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ORIGINAL ARTICLE

Mandibular asymmetry in healthy children

MAIJA LIUKKONEN, LAURI SILLANMÄKI & TIMO PELTOMÄKI

Department of Oral Development and Orthodontics, Institute of Dentistry and Department of Biostatistics, University of Turku, Turku, Finland

Abstract
Facial asymmetry is a naturally occurring phenomenon that is often due to differences in the mandibular dimensions on the right and left sides. The point where normal asymmetry turns abnormal cannot be easily defined, and no standards exist by which a judgement of abnormality can be made. The aim of the present study was to assess mandibular asymmetry in healthy children and its possible fluctuation during growth. The subjects consisted of 182 healthy children (88 girls, 94 boys) who had had an orthopantomogram taken at ages 7 (mean 7.5 years) and 16 (mean 15.9 years). On digitized orthopantomograms, condylar and ramus heights on both mandibular sides were measured with a Numonics Accugrid digitizer (Numonics Co., Montgomeryville, Pa., USA) and analysed with X-metrix software (Smart Systems, Turku, Finland). A paired *t*-test was used to determine the significance of the differences between the sides, and ANOVA to test the significance of the change in asymmetry during growth and between genders. The results revealed a statistically significant difference between the right and left sides in condylar height at age 7 years, in ramus height at both ages, and in the condylar and ramus height at age 16 years. The present study confirms that healthy young subjects generally have a statistically significant mandibular asymmetry, which, however, is only seldom clinically significant. The decision to initiate treatment because of asymmetry has to be carefully considered, since the study further showed that mandibular asymmetry may diminish or appear during growth of healthy subjects.

Key Words: *Asymmetry, mandible, mandibular condyle, orthopantomogram*

Introduction

Facial asymmetry is a naturally occurring phenomenon, and there is no truly symmetrical face regardless of the age of the individual. Thompson [1] has stated that whereas normal asymmetry is not evident, abnormal asymmetry is obvious. The point where "normal" asymmetry turns "abnormal" cannot be easily defined, and no absolute or accepted standards exist by which a judgement of abnormality can be made.

In orthodontic and orthognathic surgical patient examination and treatment planning, much emphasis is placed on analysis of the facial profile. Yet, the beauty and harmony of the face is more commonly judged from the frontal view, i.e. mirror view. In addition to clinical examination, postero-anterior (PA) cephalograms are used to study facial asymmetry. However, in determining head symmetry by means of PA roentgenography the process of taking a cephalogram induces potential error and therefore the measurements are not readily repeatable, in addition to errors in the landmark identification [2]. In many cases, the involvement of the mandible or, more precisely, the mandibular condyle, is the primary source of asymmetrical facial development, and other consequences are secondary to this [3]. Panoramic radiography offers a method to study mandibular condylar processes and rami separately on the right and left sides. Particularly vertical measurements have been considered reliable [4–8], and orthopantomograms have been widely used for mandibular asymmetry analysis in pathologic conditions of the condylar process caused by a general disease, such as rheumatoid or psoriatic arthritis [6,7,9,10].

On the other hand, in healthy subjects mandibular asymmetry and its possible fluctuation during growth have received only little attention. Based on

Correspondence to: Timo Peltomäki, Institute of Dentistry, University of Turku, Lemminkäisenkatu 2, FIN-20520 Turku, Finland. Tel. +358 2 333 8318. Fax. +358 2 333 8356. E-mail: timo.peltomaki@zzmk.unizh.ch

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a radiologic study, Melnik [11] reported that the left side of the mandible is longer at age 6 years, while the right side of the mandible becomes longer by the age of 12 years in girls and by the age of 16 years in boys. He eventually concluded that there is a near equal probability for improvement or worsening of a child's mandibular asymmetry between ages 6 and 16 years.

The purpose of the present study was to assess mandibular asymmetry in healthy children and its possible fluctuation during growth.

Subjects and methods

The subjects comprised 182 healthy children (88 girls, 94 boys), i.e. none had a general disease which could possibly have affected mandibular growth. Orthopantomograms taken at ages 7 (mean 7.5, range 6.4–8.5 years) and 16 (mean 15.9, range 15.2–17.2 years) were taken to examine the effect of deep caries in deciduous teeth to permanent teeth. Some subjects from the original 245 children were excluded if they had received orthodontic treatment or because of improper quality of orthopantomograms, particularly if condylar heads were not clearly seen. Thus, none of the included subjects had received orthodontic treatment. However, subjects, for example, with mild class II malocclusion or crowding and not considered in need of orthodontic treatment were included.

