

Pathways between temporomandibular disorders, occlusal characteristics, facial pain, and oral health-related quality of life among patients with severe malocclusion

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SUMMARY The aim of this study was to examine the pathways between temporomandibular disorders (TMDs), occlusal characteristics, facial pain, and oral health-related quality of life in patients with severe malocclusion. The study comprised 94 (34 men and 60 women, mean age 38 years) adult patients who were referred for orthodontic or surgical–orthodontic treatment. All the patients had severe malocclusion. Oral health-related quality of life was measured with the Oral Health Impact Profile-14 scale (OHIP-14), the intensity of facial pain using a Visual Analogue Scale (VAS), TMD with Helkimo’s clinical dysfunction index (Di), and occlusal characteristics with the Peer Assessment Rating (PAR). A hypothetical model of the interrelationships between these factors was constructed based on the conceptual model of biological, behavioural, and psychosocial consequences of oral diseases. The associations were studied with path analysis. Women reported poorer oral health-related quality of life, higher pain levels, and had more severe TMD than men, but the gender difference was statistically significant only in pain and TMD. In contrast to the hypothetical model, among women the occlusal characteristics were not directly associated with oral health-related quality of life or facial pain. Among men, the occlusal characteristics were directly associated with oral health-related quality of life. In conclusion, patients with severe malocclusion who also have TMD and facial pain more often have impaired oral health-related quality of life. The associations of the occlusal characteristics with oral health-related quality of life differ between genders. Therefore, these associations should be studied separately among genders.

Introduction

Malocclusions may have several harmful consequences on individual health, such as pain and functional limitations. These are also common symptoms of temporomandibular disorders (TMDs). We have previously reported that patients with severe malocclusion needing combined surgical–orthodontic or only orthodontic treatment have considerably impaired oral health-related quality of life compared to a normal population when measured with the Oral Health Impact Profile-14 scale (OHIP-14) (Rusanen *et al.*, 2010). Also patients with TMD and orofacial pain have been shown to have impaired oral health quality of life compared to controls (John *et al.*, 2007; Reissmann *et al.*, 2007; Schierz *et al.*, 2008). This association has been reported especially among those with myogenous TMD (Reissmann *et al.*, 2007; Barros *et al.*, 2009).

Although several studies have found no scientific evidence for a relationship between occlusion and TMD (Seligman and Pullinger, 1991; Mohlin *et al.*, 2007), there is also controversy as to the role of occlusion (Kirveskari and Alanen, 1993; Raustia *et al.*, 1995; Alanen and Varrela,

1997; Kirveskari, 1997). Epidemiological studies have found associations between facial pain and TMD and various forms of malocclusion, such as mesial occlusion (Sipilä *et al.*, 2006), crossbite, anterior open bite, deep bite, Angle Class II and III malocclusions and large maxillary overjet (Alamoudi, 2000; Thilander *et al.*, 2002; Celic *et al.*, 2002; Schmitter *et al.*, 2007). These results are in agreement with recent studies with patient samples (Selaimen *et al.*, 2007; Abrahamsson *et al.*, 2009). According to Abrahamsson *et al.* (2009), patients who were referred for orthognathic treatment and had dentofacial deformities had more signs and symptoms of TMD than subjects with or without minor malocclusion.

Several studies have reported a gender difference in the prevalence of facial pain and TMD (Bush *et al.*, 1993; Sarlani and Greenspan, 2005). However, the gender differences between the impacts of oral health-related quality of life and TMD have been examined in only one study, which showed that of the dimensions of OHIP-14, women presented a greater impact for functional limitation compared to men (Barros *et al.*, 2009).

Previous studies concerning relationships between TMD, malocclusions, facial pain, and oral health-related quality of life have mainly focused on bivariate associations. Since multiple bivariate associations between these factors have been found, the possible pathways between these factors should also be explored. However, we found no studies taking into account the interrelationships between these factors. The aim of this study was to examine the simultaneous associations between TMD, occlusal characteristics, facial pain, and oral health-related quality of life in both genders with severe malocclusion.

