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ORIGINAL ARTICLE

Longitudinal analysis of the quality of orthodontic treatment outcome and stability of occlusal traits

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ABSTRACT

Objectives: To assess the quality and stability of orthodontic treatment outcome relative to the initial malocclusion.

Material and methods: The study was performed in one public health care clinic in Finland. Study subjects comprised 51 orthodontic patients (age range 12.7–18.7 years). Pre-treatment medical records and lateral skull radiographs were analysed for malocclusion type. The main reasons for orthodontic treatment were mandibular retrognathia, Class II distal bite, deep bite and crowding. At the end of a retention phase (Examination 1), the quality of treatment outcome was assessed using the occlusal morphology and function index (OMFI) and patients were asked about treatment satisfaction. Stability of occlusal traits and patient satisfaction were re-evaluated after a two-year follow-up (Examination 2). Occlusal characteristics descriptive statistics were performed.

Results: At Examination 1, all six morphological criteria for acceptability were fulfilled by 76% and all functional criteria by 82% of the patients. All OMFI criteria were met by 67% of the patients. At Examination 2, 68% of the patients fulfilled all morphological and 82% all functional criteria of acceptability. At Examination 2, all the OMFI criteria were still met by 64% of the patients and 92% expressed satisfaction with own occlusion. The main reasons for unacceptability were deficiencies in canine relationship and overbite, in addition to functional protrusion interferences.

Conclusions: In the evaluated health care clinic, patient satisfaction and the quality of treatment outcome were high. However, deep bite showed a tendency for relapse.

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Long-term stability; occlusal morphology and function index (OMFI); satisfaction

Introduction

According to the definition of the World Health Organization (WHO), 'health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity' [1]. The focus in orthodontics is in treatment of malocclusion, i.e. deviation from a theoretical ideal occlusion, rather than disease. However, these deviations may have a strong impact on an individual's social well-being [2].

The aim of publicly funded orthodontic care is to provide orthodontic treatment fairly and equally to those in need within the limitations of existing resources. In Finland, orthodontic treatment is offered to all individuals with a severe malocclusion causing functional disturbances, and provided by municipal health care clinics, or in case of severe craniofacial deformities, by university hospitals. Several treatment needs indices, such as the treatment priority index (TPI) [3], the index of orthodontic treatment need (IOTN) [4], need of orthodontic treatment index (NOTI) [5] and the dental aesthetic index (DAI) [6], have been developed to ensure objectivity in the selection of children and adolescents for orthodontic treatment. In Finnish health care clinics, selection has been based on a 10-grade scale that is a Finnish modification of the TPI [7]. On the 10-grade scale, the highest scores are given to severe craniofacial anomalies and priority is given to functionally disturbing malocclusions instead of those that merely impair dental aesthetics. An updated version of the 10-grade scale was first published in 2005 and its latest modification in 2019 [8].

As the goal of publicly funded orthodontic care is to respond to the health needs of the target population, the outcome of orthodontic care should be assessed from objective (professional) and subjective (individual) perspectives. Although data on orthodontic treatment practices in Finnish health care clinics have been published [9–11], data describing the outcome of treatment and its stability is scarce. The occlusal morphology and function index (OMFI) was developed to assist in the collection of comparable, population-based data on the occlusal outcome of orthodontic treatment [12,13]. It is a clinical tool consisting of six morphological and four functional assessments or measures for acceptable, mature occlusion (Appendix). These criteria and

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their threshold values for acceptability were defined in co-operation with experienced, Finnish orthodontic and stomatognathic specialists analysing clinical data and applying theDelphi method [12,14]. Reproducibility of the OMFI criteria has been tested and the morphological criteria validated against the Dental Health Component (DHC) of the IOTN [4,13,15].