The pantomograms were digitized with a Numonics Accugrid digitizer (Numonics Co., Montgomeryville, Pa., USA) and analysed with X-metrix software (Smart Systems, Turku, Finland). Condylar and ramus heights on both sides were measured perpendicularly to the ramus tangent according to Kjellberg [6], (Figure 1). By using the magnification factor inherent of the radiologic method all the linear dimensions were reduced to actual size.

Paired *t*-test was used to test the significance of the differences between the sides, and analysis of variance (ANOVA) to test the significance of the change in asymmetry during growth and between genders. A closer follow-up was made of the 8 subjects who had larger than 2 standard deviation (SD) difference of the sample mean in the right and left sides condylar and ramus height at the age of 7 years. Similarly, the 11 subjects with larger than 2 SD difference in the same measurement at the age of 16 years were looked back at the age of 7 years.

Reproducibility of the measurements was tested by repeat digitations of randomly selected 33 subjects at least 1 month later by the same investigator (M.L.). Measurement error for each variable was calculated from the formula $\sqrt{\Sigma d^2/2n}$, where d is difference between the first and second measurements, and n the number of double measurements. In addition, to find out possible distortional effects, the pantomograms of the follow-up subjects in both age groups were scrutinized by measuring and comparing the length of the lower 1st molar on the right and left sides. In detail, an apical reference line was drawn through the mesial and distal root apices of the lower 1st molar. The length of the tooth was measured from the mesiobuccal cusp to the root apex perpendicular to the reference line (Figure 2). All the dental measurements were repeated and the measurement error was calculated using the same formula as for the mandibular measurements.

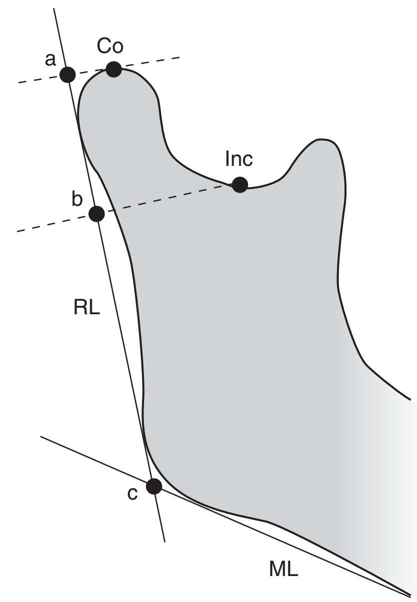

Figure 1. On digitized orthopantomograms, tangent to the ramus (RL) and lower border of the mandible (ML) were drawn and thereafter condylar (a–b) and ramus (b–c) heights on both sides were measured perpendicular to the ramus tangent. The lower point of the ramus (c) was defined as intersection of the RL and ML. Co (condylion) stands for the uppermost point on the condylar process and Inc for the lowest point at the incisura mandibulae.

Results

Measurement errors of the mandible ranged between 0.386 and 0.465 mm. These were considered to have had no significant effect on the results as far as reliability of the measurements was concerned. Measurements of teeth size showed practically no differences on the right and left sides and on repeated

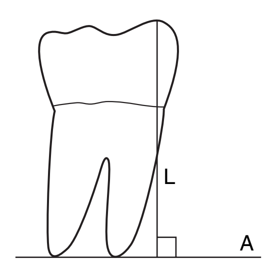

Figure 2. To measure the length of the lower 1st molar, an apical reference line (A) was drawn through the mesial and distal root apices of the molar. The length of the tooth (L) was measured from the mesiobuccal cusp to the root apex perpendicular to the reference line.

Table I. Measurement errors (in mm) for mandibular and tooth length dimensions based on double measurements

Measurement	Measurement error
Condylar height	
Right	0.399
Left	0.386
Ramus height	
Right	0.434
Left	0.386
Condylar and ramus height	
Right	0.467
Left	0.445
Tooth length	
Right	0.675
Left	0.727

exposures, thus confirming that distortional effects had no impact on the findings. Double measurements of tooth length varied between 0.675 and 0.727 (Table I).