Subjects and methods

The clinical study was performed during the years 2001–2004 in the Oral and Maxillofacial Department at Oulu University Hospital. The original study group comprised 120 consecutive volunteering patients, who were referred for orthodontic or surgical–orthodontic treatment, all with severe malocclusion, diagnosed by cephalometry, including intermaxillary discrepancy and functional disorders like pain or difficulty in mastication or traumatic occlusion. A questionnaire survey and a clinical examination were performed for 99 patients who signed the written consent to participate in this study. Five participants were excluded from the study because of missing values. Ninety-four participants had adequate clinical and questionnaire data and were included in the analyses. The types of malocclusions of the participant are presented in the Table 1. The mean age of the study sample was 38 years (SD 12 years, range 18–64 years); 60 of the participants (64%) were females and 34 (36%) males.

A standardized self-completed questionnaire was used to collect information about oral health-related quality of life during the last month and facial pain during the last year as well as background information on age and gender. Oral health-related quality of life was measured with the Finnish version of the OHIP-14 questionnaire with five ordinal response categories. This Finnish version of the OHIP-14 questionnaire has previously been found to be reliable and valid (Lahti *et al.*, 2008).

The responses to the OHIP-14 items were coded as follows: 0 ‘never’, 1 ‘hardly ever’, 2 ‘occasionally’, 3 ‘fairly often’, and 4 ‘very often’. If participants had three or more

missing OHIP items or three ‘do not know’ responses, they were omitted from the analysis (five patients), and if participants had one or two missing OHIP items, the sample mean for the group were used. A severity score for OHIP-14 was calculated by summing up the ordinal values of all items (range 0–56).

Facial pain was measured by asking the patients if they had had facial pain during the last year ‘never’, ‘occasionally’, ‘fairly often’, or ‘very often or continuously’. The intensity of pain was measured with a Visual Analogue Scale (VAS). The VAS assesses the intensity of facial pain at the moment with anchor points at the left- (no pain) and right-hand (worst pain imaginable) ends of a 100 mm horizontal line. If the patients reported having facial pain ‘occasionally’, ‘fairly often’ or ‘very often or continuously’, the VAS value was coded as 1, and if no facial pain existed, the VAS value was coded as 0.

The degree of TMD was assessed with the total score of the clinical dysfunction index (Di) of Helkimo (1974). The Di is based on the evaluation of five clinical signs: impaired range of movement, impaired function of the temporomandibular joint (TMJ), muscle pain, TMJ pain, and pain on movement of the mandible. The clinical examinations were performed by one trained and calibrated author (JR).

The occlusal analyses were performed on gypsum casts with the Peer Assessment Rating (PAR) method by one trained and calibrated examiner (A-SS). The PAR index values were calculated according to the method of Richmond *et al.* (1992), which has been shown to have excellent validity and reliability. The index has five components: an anterior component, buccal segments, overjet, overbite, and midline. All discrepancies were recorded when the casts were in occlusion defined by the wax registration. The PAR index gives a score representing the overall severity of occlusal discrepancies, which were recorded on study casts.

Statistical analysis

The mean values and 95% confidence intervals were calculated for OHIP-14 severity, Di, PAR, and VAS. The VAS was reported for all patients together and separately for those reporting facial pain. The mean values were calculated separately for men and women, and statistical significances of the differences were evaluated with *t*-tests.

Based on a conceptual model of biological, behavioural, and psychosocial consequences of oral diseases (Locker, 1988), a hypothetical model of the interrelationships between TMD, occlusal characteristics, facial pain, and oral health quality of life was constructed (Figure 1). To test if the hypothetical model fits the data, path analysis (PA) was conducted. PA is a widely used structural equation modelling (SEM) technique. SEM techniques are used to estimate how well presumed theoretical model fits the data. PA is for

Table 1 Distribution of the patients according to their malocclusions.

