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Acceptability of adolescents' occlusion in Finnish municipal health centres with differing timing of orthodontic treatment

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SUMMARY The objective of the study was to compare the acceptability of occlusion among orthodontically treated and untreated adolescents in eight Finnish municipal health centres applying different timing of treatment. A random sample of 16- and 18-year olds (n = 2325) living in these municipalities was invited for a clinical examination, and 1109 adolescents participated. Two calibrated orthodontists blindly examined the participants for the acceptability of occlusion with the Occlusal Morphology and Function Index. The history of orthodontic treatment was elicited by questionnaire. The impact of the history and timing of treatment on the acceptability of occlusion was analysed with logistic regression analysis.

The history of orthodontic treatment decreased the odds for acceptability of morphology [odds ratio (OR) = 0.719, 95 per cent confidence limit (CL), P = 0.016] and acceptability of function (OR = 0.724, 95 per cent CL, P = 0.018). The early timing of treatment increased the odds for acceptability of morphology (OR = 1.370, 95 per cent CL, P = 0.042) and of function (OR = 1.420, 95 per cent CL, P = 0.023). No substantial differences were observed in the acceptability of occlusion between the early and late timing health centres. However, the proportion of subjects with acceptable occlusion was slightly higher in the early than in the late timing group. These findings suggest that when examining the effect of timing on treatment outcome, factors other than acceptability of occlusion should be concomitantly evaluated. Consequently, in this context, the duration and cost of treatment need to be investigated.

Introduction

In publicly funded orthodontic care, the evaluation of treatment outcome should include two principal questions: are resources directed to the children most in need of treatment and do all treated children benefit from their treatment? Consequently, it is necessary to investigate at a population level and evaluate whole age cohorts, including children with and without a treatment history (Fernandes *et al.*, 1999). In publicly funded care, resources are generally scarce and the competition for resources requires identification of the children who will benefit most from treatment (Cadman *et al.*, 2002).

The indices and procedures developed for the assessment of treatment outcome, such as the Peer Assessment Rating Index and the grading system of the American Board of Orthodontics, always require documentation in the form of dental casts and/or radiographs (Richmond *et al.*, 1992; Casko *et al.*, 1998). However, when evaluating untreated individuals, these documents are seldom available. The Occlusal Morphology and Function Index (OMFI) developed to measure the acceptability of occlusion is based entirely on direct clinical assessment (Svedström-Oristo *et al.*, 2002, 2003). Therefore, it is suitable for the assessment of all age groups.

Despite a great deal of debate, controversies about the timing of treatment persist (Jang *et al.*, 2005). Most recent studies comparing early versus late treatment regard treatment as early if it is started in the late mixed dentition (Keeling *et al.*, 1998; Tulloch *et al.*, 2004). In Finland, orthodontic treatment undertaken in the primary or early mixed dentition is regarded as early treatment (Pietilä *et al.*, 2008). In a recent study from a Finnish health centre with systematically organized early treatment, early intervention was regularly carried out when a crossbite, increased overjet, deep overbite with palatal contact, and severe crowding were diagnosed (Kerosuo *et al.*, 2008). Intervention in the early mixed dentition is recommended by other authors, for example, in the case of posterior crossbite with a Class III relationship (Kennedy and Osepchook, 2005; Ngan, 2005).

In orthodontics, the decision to treat a malocclusion is based on an elective choice, and there is an apparent inconsistency in professionals' views on the benefits and feasibility of orthodontic treatment (Shaw and Turbill, 2007). In addition, the methods used in the assessment of treatment need to guide the selection of patients on a practical level. Most of the internationally used indices are designed for the assessments of occlusion in the late mixed dentition (Brook and Shaw, 1989; Espeland *et al.*, 1992). Early intervention makes the selection of patients more demanding because the decision must be based on the prognosis of occlusion. In Finland, governmental authorities have recommended a standardized 10-grade scale for the assessment of treatment need, and this scale is used by 50 per cent of health centres (Heikinheimo, 1989; Pietilä *et al.*, 1997). According to the

recommendations, children with severe malocclusions are given priority for treatment, but professionals in municipal health centres decide on the extent of the services they deliver. Therefore, access to orthodontic treatment varies considerably (Pietilä *et al.*, 1997).