This study was part of quality control assessment concerning treatment of dentofacial deformities and malocclusions and was carried out between November 2017 and February 2021 at Espoo public dental clinic. The aims of the study were to:

1. Assess the quality of orthodontic treatment outcome in one municipal dental clinic.
2. Evaluate the long-term stability of occlusal traits in orthodontically treated patients.
3. Analyse which skeletal and/or occlusal traits are associated with a reduction in OMFI scores, i.e. hamper the acceptability of occlusion.

Materials and methods

Study sample

In total, 51 randomly recruited patients (mean age 16.1 years, range 12.7–18.7 years) were examined in consecutive order at the end of their retention phase following orthodontic treatment at the Espoo Municipality public dental clinic (Examination 1). After a period of two years, all patients were invited for a re-evaluation (Examination 2). A subsample of 28 patients (55%) participated in the re-evaluation. In Examination 1, their age range was 12.9–18.7 years and two of the patients were still in the late mixed dentition phase. In Examination 2, the average age of the participants was 18.4 years (range 15.3–20.8 years).

The average active treatment time had been 36 months (range 2–69 months), the average retention period 22 months (range 3–36 months), and the mean total time in treatment 50 months (range 5–94 months). The applied treatment methods had included an extraoral traction, an intraoral expansion appliance, fixed appliances and/or a functional appliance.

The longitudinal follow-up examination was carried out approximately 51 months (range 31–70 months) after active treatment completion.

At baseline, the main reasons for orthodontic treatment had been sagittal Class II malocclusion in combination with deep bite or crowding, and the most prevalent individual ICD-10 codes [16] were K07.20 (distal bite, $N = 16$) and K07.23 (deep bite, $N = 16$), followed by K07.13 (mandibular retrognathia, $N = 14$). The number of recorded diagnostic codes varied from 1 to 4. Table 1 presents the detailed distributions of the most prevalent ICD-10 codes and their respective DHC/IOTN categories. These categories are based on clinical assessments or measures at baseline, before orthodontic treatment.

Examinations

All occlusions were clinically assessed using the OMFI [12,13]. According to the method, the results of all six morphological and four functional assessments or measures were categorized using the dichotomy of 'acceptable' (OMFI score 10) and 'unacceptable' (OMFI score less than 10). The assessments and their threshold values for acceptability are shown in the Appendix. To increase the reproducibility of the assessments and measures over time, one orthodontist (HA) examined all patients. For financial and practical reasons (the global SARS-CoV-2 pandemic outbreak), repeated examinations could not be carried out.

Additional data

In Examination 1, additional clinical data on patients' mode of breathing and lip closure were recorded in evaluation of the risk factors for relapse. Data on complications and/or problems during treatment were collected from patient records. According to the quality examination protocol, patients were asked about their satisfaction with the treatment outcome and reasons for dissatisfaction.

Table 1. Distribution of pre-treatment dentofacial ICD-10[a] codes and their respective DHC/IOTN[b] categories.

	ICD-10	CODE	*N*	IOTN category	*N*
Sagittal relationship	Mandibular prognathia	K07.11	5	–	–
	Mandibular retrognathia	K07.13	14	–	–
	Maxillary retrognathia	K07.14	2	–	–
	Disto-occlusion	K07.20	16	–	–
	Large overjet	K07.22	4	3	2
				4	10
				5	4
Vertical relationship	Deep bite	K07.23	16	4	11
	Open bite	K07.24	3	–	–
Transversal relationship	Crossbite	K07.25	7	3	1
				4	2
	Scissor bite	K07.27	5	–	–
Teeth	Congenitally missing teeth	K00.00	7	4	2
	Dental crowding	K07.30	16	4[c]	4
				3[d]	3

All ICD-10 codes with a prevalence over 5% included. DHC/IOTN categories were available for 39 of the 51 patients.
[a]ICD-10: International Statistical Classification of diseases and related health problems, 10th Revision (WHO).
[b]Dental Health Component of the Index of Orthodontic Treatment. Need. Categories 5 and 4: need treatment, category 3: borderline need.
[c]Partially erupted teeth, tipped and impacted against adjacent teeth, DHC 4.t.
[d]Contact point displacement, DHC 3.d.

