyle before and after orthognathic surgery. Hu et al. showed that 22 condyles of the patients who received SSRO for mandibular setback appeared to be positioned posteriorly in the mandibular fossa, and suggested that the temporalis muscle and the masseter muscle attached to the proximal segment might pull posteriorly and superiorly, resulting in the condylar displacement. Posterior displacement of the condyle has been cited as a causative factor in the development of TMD symptoms. However, condylar displacement was not observed in our cases, because we used the positioning device to maintain the preoperative proximal segment position. Therefore, posterior condylar displacement is not the only causative factor of postoperative TMD symptoms.

We conclude that surgical correction in skeletal malocclusion may affect TMD symptoms. Since preoperative informed consent is important, the possible postoperative risks must be explained to patients before surgery. Predictive risk factors of TMD in a variety of orthognathic surgical procedures require investigative analysis.

References


