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Orthodontic treatment practices in Finnish municipal health centres with differing timing of treatment

I. Pietilä*, T. Pietilä*, A.-L. Svedström-Oristo**, J. Varrela** and P. Alanen**
*Health Centre of Pori and **Institute of Dentistry, University of Turku, Finland

SUMMARY The aim of this study was to compare orthodontic practices in eight Finnish municipal health centres selected on the basis of an earlier survey to represent early and late timing of treatment. The health centres were grouped according to the mean age of starting treatment; earlier versus later than 9 years of age. A random sample of 16 and 18 year olds ($n = 2325$) living in these municipalities were invited for a clinical examination, and 1109 adolescents participated. The participants reported on their previous or ongoing orthodontic treatment by means of a questionnaire. Data on orthodontic treatment received were collected from the dental files of the adolescents who reported a treatment history and for those who did not recall exactly whether or not they had received orthodontic treatment. Analysis of the non-respondents was made on the basis of their dental files. Differences between the features of orthodontic treatment in the early and late starting health centres were analysed using a two-tailed *t*-test.

In the early group, 70 per cent, and in the late group 42 per cent, of adolescents had a history of orthodontic treatment. General dentists carried out 90 per cent of the treatment in the early group and specialists every third treatment in the late group. An early start resulted in more frequent visits ($P = 0.004$) and a longer treatment duration ($P < 0.001$), while later timing resulted in an increase in the number of appliances ($P < 0.001$).

Introduction

In Finland, orthodontic treatment is included in the free dental care of municipal health centres up to the age of 18 years. The allocation of public health services, including orthodontic care, is regulated by national guidelines on access to treatment which states that children with similar malocclusions should have equal access to treatment (Ministry of Social Affairs and Health, 2005). However, access to public orthodontic care varies in Finland because each municipality can decide the extent of the services they deliver. Earlier studies have revealed that up to a 20-fold difference can be found among health centres in the percentage of children receiving orthodontic treatment and that a wide variation also exists in the availability of qualified orthodontists (Pietilä *et al.*, 1997).

The majority of specialist orthodontists in Finland work in large cities or in the most densely populated areas. In sparsely populated areas, the orthodontic consultation is commonly purchased from outside orthodontists, while the actual treatment is mainly carried out by general dentists (Pietilä *et al.*, 2008). In Nordic countries, the initiative for orthodontic treatment is, in most cases, made by general dentists (Pietilä and Pietilä, 1994; Bergström, 1996). However, according to the opinion of orthodontists, diagnosis and treatment planning requires more specialist expertise (Pietilä *et al.*, 2008). Similarly, it has been considered equally important that the assessment of the timing and complexity of treatment should be made by an orthodontist (Pietilä *et al.*, 1992).

Most municipal health centres apply a standardized 10-grade scale for the assessment of treatment need (Heikinheimo, 1989), modified from the Treatment Priority Index (Grainger, 1967). According to Finnish recommendations, children with a severe malocclusion have priority in treatment (Medical Board of Finland, 1988). Severe malocclusions often require more complex treatment, implying more appointments and a longer duration of treatment than less severe malocclusions (Cassinelli *et al.*, 2003). The timing of treatment has also been shown to be associated with the difficulty of treatment (Richmond *et al.*, 2001). In Finland, orthodontic treatment is often started early, at the age of 9.5 years on average (Pietilä *et al.*, 2008). In many studies, early intervention has been shown to reduce the need for further orthodontic treatment (al Nimri and Richardson, 2000; Väkiparta *et al.*, 2005) and severity of malocclusion (Mirabelli *et al.*, 2005). On the other hand, there are findings suggesting that the duration of treatment may be shorter and the number of visits less in one-phase treatment that is carried out in the late mixed or permanent dentition (Tulloch *et al.*, 2004).

The most common indications for starting orthodontic treatment in Finland are crowding, Class II malocclusions, and crossbites (Keski-Nisula *et al.*, 2003; Väkiparta *et al.*, 2005; Pietilä *et al.*, 2008). The most frequently used appliances are headgear and quadhelices during the early mixed dentition and headgear and fixed appliances during the late mixed dentition. The use of the eruption guidance appliance increased in the 1990s (Pietilä *et al.*, 2008).

The aim of this study was to compare differences in the indications, extent and duration of treatment and the choice of appliances in eight Finnish municipal health centres using early or late timing of treatment.

Subjects and methods

Selection of health centres

The eight health centres included in the study were selected on the basis of the results of earlier research (Pietilä, 1998) in order to represent different timing of treatment. The health centres were grouped into an early (A, B, and C) and a late (D, E, F, G, and H) treatment group according to the mean age for starting treatment (earlier versus later than 9 years of age).