In the whole material there were statistically significant differences between the right and left sides in three measurements: (1) condylar height at age 7 years, but not at 16 years, (2) ramus height at both ages, and (3) condylar and ramus height at age 16 years. The change in asymmetry between the right and left sides during growth was statistically significant in all the used measurements, except for ramus height (Table II). The only gender difference was that the ramus height between the sides was statistically different in the boys at age 16 years, but not in girls. Therefore the genders have been pooled.

Figure 3 shows the change in asymmetry of the 8 subjects who had the right and left side difference in condylar and ramus height greater than 2 SD of the sample mean at age 7 years. The side difference was on an average 4.2 mm. The follow-up shows that mandibular asymmetry had decreased by the age of 16 years in 6 out of 8 subjects, but was still on average 3.0 mm. Of the 11 subjects who had asymmetry greater than 2 SD (on average 5.7 mm) at age 16 years, all but one had been close to symmetry at age 7 years (Figure 4). One subject who had greater than 2 SD right and left side difference in condylar and ramus height at ages 7 and 16 is represented in both figures.

Discussion

Judgement of mandibular symmetry/asymmetry is a difficult but important task in making the diagnosis and treatment plan for orthodontic, oral, and maxillofacial purposes. Sometimes even in cases of very obvious mandibular asymmetry it is not self-evident whether one side has overgrown or the other undergrown. In the present study, orthopantomograms taken from the same subjects at ages 7 and 16 years were used. Difference in head positioning for repeated orthopantomograms may cause image distortion and unreliability of the measurements [12–14]. However, vertical measurements, mostly used here, are considered to be less affected by the possible change in positioning [4–8]. In the present study, a possible distortional effect to the findings was examined by measuring the length of the lower 1st molar on both sides. The examination confirmed that the side differences were reliable findings and not due, for example, to positional differences in the repeated exposures at different ages.

The present study reveals that healthy young subjects generally have a statistically significant mandibular asymmetry. A closer look shows that condylar height and ramus height behave in different ways during growth. There is a statistically significant side difference in condylar height at age 7 years, but not at 16 years. On the other hand, ramus height measurements showed a statistical side difference at both examined ages. It thus seems that there is on average more fluctuation in the ramus compared to

Table II. Measurements on the mandible ($n = 182$) and tooth length ($n = 36$) at ages 7 and 16 years

		Side													
		Right				Left				R–L Difference				T-test R–L diff.	ANOVA 7–16 years
Measurement	Age (years)	Mean	SD	Range		Mean	SD	Range		Mean	SD	Range		*p*-value	*p*-value
Condylar height	7	16.6	2.1	11.7	21.8	17.4	2.1	12.8	23.1	−0.8	1.4	−6.0	2.6	⩽0.0001	⩽0.0001
	16	18.9	2.8	12.1	28.1	18.9	2.7	13.2	26.0	−0.1	1.9	−4.7	4.4	NS	
Ramus height	7	28.8	2.9	21.6	36.0	28.1	2.8	21.0	35.5	0.7	1.9	−5.1	6.6	⩽0.0001	NS
	16	36.6	4.2	26.5	50.0	36.0	4.2	25.8	48.2	0.6	2.5	−6.4	6.9	⩽0.05	
Condylar and ramus height	7	45.4	2.8	37.9	52.1	45.5	2.8	39.7	51.2	−0.1	1.7	−6.3	5.2	NS	⩽0.0001
	16	55.4	4.0	45.6	66.0	54.9	4.3	44.7	66.1	0.5	2.3	−5.6	7.9	⩽0.05	
Tooth length	7	27.6	1.8	24.0	31.0	27.6	1.9	24.5	32.0	0.0	0.6	−1.0	1.0	NS	
	16	28.0	1.2	25.0	30.0	28.1	1.3	24.0	29.5	−0.1	0.6	−1.0	1.0	NS	

NS, not significant.