Patients' pre-treatment cephalograms were available for the analyses. Four angles from Steiner's analysis were measured: sella–nasion plane to mandibular plane on the inferior border of the body of the mandible (SN to ML), SNA, SNB and ANB [17,18]. In addition, the difference between unit length of maxilla and mandible, as determined by Harvold analysis, was calculated for each patient [19]. These measures were completed by measures of upper and lower incisor inclination and respective interincisal angles.

The study protocol was approved by the Social and Health Services research board of Espoo Municipality.

Statistical analyses

Sample size calculation for power analysis was based on a previous study on the same ethnic population in a Finnish public dental clinic, which found that all morphological OMFI criteria were met by 27% of orthodontically treated adolescents and 60% of untreated adolescents [20]. According to the calculation, detection of a similar difference in OMFI score would require a sample size of 21 patients (alpha 0.05, beta 0.1 and power of 90%). Descriptive statistics were applied to quantitatively summarize the measures of central tendency and variability of the data. Spearman's rank correlation test was applied to analyse associations between OMFI scores and the pre-treatment interincisal angle, ANB angle, overjet (mm), overbite (mm) and treatment duration (months).

Results

Pre-treatment cephalometry

Distributions of the original angles SNA, SNB, ANB and SN/ML and of the Harvold difference are presented in Table 2.

OMFI

In Examination 1, the ranges for morphological, functional and total OMFI scores were 3–6, 2–4 and 6–10, respectively. All of the six morphological criteria for acceptability were fulfilled by 76% of the patients ($N = 51$) (Table 3). The reasons for unacceptability were deficiencies in canine relationship (7 occlusions), deep overbite (5 occlusions), crossbite (3 occlusions), excess overjet (2 occlusions) and deviation of upper midline (one occlusion).

Functionally, 82% of the patients fulfilled all four criteria for acceptability. Deficiencies were recorded in the criteria for protrusion ($N = 6$), working side contacts ($N = 2$) and non-working side contacts ($N = 1$). Both protrusion and working side contacts were affected in one case, and protrusion and non-working side contacts in one case. Two out of three patients (67%) had morphologically and functionally acceptable occlusion.

In Examination 1, the morphological OMFI score showed a strong positive correlation with pre-treatment overbite ($r_s = 0.5$, $p = .003$), and a weaker but statistically significant positive correlation with overjet ($r_s = 0.4$, $p = .012$). Similarly, the functional score and the total OMFI score correlated positively with large pre-treatment overjet ($r_s = 0.4$, $p = .023$ and $r_s = 0.4$, $p = .013$, respectively). The duration of treatment did not correlate with any of the cephalometric or clinical measurements.

Complications and problems

Complications or problems were reported in 33% ($N = 17$) of the treatments. In seven cases, the problems were related to patients' compliance. Problems related to treatment included unfavourable growth ($N = 7$), relapse during retention ($N = 2$) and an unerupted canine that did not

Table 2. Cephalometric measures in the pre-treatment lateral cephalograms.

	SN/ML			SNA[a]		SNB[b]		ANB[c]		Harvold difference	
N	Median	25–75% percentiles	IQR	Mean	Range	Mean	Range	Mean	Range	Mean	Range
51	31.3	26.9–35.7	8.0	83.0	77.0–91.3	78.9	72.0–89.2	4.0	−0.3–9.1	20.7	4.4–35.0

For the sella–nasion line to mandible plane angle on the inferior border of the body of the mandible (SN/ML) median value, the 25–75th percentiles, and the interquartile range (IQR), and for angles SNA[a], SNB[b], ANB[c] and for the maxillomandibular length difference (Harvold's analysis), the mean values and ranges are presented.
[a]SNA: angle between sella, nasion and subspinale point A.
[b]SNB: angle between sella, nasion and supramentale point B.
[c]ANB: angle between subspinale point A, nasion and supramentale point B.