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 signs of malocclusion. Centre E had suffered from insufficient orthodontic resources for several years in the 1990s, and thus, the intake of patients was restricted to those with most severe malocclusion. At the same time, the work division was changed, with an increasing number of treatments being carried out by general dentists.

Six of the eight health centres employed salaried orthodontists, and the ratio of orthodontist to the 0- to 17-year-old population varied from 1:7000 to 1:17 000. In the remaining two health centres, orthodontic expertise was purchased from a consultant orthodontist. In all eight health centres, diagnosis and treatment planning was usually made by a specialist, and in all, general dentists participated in the orthodontic treatments. The orthodontist–population ratio and the number of general dentists and auxiliaries involved in orthodontic treatments in each health centres are given in Table 1.

Subjects

In 2003–2005, a random sample (2325 adolescents) from two age groups, 16 and 18 year olds, living in the area of these eight municipalities was invited to participate in the study. In 2004, the total population in the area of these health centres was approximately 370 000, which is 7.4 per cent of the total population of Finland. The number of children and adolescents aged 0–17 years living in the regions was 75 200 (Table 2). In the younger age group (16 year olds), every third class of the ninth grade of the lower secondary schools in the municipality was selected after allotting a starting number and in the older age group (18 year olds), every third class of the second school grade of the upper secondary schools. 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. 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.

Methods

An invitation letter was sent via the school to the pupils of the lower and upper secondary schools and by post to the home addresses of the other adolescents in the older age group. All were offered the opportunity to telephone and change or cancel the visit. For practical and economic reasons, only a single examination period could be allocated to each municipality.

A total of 1109 (47.7 per cent) adolescents attended the clinical examination carried out by two orthodontists (A-LS-O, TP). The examiners did not know which adolescent had been orthodontically treated. After obtaining informed consent, the subjects were asked to complete a semi-structured questionnaire before the examination. In addition to demographic data: age, gender and type of school (lower

Table 1 Application of expertise and workforce in orthodontics in the eight investigated Finnish health centres during 2003–2005.

Health centre	Type of specialist orthodontist expertise	Ratio: orthodontist per 0–17 year olds	General dentists treating mainly orthodontic patients	Other dentists involved in orthodontic treatments	Full-time orthodontic hygienist
Early timing group					
A	Salaried	1:15 600	—	>5	—
B	Salaried	1:7000	—	>5	—
C	Consultant	6 days per year for 1200	—	1	—
Late timing group					
D	Salaried	1:17 000	1	—	1
E	Salaried	1:9500	1	>5	1
F	Salaried	1:9700	1	—	—
G	Consultant	4 days per year for 6800	2	—	—
H	Salaried	1:11 500	1	<5	—

secondary, upper secondary or vocational school or no school), the questionnaire included questions on the history of orthodontic treatment. One respondent did not answer the question about treatment history. The data concerning previous or ongoing orthodontic treatment provided or of those who could not recall exactly whether or not they had received orthodontic treatment in the study health centres were subsequently collected from the patient records (n = 608). Subjects with ongoing treatment (n = 39) and those treated outside the study health centres (n = 46) were excluded; thus, 518 subjects were included in the treatment group. The group with no treatment history consisted of 505 subjects.

Orthodontic treatment was regarded to have started when a fixed or removable appliance was placed in the mouth and 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.

The files of the non-participants were available only in one health centre (E), where the gender, age, school type and possible orthodontic treatment history were checked from the dental files of all adolescents (n = 128) who failed to participate in the study examination.

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.

Statistical analysis

Differences between the features of orthodontic treatment (the duration of treatment, the number of appliances and the number of visits) in the early and late starting health centres were analysed using a two-tailed t-test.

Results

Participation in the study was lowest (39 per cent) in the largest centre (D) and highest (60 per cent) in the smallest health centre (C). Females formed the majority of the subjects in all but one health centre (Table 2). Fifty-seven per cent of subjects (n = 636) belonged to the older age group with 76 per cent of them studying in the upper secondary and 23 per cent in vocational schools. One per cent of the 18 year olds were not in full-time education (Table 2).

In health centre E, the percentage of boys was higher among the non-participants than among the participants (50 versus 30 per cent). Fewer non-participants than participants had a history of orthodontic treatment (38 versus 43 per cent).

A history of orthodontic treatment in the health centres was reported by 50 per cent of all subjects. The percentage of those who had received or were receiving orthodontic treatment ranged from 27 to 85 per cent and was lowest in the two largest health centres, D and E (Table 3). Twelve per cent of all subjects had a history of discontinued treatment. The percentage of discontinued treatments was highest in the health centres with a high percentage of treatment. Only a few patients were still being actively treated, with the percentage of subjects under treatment ranging from 2 to 21 (Table 4).