Malocclusion	<i>n</i>	%
Class II malocclusion	48	51
Class III malocclusion	20	21
Lateral crossbite	34	36
Lateral scissor bite	24	26
Lateral open bite	23	24
Open bite	10	11
Deep bite (>4 mm)	49	52

analysing structural models with observed variables. It involves estimation of presumed causal relationships using multiple regressions (Kline, 2005). Since gender differences have been found in TMD and facial pain, further gender-specific analyses were conducted. Models were then modified for best fitting by weighting non-significant paths to 0 (i.e. no effect). Standardized estimates, which can be interpreted as correlation coefficients, were calculated. The fit indices used were model chi-square and its significance, normed fit index (NFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). Model χ^2 should be non-significant indicating failure to reject the hypothesized model. NFI assesses the relative improvement in fit of the hypothesized model compared to independence model, which assumes no covariance among the observed variables. NFI has shown a tendency to underestimate fit in small samples, so it was revised to CFI which takes sample size into account. For NFI and CFI values over 0.95 indicate superior fit. RMSEA is a parsimony-adjusted index including correction for model complexity. Of two models with similar fit, it favours the simpler model. Values RMSEA < 0.05 indicate very good fit (Byrne, 2001; Kline, 2005). The statistical analyses were performed using SPSS version 16.0 and AMOS version 16.0. To handle missing data, AMOS uses Full Information Maximum Likelihood (FIML) procedure, which is an approach to the estimation of simultaneous equations (Graham *et al.*, 2003).

The study has been approved by the Ethics Committee of the Northern Ostrobothnia Hospital District.

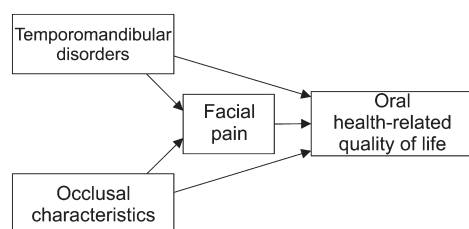


Figure 1 Hypothetical model of associations between temporomandibular disorders, occlusal characteristics, facial pain, and oral health-related quality of life.

Table 2 Mean values and 95% confidence intervals for oral health-related quality of life (OHIP-14 severity), facial pain (VAS), Helkimo's clinical dysfunction index (DI) and occlusal characteristics (PAR). Mean scores for facial pain reported separately for all and for those reporting facial pain (43 women and 12 men).

	All (<i>n</i> = 94)		Women (<i>n</i> = 60)		Men (<i>n</i> = 34)		<i>P</i>
	Mean	95% CI	Mean	95% CI	Mean	95% CI	
OHIP-14 severity	18.08	15.74–20.41	19.67	16.60–22.74	15.27	11.76–18.78	0.072
VAS	2.95	2.30–3.61	3.72	2.86–4.57	1.61	0.71–2.50	0.001
VAS among those with pain	5.05	4.33–5.76	5.19	4.34–6.04	4.55	3.13–5.97	0.467
Dysfunction index	8.99	7.88–10.10	9.95	8.62–11.28	7.29	5.36–9.23	0.022
PAR	31.55	29.13–33.98	31.35	28.20–34.51	31.90	27.91–35.89	0.568

Results

Of the examined malocclusion patients, 58% had experienced facial pain during the preceding year before the examination. The corresponding figures were 67% and 38% for women and men, respectively ($P = 0.007$, chi-squared test).

Women reported poorer subjective oral health-related quality of life, i.e. the mean OHIP-14 severity score was higher among women than among men, but the difference was not statistically significant (Table 2). Women reported higher VAS scores than men. Women also showed significantly higher scores on the Di index compared to men. The mean PAR scores were almost at the same level among both genders (Table 2).

The hypothesized model did not fit either female or male patients well. When modifying the women's model to fit the data, Di and PAR indices had to be allowed to correlate and the effects of occlusal characteristics to facial pain and oral health-related quality of life were restricted to 0 (i.e. no effect). This model resulted in a very good fit (Figure 2). When modifying the men's model to fit the data, Di and PAR indices had to be allowed to correlate and the effects of occlusal characteristics to facial pain were restricted to 0. In men, unlike in women, occlusal characteristics were associated with oral health-related quality of life. The model resulted in a very good fit (Figure 3).