In the overall appraisal of population-based orthodontic services, both the success of the selection for treatment and the results of treatment need to be evaluated. The aim of this study was to compare the acceptability of occlusion among orthodontically treated and untreated 16- and 18-year-old adolescents in eight Finnish municipal health centres applying different timing of treatment.

Subjects and methods

The study protocol was approved by the Ethics Review Committee of the Hospital District of South-West Finland and the local Ethics Review Committees of the eight health centres.

Subjects

Between 2003 and 2005 a random sample of 2325 children from two age groups, 16- and 18-year olds, in eight municipalities was invited to participate in the study. The health centres were selected on the basis of information gathered in an earlier study to represent different timing of treatment (Pietilä, 1998). The health centres were dichotomized to an early (A, B and C) and a late (D, E, F, G and H) timing group according to the mean age for starting treatment (earlier versus later than 9 years of age). In the early timing group, the mean age for starting orthodontic treatment was 8.0 years [standard deviation (SD) 1.9] and in the late timing group, 10.7 years (SD 2.3). The variation in the starting ages of treatment in the two groups is shown in Figure 1.

In the younger age group (16-year olds), every third 9th grade class of the lower secondary schools in the municipality was selected after allotting a starting number. In the older age group (18-year olds), every third 2nd grade class of the upper secondary schools in the municipality was selected after allotting a starting number. Furthermore, the names and addresses of all 18-year olds were received from the registers of the local health authorities, and after the pupils from the upper secondary schools were extracted from the list, every third name on the list was selected after allotting a starting number. It was planned to include approximately the same number of adolescents in every health centre. In one small health centre (C), with fewer than 5000 inhabitants, all the individuals of these two age groups were invited to participate in the study.

In six of the health centres (A, B, D, F, G and H), the orthodontic resources and treatment modalities had been stable during the previous 10 years, while major changes had taken place in two (C and E). In centre C, a new treatment modality was adopted in the 1990s, and orthodontic treatment was offered to all children with any sign of malocclusion. Centre E had been under resourced for many years, and therefore, only patients with the most severe problems had access to treatment. Simultaneously, the work division had been changed, and an increasing number of treatments were carried out by general dentists. A more detailed description of the subjects has been published previously (Pietilä *et al.*, 2009).

Methods

An invitation letter was sent via the school to the pupils of the lower and upper secondary schools and mailed to the home addresses of other adolescents in the older age group. All adolescents were offered a chance to either change or

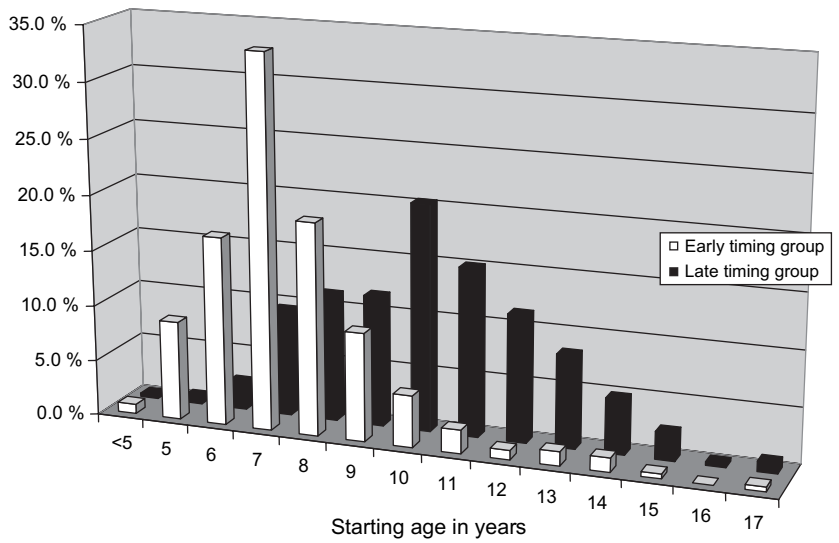

Figure 1 Distribution of starting age of orthodontic treatment in health centres with early or late timing of treatment (adjusted distribution).

cancel the visit. For practical and economic reasons, only a single examination period could be allocated to each municipality.

