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Occlusal characteristics and quality of life before and after treatment of severe malocclusion

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SUMMARY The aim of this study was to evaluate the relationship between occlusal characteristics and oral health-related quality of life in adults who underwent orthodontic or orthodontic–surgical treatment. The study group consisted of 51 adult patients (35 women, 16 men) with severe malocclusion and considerable functional disorders. Thirty-six of the patients underwent combined orthodontic–surgical treatment, while 15 underwent orthodontic treatment. Data were collected before and after treatment. Mean follow-up period was 5.0 years (range 2.2–6.7 years). Occlusal characteristics were measured from dental casts by using Peer Assessment Rating (PAR) index. A self-completed Oral Health Impact Profile (OHIP-14) was used to measure oral impacts. The changes in PAR and OHIP-14 were measured, and correlation between PAR and OHIP tested before and after treatment and in the changes during the follow-up. Statistical significance was evaluated with the paired samples *t*-test and Mann–Whitney *U*-test, and the correlation between PAR and OHIP scores assessed using Pearson's and Spearman's correlation coefficient. The occlusion was significantly improved in all subjects, mean PAR reduction being 78.1 per cent. The prevalences of oral impacts at threshold `fairly often' or `very often' before and after treatment were 70.6 per cent and 9.8 per cent, respectively ($P < 0.001$). The PAR and OHIP scores correlated after treatment but not before treatment or in the changes. The treatment of severe malocclusion reduced the reported oral impacts to the level of general population and significantly improved oral health-related quality of life.

Introduction

Malocclusion and dentofacial deformities are highly prevalent and can have an influence on physical, social, and psychological functioning (Lee *et al.*, 2007; Rusanen *et al.*, 2010). Traditionally, orthodontists and health care providers have focused on the clinical-centred measures of outcome for orthodontic treatment, but in recent years, attention to patient-based assessment has greatly increased in dental research (Cunningham and Hunt 2001; Zhang *et al.*, 2006). Oral health-related quality of life is a multidimensional concept that includes subjective evaluation of perceived physical, psychological, and social aspects of oral health and no single measure has been developed that captures the concept completely (Locker and Allen 2007). Both generic and disease-specific measures have been used to measure health and oral health-related quality of life (Allen *et al.*, 1999). Also in orthognatic research generic measures such as SF-36, Sickness Impact Profile, Oral Health Status Questionnaire, and OHIP-14 as well as disease-specific measures such as Orthognatic Quality of Life Questionnaire have been used; the OHIP-14 most often (Hatch 1998; Motegi 2003; Tajima *et al.*, 2007; Lee *et al.*, 2008; Nicodemo *et al.*, 2008, Esperão *et al.*, 2010; Feu *et al.*, 2010; Hassan and Amin 2010; Rusanen *et al.*, 2010).

In our previous work, we reported higher levels of oral impacts in patients with severe malocclusion compared with a normal population (Rusanen *et al.*, 2010). Hassan and Amin (2010) also found an impact of malocclusion on oral health-related quality of life of young adults. Furthermore, the subjects with more severe malocclusion and dentofacial deformities are more likely to report oral impacts than those with milder malocclusion (Tajima *et al.*, 2007). However, only few longitudinal studies have been published concerning the effect of a change in occlusion on the quality of life. The studies published have reported a positive impact of orthognathic surgery on the quality of life (Hatch 1998; Motegi 2003; Lee *et al.*, 2008; Nicodemo *et al.*, 2008, Esperão *et al.*, 2010), but the instruments measuring the quality of life and the study groups used have varied greatly. In addition, the follow-up periods have been very short in most of the studies. Quality of life changes in relation to conventional orthodontic treatment have been studied more in children and adolescents than in adult populations (de Oliveira and Sheiham, 2004; Chen *et al.*, 2010). The understanding of the relationship between quality of life and malocclusion, as well as the impact of treatment, is important for clinicians and patients seeking treatment.

The aim of this longitudinal study was to evaluate the changes and the relationship between occlusal characteristics and oral health-related quality of life in adults before and after orthodontic or orthodontic–surgical treatment.

Material and methods

One hundred and sixty-nine adults were screened for the investigation. All the patients were referred for orthodontic treatment to the Oral and Maxillofacial Department at Oulu University Hospital, Finland, during the years 2001–2004. The inclusion criterion was severe malocclusion with considerable functional disorders. The original study group comprised 99 adult patients all of whom had severe diagnosed skeletal malocclusion, diagnosed by cephalometry, with considerable functional disorders like pain or difficulty in mastification or traumatic occlusion. The flow of the subjects through each stage of the study is shown in Figure 1. Analysis of the loss of subjects was conducted, but no statistically significant differences were found in gender, age, oral health impacts, or Peer Assessment Ratings (PARs) of occlusion between the follow-up participants and the subjects who declined to take part in the study.