Discussion

The results of the study showed that TMD, occlusal characteristics, and facial pain were associated with oral health-related quality of life among men and women with severe malocclusion, but the association of the occlusal characteristics with oral health-related quality of life differed between genders. Both men and women had direct and indirect (via facial pain) associations between TMD, and the oral health-related quality of life and the associations were almost similar. However, there was a gender difference in the associations between occlusal characteristics and oral health-related quality of life. Among men, the occlusal characteristics were directly associated with oral health-related quality of life, whereas among women, these factors

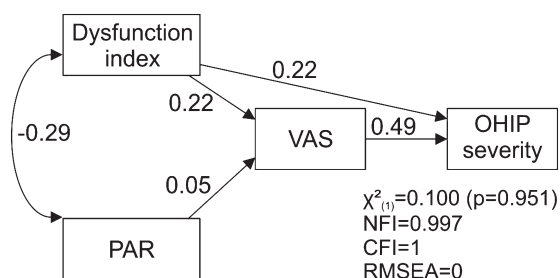


Figure 2 Standardized estimates for women's final modified path model of associations between temporomandibular disorders (Helkimo's clinical dysfunction index), occlusal characteristics (PAR), facial pain (VAS), and oral health-related quality of life (OHIP-14 severity).

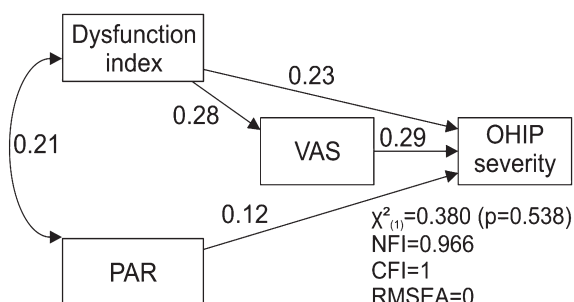


Figure 3 Standardized estimates for men's final modified path model of associations between temporomandibular disorders (Helkimo's clinical dysfunction index), occlusal characteristics (PAR), facial pain (VAS), and oral health-related quality of life (OHIP-14 severity).

did not associate. Women reported generally poorer oral health-related quality of life, higher pain levels, and had more severe TMD than men, but the gender difference was statistically significant only in pain and TMD.

The sample of the present study consisted of patients who had been referred for orthodontic or combined surgical-orthodontic treatment, thus representing a specific group of patients. Those patients were chosen for the study because severe malocclusions are quite rare in a healthy population. The patients had diagnosed severe malocclusion with considerable functional disorders, and different types of malocclusions were evenly represented in this study group (Rusanen *et al.*, 2010). The number of patients was sufficient, allowing us to analyse interrelationships between TMD, occlusal characteristics, facial pain, and oral health-related quality of life separately for both genders. In the present study, using Helkimo's dysfunction index (Di) was preferred because it allows numerical scoring of the severity of TMD, although it gives no information of any diagnostic subclassification, unlike the generally used valid criteria, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Dworkin and LeResche, 1992). Occlusal characteristics were measured with the generally used PAR index. The PAR index gives a score representing the overall severity of occlusal discrepancies, and it has been shown to have excellent validity and reliability (Richmond *et al.*, 1992). The application of occlusal indices

have had a role in resource allocation and planning but also in promoting treatment standards and measuring the outcome. The most commonly used in this respect have been IOTN (an index of treatment need) and PAR (an index of treatment outcome) (Richmond *et al.*, 1995). As IOTN is mostly used in epidemiological studies to evaluate the prevalence and PAR in longitudinal treatment outcome studies, we decided to use PAR, especially as we wanted to evaluate the outcome on dental casts.

Previous studies concerning TMD, malocclusions, facial pain, and oral health-related quality of life have focussed on bivariate associations and have not taken into account the interrelationships of these factors (Seligman and Pullinger, 1991; Sipilä *et al.*, 2006; John *et al.*, 2007; Reissmann *et al.*, 2007; Mohlin *et al.*, 2007; Selaimen *et al.*, 2007; Abrahamsson *et al.*, 2009). Thus, there was a need to construct a single PA model of associations between TMD, occlusal characteristics, facial pain, and oral health-related quality of life. Because the association of the occlusal characteristics with oral health-related quality of life differed between genders, separate modified models of the associations were made for women and men.