Table 3. Percentage shares of patients fulfilling the occlusal morphology and function index (OMFI) criteria for acceptability in Examination 1 (at the end of the retention phase) and Examination 2 (after a two-year follow-up).

		Morphological criteria						Functional criteria			
	Average time (years) and SD from treatment completion	Coincidence of upper dental arch midline to facial midline	Overjet	Overbite	Sagittal canine relationship (both sides)	Crossbite	Scissor bite	Discrepancy between centric and intercuspal relation	Working side contacts	Non-working side contacts	Protrusion contacts
Examination 1 ($N = 51$)	1.9 (±0.7)	98	96	90	86	100	94	100	94	96	86
Examination 2 ($N = 28$)	4.3 (±0.8)	100	93	79	86	100	93	100	100	100	82

respond to traction and had to be extracted ($N = 1$). Four of these cases did not fulfil all of the morphological criteria (total OMFI scores 8–9), while in another four cases, neither morphological nor functional criteria were fulfilled (total OMFI scores 6–8).

Long-term stability

In Examination 1, the age in the subgroup of 28 participants ranged from 12.9 to 18.7 years and in Examination 2, from 15.3 to 20.8 years. At the two-year follow-up, the share of acceptable occlusions was 64% as assessed using the OMFI. For both examinations, the shares of patients who met the morphological and functional criteria for acceptability are presented in Table 3. Similarly, in Table 4, the prevalence of occlusal traits that did not meet the criteria is shown with respect to the original ICD-10 codes. In Examination 2, the ranges for morphological, functional, and total OMFI scores were 4–6, 3–4 and 6–10, respectively ($N = 28$). All morphological criteria were met by 68% and all functional criteria by 82% of the patients. Detailed data describing the longitudinal subgroup are presented in Table 5.

The longitudinal analysis of the 28 patients revealed that in 71% of the cases, OMFI scores had remained unchanged. In three patients, the functional scores of OMFI had improved, due to improvement in working side contacts. These changes were not reflected in morphology. In Examination 1, these three patients were aged between 15.7 and 17.7 years, and had permanent dentitions. Functional assessments deteriorated in one patient due to loss of anterior protrusion contacts.

The morphological scores changed in five patients: In one patient, the canine sagittal relationship improved over the follow-up period during which time the dentition transitioned from the mixed dentition phase in the age of 13.3 years to a permanent dentition. In contrast, four patients had experienced relapse in comparison with Examination 1. In two patients, overbite had increased; in one, overbite had decreased; and in another, overjet and canine relationship had deteriorated due to sagittal relapse. In addition, a fixed retention wire complication caused one canine to incline lingually. In Examination 1, the youngest of the four patients with a deteriorating morphology was 14.9 years old.

In Examination 1, four patients had been registered as mouth breathers with incomplete lip closure. Of them, three participated in Examination 2. As in Examination 1, all three patients failed to fulfil the functional criteria and two also the morphological criteria.

In Examination 1, 96% (49 out of 51 patients) were satisfied with the treatment results, whereas in Examination 2, the percentage of satisfied patients was 92% (24 of 26 patients; data missing for 2 patients). One of the 28 patients participating in the follow-up, who earlier expressed satisfaction, had become dissatisfied due to self-perceived alteration in the position of upper incisors.

Table 4. The prevalence of morphological and functional traits causing unacceptability of occlusion according to the occlusal morphology and function index (OMFI) in relation to the ICD-10 codes.