A total of 1109 adolescents (47.7 per cent) attended for the clinical examination. Before the examination, informed consent was obtained. Moreover, the subjects filled in a questionnaire, requesting information concerning, for example, previous orthodontic treatment. One respondent did not answer the question about treatment history. The subjects were clinically examined by two calibrated orthodontists (A-LS-O and TP) for acceptability of occlusion with the OMFI (Svedström-Oristo *et al.*, 2002, 2003) consisting of six morphological and four functional measurements (Appendix 1). The examiners did not know which subjects had been orthodontically treated.

The data concerning orthodontic treatment were later collected from the patient records of all the subjects (n = 608) who reported previous or ongoing orthodontic treatment or who could not recall whether they had received orthodontic treatment. The subjects with ongoing treatment (n = 39), with discontinued treatment (n = 66) and those treated elsewhere (n = 46) were excluded. The remaining 452 subjects were included in the treatment group. The group with no treatment history consisted of 505 subjects. The subjects grouped according to history of treatment are presented in Table 1.

Orthodontic treatment was regarded to have started when a fixed or removable appliance was placed in the mouth and as completed when a removable retention appliance was used less often than every night and when regular check-ups of fixed retainers were no longer needed.

In the early health centres A and B, headgear was the most frequently used appliance, while in health centre C, it was an eruption guidance appliance. In the late group, the most frequently used appliances were an upper fixed appliance and headgear, even though in health centre H, a fixed appliance was the dominating appliance. Extraction of teeth for orthodontic reasons was undertaken in 23 cases. The frequency of extractions was higher in the early (7.5 per cent) than in the late group (3.7 per cent).

Statistical methods

Interexaminer agreement between the two examiners was analysed using Kappa statistic (Fleiss, 1986).

The impact of the history and timing of treatment on the acceptability of occlusion was analysed with logistic regression analysis using the backward elimination method.

Results

The main results were that the proportion of subjects with acceptable occlusions was slightly higher in the early than in the late timing group, when measured with both the morphological and functional criteria of the OMFI.

Table 1 Subjects grouped according to treatment history (treatment given in the studied health centres*).

Health centre (n)	Treated (orthodontic treatment completed), n (%)	Untreated no treatment history), n (%)
A (112)	73 (65)	39 (35)
B (112)	73 (65)	39 (35)
C (39)	29 (74)	10 (26)
Early timing group (263)	175 (67)	88 (33)
D (124)	28 (23)	96 (77)
E (147)	50 (34)	97 (66)
F (140)	59 (42)	81 (58)
G (133)	65 (49)	68 (51)
H (150)	75 (50)	75 (50)
Late timing group (694)	277 (39)	417 (59)
Total (957)	452 (47)	505 (53)

*Subjects with ongoing (n = 39) and discontinued (n = 66) treatment excluded.

The acceptability of morphology

There was greater interexaminer agreement between the two examiners in the assessment of morphology [Kappa 0.70, 95 per cent confidence limit (CL) 0.48–0.92] than in the assessment of function (Kappa 0.51, 95 per cent CL 0.26–0.76).

The share of subjects with acceptable occlusion after the completion of treatment ranged from 42 to 72 per cent among the health centres. In both groups, the percentage of subjects with acceptable morphology was higher among untreated than treated adolescents (Table 2).

In the logistic regression analysis, both explaining factors, the history and timing of treatment, had a statistically significant association with the acceptability of the morphology of the occlusion. A history of orthodontic treatment decreased the odds [odds ratio (OR) = 0.719, 95 per cent CL, P = 0.016], while the early timing of treatment increased the odds (OR = 1.370, 95 per cent CL, P = 0.042) for acceptability.

For all groups, the most frequent feature leading to the non-acceptance of morphology was an unfavourable canine relationship, followed by a deep bite (Table 3). Health centre C had no subjects with an unacceptable deep bite, and health centre H had none with an anterior crossbite.

The acceptability of function

The percentage of subjects with a functionally acceptable occlusion after completion of treatment ranged from 46 to 72. In the early group, the percentage was similar among the untreated and treated adolescents, while in the late group, the percentage of functionally acceptable occlusions was higher among the untreated adolescents (Table 4).

Table 2 Proportion of subjects with acceptable morphology as measured using the Occlusal Morphology and Function Index.