The subjects for this study consisted of 51 patients; 36 underwent combined orthodontic–surgical treatment and 15 underwent orthodontic treatment. The surgical techniques were either a sagittal ramus osteotomy and/or Le Fort I osteotomy. With reference to oral health status, the necessary dental care was conducted before the treatment. The post-treatment dental casts were taken an average of 1.5 years after active treatment and the questionnaires collected an average of 2.8 years after treatment. The total follow-up period was on average 5.0 years (range: 2.2–6.7 years). The demographic characteristics of patients are described in more detail in Table 1.

Occlusal characteristics were measured by using the PAR index (Richmond *et al.*, 1992a), which has been shown to have excellent validity and reliability (Richmond *et al.*, 1992a; DeGuzman *et al.*, 1995). The PAR index consists of five components: an anterior segment, buccal segments, overjet, overbite, and midline. The individual scores of the components were weighted according to British weightings and summed to the weighted PAR score (Richmond *et al*. 1992b). Higher scores indicated increased levels of irregularity. In cases with an individual missing tooth, a space of more than 4 mm was not recorded if the patient was to receive a prosthetic replacement. One author (AS), calibrated for the use of the PAR index, scored the dental casts with the PAR ruler. The intra-observer error of the measurements was evaluated by rescoring 20 randomly selected dental casts. The repeated measurements were compared using intraclass correlation (ICC). The correlation was 0.99 in weighted PAR scores.

The oral health-related quality of life was measured using a Finnish translation of the 14-item Oral Health Impact Profile (OHIP-14) as it was valid and reliable and had been used in a nationally representative survey to get population estimates for prevalence, extent, and severity (Lahti *et al.*, 2008). It had five ordinal response categories. A questionnaire was collected before treatment and after the follow-up period.

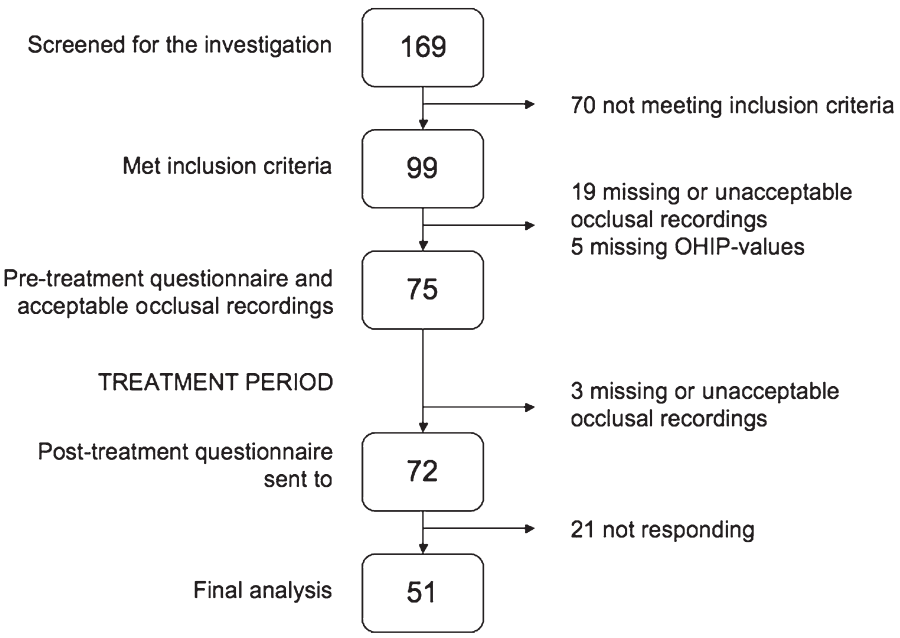

Figure 1 Chart showing the flow of the subjects through each stage of the study.

Table 1 Demographic characteristics of patients.