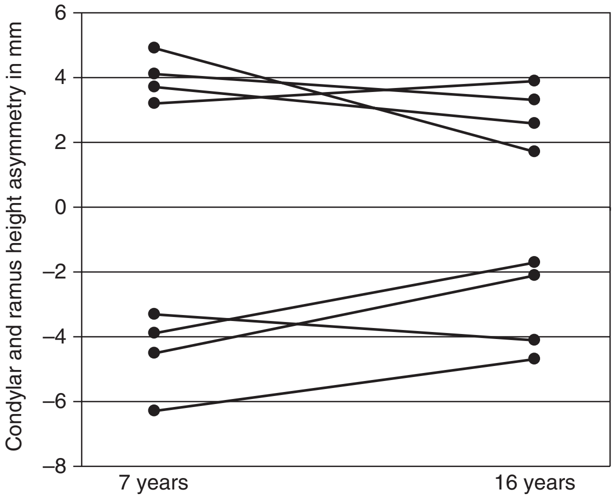

Figure 3. Follow-up of the 8 subjects with condylar and ramus height asymmetry more than 2 SD of the sample mean at age 7 years shows that, with the exception of two subjects, the asymmetry was decreased by age 16 years. Values designed positive indicate that the right side was longer and negative values the opposite.

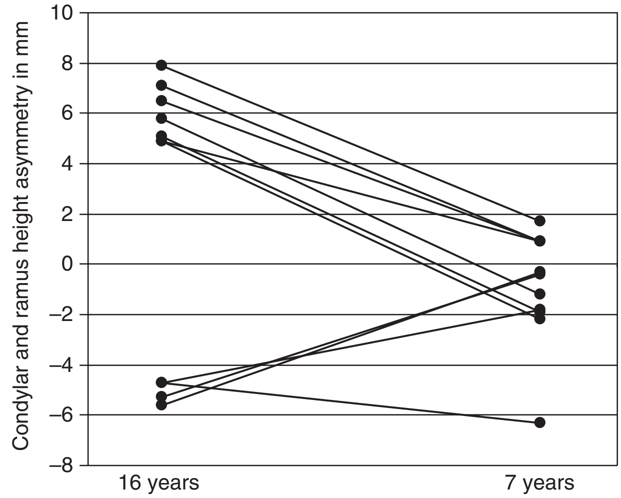

Figure 4. Retrospective study of the 11 subjects with condylar and ramus height asymmetry more than 2 SD of the sample mean at age 16 years shows that, all but one, had been close to symmetry at age 7 years. Values designed positive indicate that the right side was longer and negative values the opposite.

condylar height measurements. However, 0.8 mm side difference in condylar height at age 7 constitutes about 11% of the total condylar height, while 0.7 mm side difference in ramus height is only about 2.5% of the total ramus height. The evident difference in condylar and ramus height behavior can be explained by the fact that the condylar process and the lower border of the ramus are under a different growth regulation during growth. While the condylar process is elongated through endochondral bone formation in the condylar cartilage, the gonial region is built up of periosteal bone apposition related to the musculature attached to the area. These two different growth processes may compensate one another, however. It has been postulated that loss in condylar height, for example because of rheumatoid arthritis, is followed by bone apposition in the lower border of the ramus and formation of the antegonial notching [15].

Despite the finding that there is a statistically significant difference between the right and left condylar and ramus heights, the clinical bearing of this finding can be questioned. Usually the asymmetry does not become a clinical problem. However, the range in asymmetry was large, and when it is clearly detectable it can create a problem to a young individual. None of the present subjects has paid a return visit to our clinic because of a problem due to facial asymmetry. The decision to initiate treatment has to be carefully considered, since the follow-up subjects with extreme mandibular asymmetry among the studied subjects (Figures 3 and 4) reveal, in agreement with Melnik [11], that mandibular asymmetry may diminish or appear during the growth period in healthy children. This fluctuation during growth may indicate that functional forces to the joints and mandibular gonial regions are not necessarily in balance, which may lead to unequal growth of the condyle and ramus heights on the right and left sides. No clear-cut values can be given to indicate treatment need. The decision has to be based on the probability that the facial asymmetry generates either functional or esthetic problems for the individual. Furthermore, other diagnostic tools (magnetice resonance imaging and/or computed tomography scans) have to be used to achieve a proper diagnosis and follow-up in cases of only mild asymmetry on orthopantomogram if the subject has other indications of a syndromic condition, such as ear deformity in hemifacial microsomia.

Acknowledgments

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