The mean age for starting orthodontic treatment in the health centres varied from 7.8 to 11.7 years: In the early group it was 8.0 years [standard deviation (SD) 1.9] and in the late group 10.7 years (SD 2.3). The variation in starting age of the subjects in the two groups is given in Figure 1.

The mean duration of treatment in the group with completed treatment ranged from 20.1 to 67.1 months (Table 5). In the group with discontinued treatment, the mean duration of treatment ranged from 15.5 to 47.3 months, being 39.2 months (SD 26.3) in the early group and 29.5 months (SD 20.1) in the late group.

Crowding was the most frequent indication for orthodontic treatment in four health centres (B, E, F, and G), a Class II malocclusion in three health centres (A, C, and H) and in one health centre (D) both with a similar frequency. The

Table 2 Population in the eight Finnish health centres and grouping of the participants.

Health centre	Total population	Number of 0–17 year olds	Number of invited adolescents	Examined n (% of invited)	Boys, %	Girls, %	16 years, %	18 years, %
Early timing group								
A	35 700	7800	310	133 (43)	37	63	19	81
B	36 200	7000	306	130 (43)	44	56	35	65
C	4700	1200	113	68 (60)	50	50	59	41
Early timing group	76 600	16 000	729	331 (45)	44	56	34	66
Late timing group								
D	83 500	17 000	374	146 (39)	34	66	40	60
E	76 000	14 200	300	172 (57)	30	70	51	49
F	43 000	9700	312	156 (50)	42	58	55	45
G	27 600	6800	300	144 (48)	38	62	44	56
H	56 800	11 500	310	160 (52)	38	62	42	58
Late timing group	293 400	59 200	1596	779 (49)	36	64	47	53
Total	370 000	75 200	2325	1109 (48)	38	62	43	57

Table 3 Subjects grouped according to their orthodontic treatment history.

Health centre (subjects, *n*)	No history of treatment, %	Treatment undertaken elsewhere*, %	Treatment history: treatment given in the studied health centres, %
Early timing group			
A (133)	29	5	65
B (130)	30	2	68
C (68)	15	0	85
Early timing group	27	3	70
Late timing group			
D (146)	66	8	27
E (171)	57	10	33
F (156)	52	1	47
G (144)	47	2	51
H (160)	47	2	51
Late timing group	54	5	42
All subjects (1108)†	46	4	50

*Orthodontic treatment given in another health centre, central hospital or in private practice; excluded from the study.
†One subject did not answer the question concerning treatment history.

Table 4 The phase of treatment in the groups with a history of orthodontic treatment.

Health centre (subjects, *n*)	Completed, %	Continuing, %	Discontinued, %
Early timing group			
A (87)	84	2	14
B (88)	83	4	13
C (58)	50	7	43
Early timing group	75	4	21
Late timing group			
D (39)	72	21	8
E (57)	88	5	7
F (73)	81	15	4
G (73)	89	5.5	5.5
H (82)	92	3	5
Late timing group	85	9	6
All subjects (577)	81	7	12

next most frequent indications were a deep bite, a lateral crossbite and an anterior crossbite. The most frequently used appliance was headgear followed by fixed appliances, the eruption guidance appliance and a quadhelix. Headgear was the most frequently used appliance in four and an upper fixed appliance in three health centres. In centre C, the eruption guidance appliance was the prevailing appliance (Table 6).

The duration of treatment and number of visits were higher in the early group (*t*-test, $P < 0.001$ and $P = 0.004$, respectively), and the number of appliances was higher in the late group (*t*-test, $P < 0.001$). The features of orthodontic treatment in the early and late health centres are shown in Table 7.

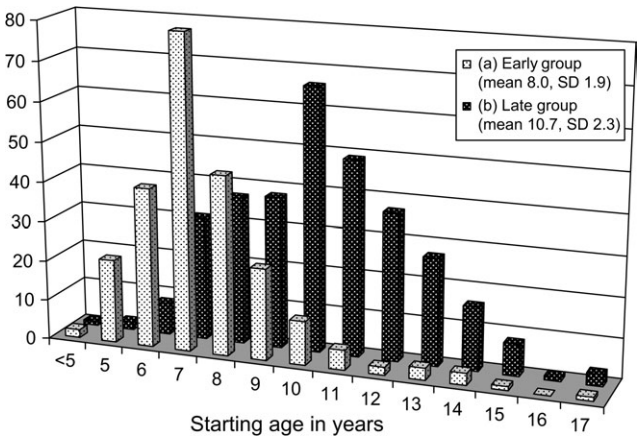

Figure 1 Distribution of starting age of orthodontic treatment in health centres with early and late timing of treatment.