				Morphology							Function			
ICD-10[a]	CODE	*N*		Midline *N* (%)	Overjet *N* (%)	Overbite *N* (%)	Non-Class I unilateral *N* (%)	Non-Class I bilateral *N* (%)	CROSS-BITE *N* (%)	SCISSOR BITE *N* (%)	Working side contacts *N* (%)	Non-working side contacts *N* (%)	Protrusion contacts *N* (%)	SLIDE CR[b]–ICP[c] *N* (%)
Mandibular prognathia	K07.11	5	Examination 1	–	1 (20)	1 (20)	1 (20)	2 (40)	2 (40)	–	1 (20)	–	4 (80)	–
			Examination 2	–	–	1 (20)	1 (20)	1 (20)	1 (20)	–	–	–	2 (40)	–
Mandibular retrognathism	K07.13	14	Examination 1	–	–	1 (7)	–	1 (7)	–	–	1 (7)	1 (7)	–	–
			Examination 2	–	–	1 (7)	–	–	–	–	–	–	1 (7)	–
Disto-occlusion	K07.20	16	Examination 1	–	–	1 (6)	–	1 (6)	–	–	1 (6)	1 (6)	–	–
			Examination 2	–	1 (6)	1 (6)	1 (6)	–	–	–	–	–	1 (6)	–
Deep bite	K07.23	16	Examination 1	–	–	1 (6)	–	–	–	–	–	–	–	–
			Examination 2	–	1 (6)	1 (6)	1 (6)	–	–	–	–	–	–	–
Crossbite	K07.25	7	Examination 1	–	–	–	–	1 (14)	2 (29)	–	1 (14)	–	2 (29)	–
			Examination 2	–	–	–	–	1 (14)	2 (29)	–	–	–	2 (29)	–
Dental crowding	K07.30	16	Examination 1	1 (6)	–	–	2 (13)	1 (6)	2 (13)	–	2 (13)	–	2 (13)	–
			Examination 2	–	1 (6)	–	1 (6)	1 (6)	2 (13)	–	–	–	2 (13)	–

All criteria were fulfilled in cases with code K07.22 (overjet) or K00.00 (Congenitally missing teeth). Examination 1 ($N = 51$) was carried out at the end of the retention phase and Examination 2 ($N = 28$) after a two-year follow-up.

[a]ICD-10: International Statistical Classification of diseases and related health problems, 10th Revision (WHO).

[b]CR: centric relation; [c]ICP: intercuspal position/centric occlusion.

Table 5. Pre-treatment cephalometric and occlusal characteristics, and the OMFI scores in Examinations 1 and 2 in the longitudinal subsample ($N = 28$).

Patient number	Gender (M/F)	Age (years)			ANB baseline (degrees)	UI-SN[a] (degrees)	LI-MP[b] (degrees)	Overjet (mm)[c]	Overbite (mm)[c]	Treatment duration (months)	OMFI scores	
		Treatment onset	Examination 1	Examination 2							Examination 1	Examination 2
1	F	13.5	17.3	20.1	6.3	102.9	112.4	6.0	5.0	24	10	9
2	M	8.5	13.8	16.5	3.0	105.8	96.0	8.5	3.5	64	10	10
3	F	11.3	16.0	19.7	4.8	109.7	101.6	3.0	1.0	39	10	10
4	F	12.8	16.5	19.2	3.1	91.3	91.3	1.5	7.5	20	10	9
5	F	9.9	14.3	18.0	4.4	100.4	103.1	5.0	0.5	52	10	10
6	F	13.5	18.0	20.6	6.1	109.2	87.4	3.5	5.0	2	10	10
7	M	10.5	16.2	18.9	4.3	109.8	94.6	4.0	2.0	31	8	8
8	F	9.3	17.7	20.2	1.2	110.1	96.1	1.5	1.5	53	6	6
9	F	9.0	13.3	16.8	1.9	110.9	100.8	2.0	3.5	48	9	10
10	M	11.9	18.1	20.7	1.5	107.2	94.7	1.0	0.0	46	7	7
11	M	11.3	14.3	17.8	8.0	109.4	99.5	9.0	5.5	30	10	10
12	M	12.9	16.7	20.0	3.8	119.3	92.2	9.0	3.5	14	10	10
13	F	9.7	16.7	19.6	6.0	88.2	90.6	3.0	7.0	52	10	10
14	M	12.9	16.8	20.1	5.9	100.9	106.5	6.0	6.0	35	10	10
15	F	8.9	15.6	18.1	5.3	102.6	88.6	6.0	5.0	46	10	10
16	F	10.8	13.2	15.7	6.1	112.6	109.1	8.0	4.0	28	10	10
17	F	11.6	14.1	16.5	2.6	112.2	87.7	3.0	4.0	39	10	10
18	F	12.3	12.9	15.3	4.5	104.9	112.0	4.0	5.0	7	10	10
19	M	11.8	17.3	19.7	7.3	77.1	90.2	2.0	10.0	54	9	10
20	M	13.9	16.0	18.3	4.0	116.8	98.5	8.0	6.0	12	10	10
21	M	9.7	14.3	16.3	4.5	118.7	99.4	10.5	6.0	52	10	8
22	F	13.4	15.3	17.5	0.9	114.2	98.6	2.5	1.0	21	8	9
23	M	11.8	15.3	17.6	5.1	105.8	91.0	7.0	3.0	19	9	9
24	F	11.7	16.2	19.1	5.8	94.1	97.6	2.5	4.0	29	10	10
25	F	12.7	15.6	17.7	2.2	107.6	95.9	2.0	3.0	14	10	10
26	M	10.9	18.7	20.8	1.5	104.1	93.2	2.5	5.5	59	9	9
27	F	10.9	14.9	17.8	7.7	112.7	98.0	10.0	5.0	47	10	8
28	F	11.6	15.7	17.7	2.9	99.2	88.1	4.0	6.0	24	9	10