	Male	Female	All
Gender (*n*)	16	35	51
Treatment (%)			
Surgery	75.0	68.6	70.6
Orthodontic	25.0	31.4	29.4
Age (y)			
Mean	33.8	37.5	36.4
Min	18.2	20.1	
Max	54.9	61.6	
Treatment time (y)			
Mean	2.20	2.1	2.1
Min	1.6	1.0	
Max	2.7	3.2	
Follow-up period (y)			
Mean	5.0	5.0	5.0
Min	2.8	2.2	
Max	6.4	6.7	

OHIP-14 includes seven conceptual dimensions of oral health-related quality of life. The dimensions are functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap (Slade and Spencer 1994). These dimensions are based on the conceptual model of oral health (Locker 1988). It has been shown that OHIP shows good discrimination, construct validity properties, and has good reliability, validity, and precision (Slade 1997; Allen *et al.*, 1999). The Finnish translation has been found to be valid and reliable (Sutinen *et al.*, 2007; Lahti *et al.*, 2008).

Responses were coded as follows: 0 = 'never', 1 = 'hardly ever,' 2 = 'occasionally', 3 = 'fairly often', and 4 = 'very often'. The OHIP-14 severity score (potential range 0–56) was calculated by summing ordinal values for 14 items. Item-specific responses were categorized by using two cut-off points: FoVo (fairly often, very often) and OFoVo (often, fairly often, very often). The extent and prevalence scores were calculated using both cut-off points. The extent score is the number of items reported (potential range 0–14). The prevalence is the percentage of people reporting one or more items. Higher OHIP scores indicate worse and lower scores indicate better oral health-related quality of life. For cases with one or two missing OHIP items, values were imputed using the item's sample mean.

Statistical analysis

Normality of changes in PAR and OHIP scores was assessed before the analysis. Post-treatment PAR and OHIP scores were non-normal, which is why non-parametric methods were used. Pre-treatment PAR and OHIP scores and the changes in PAR and OHIP scores were normally distributed, so parametric tests were used when studying those. The means and medians of the PAR scores were calculated and the statistical significances were evaluated using the paired samples *t*-test. Differences in PAR scores between treatment groups (orthodontic–surgical treatment versus orthodontic treatment) were evaluated using *t*-tests and Mann–Whitney *U*-test. The reduction and the percentage reduction of the pre- and post-treatment weighted PAR scores were calculated. The cases were also divided into three categories: 'Worse/No different', 'Improved', and 'Greatly improved'. In order for a case to be improved, the PAR score has to be reduced by at least 30 per cent. For a case to be greatly improved, the score has to be reduced by at least 22 PAR points (Richmond *et al.*, 1992 b). The means and medians of the OHIP scores were calculated and the statistical significances were evaluated using the paired samples *t*-tests. The reduction and the percentage reduction of the pre- and post-treatment OHIP scores were calculated. The mean scores for the seven dimensions of OHIP-14 before and after treatment as well as the mean change scores were evaluated. The correlation between PAR total scores and OHIP severity scores was assessed before and after treatment and between the changes during the follow-up period, using Pearson's and Spearman's correlation coefficients. The subjects were divided into groups depending on the improvement in PAR. The groups were compared according to the changes in OHIP, and the independent samples *t*-test was used to test the statistical significance. The statistical analyses were performed using the Statistical Package for Social Sciences version 16.0 (SPSS Inc., Chicago, Illinois, USA).

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

Table 2 The components and the weighted total score of the Peer Assessment Rating (PAR) index before and after treatment (*P* values of paired samples *t*-tests).

PAR	Before		After		Change (%)	*P*
	Mean	Med	Mean	Med		
Anterior segments	6.1	6	0.4	0	93	<0.001
Buccal segments	4.5	4	2.7	3	40	<0.001
Overjet	2.6	3	0.5	0	81	<0.001
Overbite	1.5	1	0.2	0	87	<0.001
Centreline	0.6	1	0.2	0	67	<0.001
PAR weighted total	31.8	34	6.9	4	78	<0.001

Results

Occlusal characteristics

The total PAR decreased on average 78 per cent, and the change was statistically significant in all PAR components ($P < 0.001$; Table 2). The pre-treatment PAR scores were significantly lower in the orthodontically treated group compared to the orthognathic–surgery group, the mean values being 25.5 and 34.5, respectively ($P = 0.005$), but no

significant difference was found in PAR scores between the groups after treatment (6.1 versus 7.2, respectively, $P = 0.524$). The improvement was greater in the surgery group than in the orthodontic group, mean values being 27.3 and 19.4, respectively ($P = 0.007$). When the results were expressed in terms of treatment outcome, 29 patients (57 per cent) were allocated to the Greatly improved group and 22 patients (43 per cent) were classified as Improved. None of the patients were classified as 'Worse or no different'.