Health centre (*n*)	Treated (%)	Untreated (%)
Early timing group		
A (112)	59	72
B (112)	56	72
C (39)	72	80
Early timing group (263)	60	73
Late timing group		
D (124)	57	67
E (147)	42	47
F (140)	66	65
G (133)	57	68
H (150)	53	63
Late timing group (694)	55	63
Total (957)	57	63

Table 3 Morphological features causing non-acceptance of occlusion as measured using the Occlusal Morphology and Function Index.

Morphological features	Early timing group, *n* = 263		Late timing group, *n* = 694	
	Treated (%)	Untreated (%)	Treated (%)	Untreated (%)
Canine relationship, right	15	15	18	17
Canine relationship, left	15	9	15	16
Overbite	11	14	12	14
Crossbite, anterior	7	1	5	4
Open bite	5	3	5	2
Scissor bite	4	1	3	1
Overjet	2	0	2	4
Crossbite, lateral	3	2	1	1
Coincidence of the facial midline and the midline of the upper dental arch > 3 mm	0	0	0	0

In the logistic regression analysis, both explaining factors, the history and timing of treatment, had a statistically significant association with the acceptability of the function of occlusion. The history of orthodontic treatment decreased the odds (OR = 0.724, 95 per cent CL, $P = 0.018$), while the early timing of treatment increased the odds (OR = 1.420, 95 per cent CL, $P = 0.023$) of acceptability.

In both groups, protrusion was the most frequent feature leading to non-acceptance of function, followed by disturbances in guided lateral occlusion (Table 5). Health centre C had no subjects with a discrepancy between centric relation and intercuspal position.

Discussion

In this study, the early timing of orthodontic treatment seemed to slightly increase the odds for higher acceptability of morphological and functional features of occlusion.

Table 4 Percentage of subjects with acceptable function as measured using the Occlusal Morphology and Function Index.

Health centre (*n*)	Treated (%)	Untreated (%)
Early timing group		
A (112)	62	69
B (112)	58	59
C (39)	72	70
Early timing group (263)	62	65
Late timing group		
D (124)	46	64
E (147)	47	63
F (140)	58	56
G (133)	68	59
H (150)	35	59
Late timing group (694)	51	60
Total (957)	55	61

Table 5 Functional features causing non-acceptance of occlusion as measured using the Occlusal Morphology and Function Index.

Functional features	Early timing group, *n* = 263		Late timing group, *n* = 694	
	Treated (%)	Untreated (%)	Treated (%)	Untreated (%)
Protrusive contacts	31	26	37	28
Guided lateral excursion, right	11	11	21	12
Guided lateral excursion, left	10	6	14	12
Discrepancy between centric relation and intercuspal position	3	7	7	5

However, in both the early and the late group, there was a considerable variation in acceptability.

In the present study, whole age cohorts were investigated, because in publicly funded dental care, all aspects of orthodontic service delivery should be concomitantly assessed. This viewpoint is not often used in the appraisal of orthodontic services, and therefore, it is difficult to make comparisons with earlier investigations. In addition, comparison with studies from other countries is problematic, because in Finland, early treatment is usually started at the age of 5–8 years (Väkiparta *et al.*, 2005), i.e. earlier than in several previous studies evaluating early treatment (Tulloch *et al.*, 2004; Hsieh *et al.*, 2005; Dolce *et al.*, 2007). In fact, the starting age of the subjects in those studies (8–13 years) is similar to that of the later timing group in the present study.

Svedström-Oristo *et al.* (2003) found acceptable morphology more frequently among untreated than treated adolescents. The present study corroborates their findings with one exception (health centre F), where both groups had a similar percentage of acceptability. Early timing seemed to increase the odds for acceptability, and the rate of acceptable morphology was higher in early than in the late timing health centres. The most frequent features causing

unacceptability, poor canine relationship and large overbite, were identical with the findings of Svedström-Oristo *et al.* (2003). In the present study, the early timing of treatment increased the odds for acceptability of the function of occlusion. Furthermore, acceptable function was more often found among untreated than treated subjects in both timing groups and in nearly all health centres. A corresponding tendency among treated and untreated adolescents has been reported earlier by Svedström-Oristo *et al.* (2003). In both studies, protrusive contacts were the most common features causing non-acceptance.