[a]UI-SN: upper incisors to sella-nasion angle.
[b]LI-MP: lower incisors to the mandibular plane angle.
[c]Clinical measurements to the nearest 0.5 mm.

Discussion

During childhood and adolescence, orthodontic treatment is usually introduced on the basis of growth modification and building of dentoalveolar compensations [21]. However, in most cases, growth will continue after completion of treatment, and the occlusion is subjected to changes. Post-retention occlusal settling, in turn, increases occlusal contact areas [22]. The main aims of this study were to evaluate the quality of orthodontic treatment outcome and the stability of occlusal traits in patients treated during adolescence.

In this study, the percentage of individuals meeting all the OMFI criteria was high, 67%. In the follow-up, similar results were observed, with 64% of the subsample fulfilling all of the OMFI criteria. In a previous investigation, conducted in Finnish public dental clinics, 40–72% of orthodontically treated 15–18-year-olds were reported to fulfil all the morphological, and 35–72% all the functional criteria of the OMFI [20,23,24]. In comparison, the current percentages indicate a high standard of orthodontic treatment in the target dental clinic, with 68–76% of morphologically and 82% of functionally acceptable occlusions.

Although the vast majority of all patients fulfilled the applied criteria, some trends can be outlined. First, from the morphological point of view, it seems that achievement of a proper Class I canine relationship is demanding with orthodontics alone, without surgery. The percentages of non-Class I canine relationships are well in line with previous findings, which apply as well early as late treatment protocols [23,24]. On the other hand, in an older study [25], only 50% of normal occlusions with no orthodontic treatment need showed 'a textbook normal' canine relationship, while in rest of the cases there was a cusp-to-cusp relationship either uni- or bi-laterally. Thus, the authors suggested that 'vertical upper or distally tipped lower canines leading to a cusp to cusp relationship could be accepted as stable and functional' [25].

Second, some excessive overbites prevailed; even here, the percentage is in line with previous findings [23]. As shown, continuing vertical growth and/or relapse in incisor inclination can affect overbite [26,27]. In the small study sample, also bite opening was seen in one case. It seems that the methods of correction and retention of vertical relationship need further consideration [27].