Patients with TMD suffer from orofacial pain more often than subjects without TMD (Sipilä *et al.*, 2002; Sarlani and Greenspan, 2005; Abrahamsson *et al.*, 2009). Barros *et al.* (2009) found that orofacial pain had a great impact on the quality of life of individuals with TMD in both genders, which is congruent with our study. Also other studies have shown an impairment of oral health-related quality of life among patients with facial pain and TMD (Segu *et al.*, 2005; John *et al.*, 2007; Reissmann *et al.*, 2007; Schierz *et al.*, 2008; Renner-Sitar *et al.*, 2008; Dahlström and Carlsson, 2010). Severe malocclusion has been shown to impair considerably patients' physical, psychological, and social aspects of quality of life (Bernabé *et al.*, 2008; Rusanen *et al.*, 2010). The association between VAS on facial pain and OHIP-14 found in our study is in line with the results by Luo *et al.* (2007), who found that community-dwelling elderly people reported higher OHIP-14 scores and poorer oral health-related quality of life when they had simultaneous facial pain. In this study, the VAS score among patients with facial pain was congruent with the study of Selaimen *et al.* (2007), where facial pain level was of moderate intensity. The total mean VAS scores of the subjects in this study were 3.72 for women and 1.61 for men, indicating that the facial pain was not, on average, the major complaint among these patients with severe malocclusion.

The association between occlusal discrepancies and TMD has also been found in other studies (Mohlin *et al.*, 2004; Cuccia and Caradonna, 2008), thus supporting our results. A follow-up study by Mohlin *et al.* (2004) reported significantly higher PAR scores among subjects with most severe TMD. The correlation between TMD and occlusal characteristics was found in both genders being positive among men (TMD problems occurring more often among

those with occlusal discrepancies) and negative among women (TMD problems occurring less often among those with occlusal discrepancies). Studies have shown controversial results regarding the role of occlusion in TMD. Gesch *et al.* (2005) found no significant associations between factors of functional occlusion and TMD symptoms, while Wang *et al.* (2002) did not find any significant occlusal feature differentiating TMD patients from patients with malocclusion or from the average population.

According to previous studies, women suffer more often from TMD (Sarlan and Greenspan, 2005) and chronic orofacial pain (Bush *et al.*, 1993) as well as report more often severe oral impacts (McGrath and Bedi, 2000) than men. The present study also showed that women had poorer oral health-related quality of life, more intense facial pain (measured with the VAS), and more severe TMD than men. One explanation to the gender difference has been suggested to be the neural processing concerning pain perception. The nociceptive input may be more easily unregulated into pathological hyperexcitability among women than among men (Sarlan and Greenspan, 2005), which may in turn contribute to development and/or maintenance of chronic TMD pain.

The higher proportion of women in this study sample may reflect the differences in treatment-seeking behaviour between the genders. Pain and poor oral health-related quality of life were possibly the main reasons for women to seek TMD or orthodontic treatment. In addition, women usually have greater awareness or interest in symptoms (Bush *et al.*, 1993). Besides pain, there are also other reasons for seeking orthodontic treatment, like aesthetic problems and health-related or functional concerns (Mayo *et al.*, 1991), or distinct psychological problems, such as anxiety, lower body image, and facial body image (Cunningham *et al.*, 2000). In this study, women and men had different pathways of how the occlusal characteristics were associated with the oral health-related quality of life. Among men, the association between those variables was direct. The daily lives of men were impaired mainly due to malocclusion instead of pain, which occurred in women. This result could indicate gender differences in reasons leading to treatment seeking.

In this study, some questions were raised. It would be interesting to assess how men and women seek or are referred to treatment because if men did not suffer from pain at the same level as women, there must be other factors that affect treatment seeking. It would also be interesting to know whether there are some differences in treatment outcome between genders because women had poorer oral health-related quality of life and more facial pain than men at baseline.

Conclusion

The association of the occlusal characteristics with oral health-related quality of life differed between genders.

Because of the gender difference, these associations should be studied separately.

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