Table 5 Mean age for starting treatment and mean duration of treatment.

Health centre	Mean age, years (SD)	Mean duration, months (SD)
Early timing group		
A	7.8 (2.5)	35.6 (20.1)
B	8.0 (1.3)	39.0 (23.1)
C	8.5 (1.6)	67.1 (31.8)
Early timing group	8.0 (1.9)	42.3 (26.0)
Late timing group		
D	11.0 (2.4)	43.4 (25.0)
E	10.4 (2.7)	26.5 (18.6)
F	10.3 (2.2)	38.3 (27.9)
G	10.3 (1.7)	39.4 (22.3)
H	11.7 (2.2)	20.1 (13.9)
Late timing group	10.7 (2.3)	32.1 (23.0)
All subjects	9.5 (2.5)	36.0 (24.7)

A second phase of treatment was found in 22 per cent in the early and 17 per cent in the late group. During the first treatment phase, a specialist was involved in the treatment procedure in every tenth case in the early group and in every third case in the late group. The specialist was involved in the treatment procedure in approximately half of the cases during the second treatment phase in both groups (Table 8).

Discussion

The health centres in this study were selected from among medium-sized municipalities, on the basis of the results of earlier surveys, to represent different orthodontic treatment timing practices in Finland (Pietilä, 1998; Pietilä *et al.*, 2008). Health centre C, even if smaller than the others, was included in the study because it was using a new treatment approach—the eruption guidance appliance. Because the starting age for orthodontic treatment is generally early in

Table 6 Frequency of use of active appliances in the eight health centres*.

Health centre	First most frequently used, %	Second most frequently used, %	Third most frequently used, %
Early timing group			
A	Headgear 77	Palatal/lingual bar 19	Upper fixed 15
B	Headgear 76	Quadhelix 21	Upper fixed 16
C	Eruption guidance 82	Upper fixed 30	Headgear 26
Late timing group			
D	Upper fixed 36	Headgear 33	Lower fixed 18
E	Headgear 36	Upper fixed 34	Eruption guidance 34
F	Upper fixed 46	Headgear 38	Lower fixed 31
G	Headgear 64	Upper fixed 49	Eruption guidance 39
H	Upper fixed 76	Lower fixed 44	Functional 18

*One or several appliances per patient.

Finland, it was not possible to recruit to the late timing group health centres, for example starting in the early permanent dentition.

The timing of orthodontic treatment has been actively discussed in Finland. Therefore, it was considered important to study the results obtained by health centres with early or late treatment timing. The age groups were selected to ensure that most participants would have finished their treatment. Moreover, the 16 year olds were the highest age group that could be easily reached for examination.

The investigation of early timing of orthodontic treatment is complex because of the need for a long follow-up period in order to ascertain whether later interventions are needed. It was found that a second phase of treatment was necessary in about every fifth case in both the early and late groups. Early treatment of Class II division 1 malocclusions has recently been evaluated in three randomized clinical trials (RCT; Keeling *et al.*, 1998; O'Brien *et al.*, 2003a,b; Tulloch *et al.*, 2004). However, comparison with Finnish treatment practices is not straightforward because in Finland, early treatment is usually started at 5–8 years of age, that is much earlier than the 9–12 years in the three RCT studies. In fact, the starting age of the subjects in those RCT investigations are more comparable with the late group in the present study.

In the orthodontic literature, a good availability of specialist resources has been considered desirable (Espeland *et al.*, 1993; Richmond and Andrews, 1993). On the other hand, no statistically significant differences were found in the standard of treatment carried out by specialists versus general dentists in England and Wales (Richmond *et al.*, 1993). In this study, general dentists carried out treatment both in the early and late groups, even though their involvement in the treatment procedure was higher in the early group, especially during the first phase of treatment. The utilization of orthodontic auxiliaries was rare. A full-time orthodontic hygienist was employed in only two health centres.

In the UK, children living in deprived and rural areas have been shown to receive less orthodontic treatment (Morris and Landes, 2006; Drugan *et al.*, 2007). In Finland, the socio-economic status of the family has little effect on the access to treatment in rural areas because only public orthodontic services are available. As a whole, most of the health centres had offered orthodontic treatment to at least every second adolescent. The urban health centre, E, which had restricted access to treatment more than the others, had the highest percentage of adolescents with a treatment history from the private sector. This implies that in Finland, access to treatment depends mostly on the capacity of orthodontic services provided by the local health centre.