From the functional points of view, the main reason for unacceptability was protrusion interferences. This finding may reflect either a straight curve of Spee or a small overjet. In fact, the lower threshold value for an acceptable overjet, 0 mm, conflicts with the requirement of anterior guidance in protrusion. Although the value of 0 mm is in line with a previous finding that a normal occlusion can have an overjet from 0.5 to 5.5 mm [25], the lower limit for acceptable overjet needs to be adjusted to fulfil the functional requirement. Interestingly, the mean overjet and overbite in Finnish 32-year-olds with Class I occlusion have been found to vary from 2.6 to 3.0 mm, which coincides with the findings in the study regarding ideal occlusions [7,25].

Occlusal changes related to growth could be anticipated in some of the youngest participants (under 16 years of age) in the longitudinal subsample. Thus, somewhat unexpectedly in nine of these 13 patients (69%), the OMFI score remained unchanged during the whole follow-up period. However, changes in the OMFI score were observed in four of the 13 patients (31%).

The mean duration of single-phase fixed appliance treatment has been proposed to vary between 19 and 28 months, and long treatment duration has been shown to increase patient dissatisfaction [28,29]. However, there are conflicting results as well [30]. In this study, the duration was longer, with a mean of 36 months, likely due to several operators being involved in most of the treatments. Transfer of operators has been shown to increase treatment time [31]. Despite the longer duration, the level of patient satisfaction in this study was higher than a previously reported finding of 77% satisfaction five years post-treatment [30]. Our study showed 96% patient satisfaction two years after completion of treatment and 92% satisfaction after four years.

The OMFI is quick to apply, the assessment only taking up to 3 min per patient. Reproducibility of the OMFI criteria has been tested and the morphological criteria have been validated against the DHC of the IOTN [4,13,15]. However, the conflicting threshold values for acceptable overjet and protrusion contacts can be seen as a weakness of the OMFI. With accumulating data, the threshold values need to be adjusted, as suggested by the developers of OMFI [15].

The small sample size with a rather wide age range can be seen as a limitation of this study. However, the number of participants exceeded the minimum requirement of 21 pointed out in the sample size calculation. Presumably due to the outbreak of the global SARS-CoV-2 pandemic, participation in the follow-up study remained lower than expected. Unfortunately, the pandemic also led to several restrictions that made re-examinations impossible. Thus, the possibility of measurement errors cannot be ruled out. The narrow interquartile range for SN/ML angle at baseline indicates little variation in patients' skeletal pattern, thus increasing similarity in our sample.

Conclusions

In the evaluated public dental clinic, a high standard of orthodontic treatment outcome was achieved, although some challenges were seen in sagittal corrections. Most of the studied occlusal traits showed good long-term stability, with the exception of vertical relationship.

Disclosure statement

The authors report no conflict of interest.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article. Raw data were generated at City of Espoo and is available from the corresponding author on request.

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APPENDIX

Morphological and functional criteria of the Occlusal Morphology and Function Index (OMFI) and the cut-off values for acceptable occlusion.

MORPHOLOGICAL CRITERIA	*Cut-off for acceptability*
Coincidence of the facial midline and the midline of the upper dental arch	Up to 3 mm accepted
Overjet - Measured from the most labial central incisor	0–5 mm accepted
Overbite	Occlusal contact incisal to the gingival third of the palatal surface of upper incisors accepted. Open bite only accepted in lateral incisors.
Canine relationship on both sides	Normal ±2 mm accepted. Post-normal relationship accepted in case of missing upper incisors.
Crossbite	Anterior crossbite not accepted. Posterior crossbite not accepted in canines. Accepted in one tooth pair per side, if no interference or slide between CR–ICP.
Scissor bite	Not accepted.

FUNCTIONAL CRITERIA	*Cut-off for acceptability*
Slide between CR*–ICP**	Max 2 mm slide accepted horizontally and vertically. No slide accepted laterally.
Working side contacts - Guided lateral excursions	Canine protection/ group contact including canine/ contacts in incisors, premolars and molars accepted.
Non-working side contacts	Accepted without disclusion of working side contacts
Protrusion contacts	Anterior guidance accepted

* CR = centric relation
**ICP = intercuspal position / centric occlusion