Oral health-related quality of life

In all OHIP outcome variables ('severity', 'extent', and 'prevalence'), the change in reported oral impacts before and after treatment was statistically significant (Table 3). The proportion of subjects reporting at least one oral impact 'fairly often' or 'very often' ('prevalence') at the end was over 7-fold lower than before treatment. There were no statistically significant differences in any OHIP variables between the surgical and non-surgical groups in any OHIP variables (severity, extent, prevalence) before or after treatment in the changes during the follow-up. The mean scores for the seven dimensions of OHIP-14 before and after treatment as well as the mean change scores are presented in Figure 2.

The relationship between occlusal characteristics and oral health-related quality of life

The correlation between PAR total scores and OHIP severity scores was assessed before and after treatment and between the changes during the follow-up period. A statistically significant correlation 0.307 ($P = 0.028$) was found after the follow-up. Higher PAR scores were associated with higher level of oral impacts. Among all subjects, the change in occlusion was classified as Improved or Greatly improved. No statistically significant differences were found in the changes in OHIP scores between 'Improvement' and 'Greatly improvement' groups (Table 4).

Table 3 Mean and medians of the scores of the Oral Health Impact Profile-14 (OHIP-14) before orthodontic/orthodontic–surgical treatment and after the follow-up period (P values of paired samples t-tests).

OHIP	Before		After		Change (%)	P
	Mean	Med	Mean	Med		
Severity	17.6	18	4.1	3	77	<0.001
Extent (FoVo)	2.6	2	0.1	0	96	<0.001
Extent (OFoVo)	5.8	6	1.2	0	79	<0.001
Prevalence (FoVo)	70.6		9.8		86	<0.001
Prevalence (OFoVo)	94.1		49.0		48	<0.001

Severity, sum of OHIP impacts (0–56); extent, number of items reported (potential range 0–14) fairly often or very often (FoVo) or occasionally, fairly often or very often (OFoVO); prevalence, the percentage of subjects reporting at least one OHIP impact.

Discussion

When occlusion is improved, oral health-related quality of life improves in general. The mean PAR reduction that was achieved was 78.1 per cent, an improvement of more than 70 per cent being considered a good standard of orthodontic treatment (Richmond *et al.*, 1992b). In the present sample, the prevalence of reported oral impacts before treatment was 7-fold higher when compared with the results of the average Finnish adult population (Lahti *et al.*, 2008). After

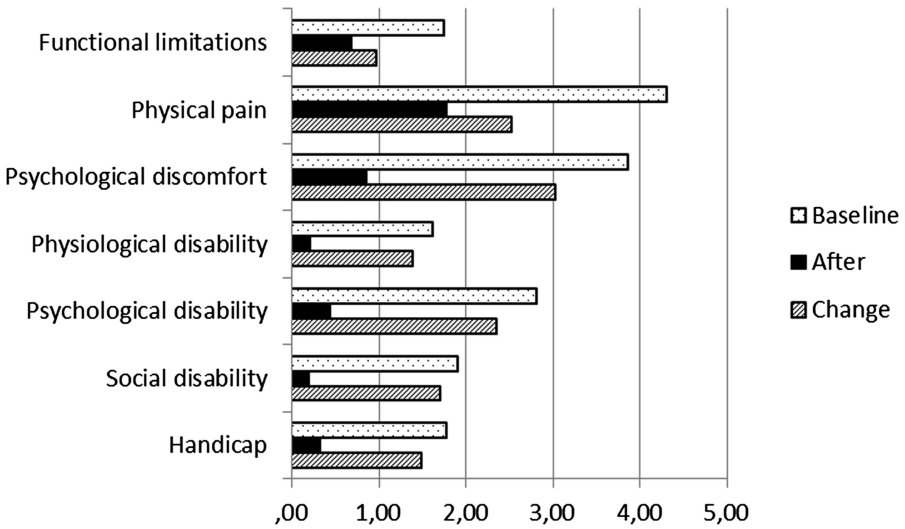

Figure 2 Mean scores for OHIP-14 dimensions before and after treatment and the mean scores for change.

Table 4 Changes in Oral Health Impact Profile-14 variables in relation to the Improved and Greatly Improved occlusal outcome groups.