Table 7 Features of orthodontic treatment in the early and late starting health centres.

	Early timing group, mean (SD)	Late timing group, mean (SD)
Duration of treatment	42.4 (27.1)	32.3 (22.8)
Number of appliances	3.1 (2.7)	5.9 (4.7)
Number of visits	26.9 (15.6)	23.3 (14.5)

The International Statistical Classification of Diseases, ISD-10, has been used in Finnish oral health care units since the late 1990s (World Health Organization, 2005). However, decisions concerning the main indication are always a matter of choice, and the orthodontist's or dentist's own treatment preferences, or even the choice of appliances, might have systematically influenced the decision. In spite of that, in the present study, the main indications, crowding and a Class II malocclusion, were the same as found in earlier investigations (Keski-Nisula *et al.*, 2003; Tausche *et al.*, 2004; Väkiparta *et al.*, 2005).

A later starting age and the use of extra-oral traction have been mentioned as factors connected with discontinuation of treatment (Richmond and Andrews, 1995). According to earlier Finnish studies (Pietilä and Pietilä, 1996; Svedström-Oristo *et al.*, 2003), the percentage of discontinued treatments varies between 11 and 13 per cent, which is similar to the percentages, for example, in Sweden and the

Table 8 Percentage of treatments undertaken by specialist orthodontists or/and general dentists.

Provider	Early timing group		Late timing group	
	First treatment phase (n = 231), %	Second treatment phase (n = 50), %	First treatment phase (n = 321), %	Second treatment phase (n = 55), %
Specialist orthodontist	7	42	25	31
General dentist	90	48	68	58
Jointly	3	10	8	11

UK (Murray, 1989; Ahlgren, 1993; Eaton *et al.*, 1996), but higher percentages have been reported (Fox and Chapple, 2004). In the present study, the discontinuation of treatment varied considerably. The highest percentages were seen in the early group, where headgear or the eruption guidance appliance were frequently used, both treatment methods demanding good cooperation. In these health centres, the treatment had been offered to many patients; even children with poor compliance and/or minor perceived need may have been selected for treatment.

Turbill *et al.* (2001) found that treatment of complex malocclusions requiring the use of fixed appliances or multiple stages of treatment tended to increase the duration of treatment. Further, they found that orthodontically qualified practitioners were associated with a longer duration of treatment, which may also be connected with more complex malocclusions.

The findings of von Bremen and Pancherz (2002) and Tulloch *et al.* (2004) indicated that early treatment of Class II division 1 malocclusions is associated with a longer duration of treatment. The mean duration of treatment in the early group in the present study was 10 months longer than in the late group. However, the definitions of treatment and retention periods may vary, making comparisons misleading; permanent or semi-permanent retention is frequently used after treatment with fixed appliances, whereas treatment carried out with a headgear, eruption guidance appliance or functional appliance is frequently retained with the same appliance, making the demarcation between active treatment and retention somewhat arbitrary.

The completion of treatment with fixed appliances in the permanent dentition has been recommended for good and stable treatment results by Birkeland *et al.* (2000) and Fox and Chapple (2004). Turbill *et al.* (1999) found that, in the UK, practitioners with an orthodontic qualification tended to start treatment more often with fixed appliances and that the age of the patient had an association with the choice of appliance. Fixed appliances were used in the treatment of older patients, while treatment started in the mixed dentition was associated with the use of removable or myofunctional appliances. In Finnish health centres, orthodontic treatment is often devolved to general dentists, and this favours simple treatment methods (Pietilä *et al.*, 1997). This practice was seen in the present study in the early group, and it probably explains why headgear was so widely used during early interventions. On the other hand, in the health centres where treatment was mainly devolved to the orthodontist, fixed appliances were preferred at least in late treatments. Furthermore, different timing affected the choice of appliances, and the number of appliances was higher in the late group. In addition, a second phase of treatment was found more often in the early group.

Conclusions

Early versus later timing of orthodontic treatment seems to show clear differences in the number of visits, duration of treatment, type and number of appliances and required orthodontic skills. In the early group, treatment was mainly carried out by general dentists applying simple treatment methods. In the late group, specialists were more closely involved in treatment, and fixed appliances were commonly used. However, for a thorough comparison of the feasibility of treatment in the early and late mixed dentition, data on the outcome and cost-effectiveness of orthodontic treatment are needed.

Address for correspondence

Ilpo Pietilä
Oral Health Services
Health Centre of Pori
PO Box 33
FIN-28601 Pori
Finland
E-mail: ilpo.pietila@pori.fi

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