The better acceptability of occlusion in the untreated group may appear confusing. However, treatment can be regarded as beneficial, when those adolescents who from the beginning had a severe malocclusion moved closer to the untreated adolescents with an acceptable occlusion. Conflicting findings have been reported by Birkeland *et al.* (2000), who found a better occlusion among treated than untreated individuals in Norway.

One explanation for the findings might be the high levels of delivery of orthodontic treatment in general and especially in early timing health centres. Presumably, only occlusions with a favourable prognosis were left untreated, which indicates that the selection for treatment was successful, while most untreated individuals had an acceptable occlusion. In support of these findings, in Norway, the lowest percentage of adolescents with a residual treatment need among untreated individuals was found in a region with the highest treatment rate (Espeland and Stenvik, 1999).

The wide variation in orthodontic appliances complicated the appraisal of whether the use of different appliances influences the acceptability of occlusion. The early timing health centres used one appliance more than others, but a large variety of appliances were used in the late timing health centres. In this study population, the frequency of treatment with an upper fixed appliance varied from 34 to 76 per cent in the late group compared with 15 to 30 per cent in the early group (Pietilä *et al.*, 2009). Headgear is the predominant appliance used in early treatment in Finland (Pietilä *et al.*, 1997), and this was also found in this study. The use of headgear as an early orthopaedic appliance has been described in Finnish studies (Kirjavainen *et al.*, 2000; Pirttiniemi *et al.*, 2005). Furthermore, the wide use of headgear even in the late timing health centres indicates that the appliance was also used as an anchoring device.

In Norway, the children treated with fixed appliances had a better treatment outcome than those treated with removable appliances (Birkeland *et al.*, 2000). However, in the current study, health centre C, where the removable eruption guidance appliance was most commonly used, had the highest rates of acceptability. Favourable treatment results have also been reported in an earlier Finnish study concerning the use of the eruption guidance appliance (Keski-Nisula *et al.*, 2008).

The findings of an earlier study showed that there were several differences in the features of orthodontic services provided by these eight health centres (Pietilä *et al.*, 2009). In the early group, treatments were mainly carried out by general dentists applying simpler treatment methods. In the late group, specialists were more closely involved in the treatment. In general, the provider effect has a strong influence on treatment practices (Fox *et al.*, 1997), and this may partly mask the impact of timing of treatment. Overall, the variation in the provider's expertise complicates the assessment. Practitioners with an orthodontic qualification seem to prefer to start treatment with fixed appliances (Turbill *et al.*, 1999).

Conclusions

With regard to the early versus late timing of treatment, only minor differences were found in the acceptability of occlusion. However, the early timing of treatment slightly increased the OR for both the morphological and functional acceptability of occlusion. Furthermore, the findings suggest that the effect of timing on treatment outcome needs to be considered in connection with other aspects of treatment, e.g. the duration and cost of treatment.

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Appendix 1. Morphological and functional criteria in the OMFI.

	Cut-off for acceptability	Conventions
Morphological criteria		
Coincidence of the facial midline and the midline of the upper dental arch	Maximum 3 mm deviation accepted	
Overjet	0–5 mm accepted	Measured from the most labial central incisor
Overbite	Occusal contact incisal to the gingival third of the palatal surface of upper incisors accepted. Open bite only accepted in laterals	
Canine relationship right/left	Normal ± 2 mm accepted. Post-normal relationship accepted in the case of missing upper incisors	
Crossbite, anterior	Not accepted	
Crossbite, lateral	Not accepted in canines. Accepted in one tooth pair/side without inference or slide between centric relation and intercuspal position	
Scissor bite	Not accepted	
Functional criteria		
Discrepancy between centric relation and intercuspal position	Max 2 mm accepted sagittally and vertically. No slide accepted laterally	Measured from pencil markings on one pair of premolars and incisors
Guided lateral excursions	Accepted: canine protection/group contact including canine/contacts in incisors, premolars and molars	Guided lateral gliding until upper and lower canines at the same transverse level
Non-working side contacts	Accepted without disclusion of working side contacts	
Protrusive contacts	Anterior guidance accepted	