	Improved	Greatly improved	
	Mean	Mean	*P*
Severity change	12.4	14.3	0.530
Extent change (FoVo)	2.2	2.7	0.494
Extent change (OFoVo)	4.5	4.7	0.854
Prevalence change (FoVo)	0.5	0.7	0.211
Prevalence change (OFoVo)	0.6	0.3	0.108

Improved = more than 30% improvement in the total weighted PAR score. Greatly improved = more than 22 points reduction in the total weighted PAR score.

treatment, the OHIP severity score was lowered to the normal level of Finnish adults (Lahti *et al.*, 2008). However, the correlation between the changes in occlusion and changes in oral health impacts was not statistically significant. This can be explained by the fact that all the subjects had severe malocclusion with functional disorders at the beginning of the study, causing the low variability in the study group.

The strength of this study was the long follow-up period compared to previous studies (Azuma *et al.*, 2008; Lee *et al.*, 2008; Nicodemo *et al.*, 2008). The instruments used were tested to be valid and reliable (Richmond *et al.*, 1992a; DeGuzman *et al.*, 1995; Slade 1997; Allen *et al.*, 1999; Lahti *et al.*, 2008). The intra-observer reliability was very high in PAR measurements. The study did not include an untreated control group, but it would not be ethically acceptable to leave part of the patients with symptoms untreated, which is why the population standard was used instead (Lahti *et al.*, 2008). In this study, loss of subjects was mostly seen due to long follow-up and external reasons, such as migration. The analysis of the loss of subjects revealed no statistically significant differences between the study group and the lost subjects in gender, age, pre-treatment PAR status, or pre-treatment OHIP status.

The treatment outcome measured with PAR index was good, but the PAR score for buccal occlusion was still relatively high after treatment. The high score in the post-treatment buccal occlusion indicates the difficulty of achieving good interdigitation with orthodontic/orthodontic–surgical treatment as many of the patients had severe sagittal malocclusion before treatment.

In 45 patients (88 per cent), the OHIP severity score was reduced more than 2.5 units, which is regarded as a clinically relevant change (Sutinen *et al.*, 2007). The results in this longitudinal study show that the improvement in quality of life is not just a temporary situation after treatment. The improvement after orthodontic–surgical treatment is in agreement with previous studies (Motegi *et al.*, 2003; Lee 2008; Hatch *et al.*, 1998). However, the reduction of oral impacts in this study was more obvious than in most studies. Lee (2008) found an improvement in OHIP-14 in orthognathic patients 6 months post-operatively, but the change was significantly smaller compared to the previous study with long follow-up. Hatch *et al.* (1998) followed orthognathic patients for 2 years post-operatively and found progressive improvement after surgery in disease-specific and generic health-related quality of life. Motegi *et al.* (2003) found that improvements in oral health-related quality of life were stable between 2 and 5 years after surgery. To date, oral health-related quality of life in relation to conventional orthodontics in adult patients is still widely an unexplored field in dental research. It can be discussed whether this is a consequence of patient material being available or researchers focussing on orthognathic surgery.

In this study, no statistically significant difference was found in changes in OHIP variables between Improved and Greatly improved groups of occlusion shown by PAR index. In another longitudinal study, the orthodontic patients for whom PAR index was greatly improved were the most satisfied with treatment (Nurminen *et al.*, 1999). It must, however, be remembered that when 'satisfaction' with treatment is asked, it measures only one aspect of the patient experience, whereas OHIP is generated to measure, besides functional aspects, also patients' perception of the social and psychological impact of oral disorders on their well-being more widely. A statistically significant correlation was found between PAR and OHIP severity after treatment, suggesting that patients with less perfect occlusal outcome are more likely to report oral impacts than those with better occlusal outcome. This result confirms that it is significant for clinical orthodontists to try to achieve an ideal occlusion.

When treating the occlusion, it is possible to improve facial and dental aesthetics and function. Functional reasons, aesthetic reasons, or reasons related to self-esteem and self-confidence are commonly reported as patients' motivation factors to seek treatment, although the percentages of patients reporting these motives have a great variation in different studies (McKiernan *et al.*, 1992; Bailey *et al.*, 2001; Siow *et al.*, 2002, Pahkala and Kellokoski, 2007). In the present study, the main focus was in the functionality and occlusion and aesthetic of occlusion was not evaluated.

The results of the present study show that when severe malocclusion is treated, it really has a strong impact on patient well-being and quality of life.

Conclusions

The prevalence of oral impacts reported 'fairly often' or 'often' was 7-fold higher before treatment than after treatment in patients with severe malocclusion. After the orthodontic or orthodontic–surgical treatment, oral impacts

declined to the level of general population. The improvement of occlusion seems in general to have a favourable effect on the oral health-related quality of life.

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