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Mandibular Border Positions in Eugnathic Subjects during the Second Bite Lifting

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ABSTRACT

This research was aimed at performing a clinical functional analysis during the second bite lifting, in order to define mandibular border positions and possible differences by sex and/or age. Out of a total of 9680 examined children from the region of Međimurje, Croatia, 103 were found to be eugnathic, with dentition in occlusion during the phase of the second bite lifting. All the eugnathic patients belonged to the class I by Angle, without any caries, fillings or extracted teeth. They were divided into three predefined groups for the sake of comparison. The obtained values of mandibular border positions in eugnathic subjects during the second bite-lifting phase vary with age and with the number of present permanent teeth in occlusion. Generally, all the values are higher in girls than in boys, which speaks in favour of the assumption that mandibular border positions are determined by sex, hormonal activity, growth and intercuspidation. Also, girls show a higher TMJ flexibility as well as a higher mandibular mobility. The knowledge of these facts will contribute to a more precise treatment in child prosthetics and pedodontics.

Introduction

The mandible makes complex and extensive movements, which are controlled by the central neural system, and are mostly determined by condylar actions, directed by dental occlusion and the function of masticatory muscles, Temporomandibular joints (TMJ)[1], condylar growth[2], and condylar movements[3] have a decisive effect on mandibular movements[4]. The condyles must follow the determined trajectories when the muscles move the mandible, while rotation centres are located at different distances and TMJ directions[5–7]. The lower jaw movements are

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divided into basic, functional, parafunctional, border and masticatory movements[8]. All exterior mandibular movements are defined as border ones[9].

A successful clinical work requires a precise definition of the mandible position and its relationship toward the maxilla and the cranium, as well as a possible reproduction of the lower jaw movements with a careful clinical and instrumental analysis[10–12]. It is the mandibular border positions that are the most suitable for the reproduction of the lower jaw movements, as they can be reproduced by articulators or presented by graphical and/or electronic instruments[13,14]. Border mandibular movements begin at the border positions of the mandible, such as maximum opening of the mouth, maximum protrusion, maximum retrusion and maximum lateral movements [8,9,15,16]

This research was aimed at defining the mandibular border positions during the second bite-lifting phase of growth and development in eugnathic subjects of the Croatian population.

The specific goals were to find out the following:

- The average value of the maximum mouth opening and the time it reaches its peak; whether it increases with age and with the number of permanent teeth in occlusion.
- The average value of the maximum protrusion movement and the time it occurs, as well as possible differences by sex, i.e. between boys and girls.
- The average value of the maximum right lateral, the time it occurs, whether it is the same as the maximum left movement and whether it is higher in boys or in girls.

The age at which the increase of all the values of border mandibular movements stops, and possible differences by sex and/or age.

Subjects and Methods

Out of a total of 9680 examined children from the region of Međimurje, Croatia, 103 were found to be eugnathic, with dentition in occlusion during the phase of the second bite lifting. All the eugnathic patients belonged to the class I by Angle, without any caries, fillings or extracted teeth. They were divided into three predefined groups for the sake of comparison.

The first group consisted of 23 examinees aged on the average 6.7 years, with all the first permanent molars and complete milk dentition in occlusion. The second group consisted of 40 subjects aged on the average 9.3 years, with all the first permanent molars, milk resistance zone and permanent incisors. The third group was formed by 40 eugnathic subjects aged on the average 11.5 years, with complete permanent dentition in occlusion from I1 to M1 in all four squares.

The maximum mouth opening was measured in the following way: the overlapping lower edge of the upper incisors was marked on the lower incisors with a waterproof pencil. Then, the patient opened his mouth to its maximum and the distance between the incisive edge of the upper incisors to the marked overlap on the lower incisors was measured in mm.

The maximum protrusion movement was measured in the area of the milk or permanent canine by drawing with a waterproof pencil a line following the longitudinal axis of the upper and the lower canine. Then, the maximum protrusion movement was performed, and the distance between the two lines was measured[17]. The measurements were performed both on the left and right side of the mandibular arch, and the obtained values in mm were recorded in the patient's file-card[18].

The maximum lateral movements were measured by drawing with a waterproof pencil the line, passing through the

mesial parts of the central incisors to the lower incisors. During the maximum left and right lateral movement the distance between the marks on the upper and lower teeth was measured[17].

Results

Maximum mouth opening (MMO)

Table 1 shows the values in mm obtained by measuring the maximum mouth opening by group, sex and age. In the first group, the minimal mouth opening regularly increases with age from 37 mm at age 6 to 50 mm at age 8. MMO varies irregularly with age, as it does not depend only on age. The mean MMO value increases with age in both boys and girls. It amounts to 44.6 mm in boys and 45.0 in girls. In the second group, aged on the average 9.3 years, both minimal and maximal mouth opening increases with age.

TABLE 1
MAXIMUM MOUTH OPENING BY GROUP, SEX AND AGE

Group	Sex	Age in years	No. of subjects	Min	Max	Average	Std. dev.
1	M	6	4	37	53	44.0	
1	M	7	9	38	49	44.2	
1	M	8	1	50	50	50.0	
1	M	6.8	14	37	53	44.6	
1	F	6	4	40	46	43.5	
1	F	7	4	42	50	47.0	
1	F	8	1	43	43	43.0	
1	F	6.7	9	40	50	45.0	
1	M+F	6.7	23	37	53	44.7	4.04
2	M	8	8	41	53	47.9	
2	M	9	5	44	55	50.6	
2	M	10	4	48	55	51.8	
2	M	11	2	51	53	52.0	
2	M	9.0	19	41	55	49.8	
2	F	8	1	53	53	53.0	
2	F	9	11	40	56	46.6	
2	F	10	8	42	60	52.0	
2	F	12	1	51	51	51.0	
2	F	9.5	21	40	60	49.2	
2	M+F	9.3	40	40	60	49.5	4.88
3	M	11	5	45	62	54.8	
3	M	12	12	46	57	52.1	
3	M	13	3	49	51	50.0	
3	M	11.9	20	45	62	52.5	
3	F	10	5	50	59	53.0	
3	F	11	10	45	61	52.4	
3	F	12	5	48	61	54.0	
3	F	11.0	20	45	61	53.0	
3	M+F	11.5	40	45	62	52.7	4.38
Total	M+F		103	37	62		5.39

TABLE 2
MAXIMUM MOUTH OPENING VALUE BY SEX AND AGE

Sex	Age in years	No. of subjects	Min	Max	Average	Std. dev.
M	6	4	37	53	44.0	
M	7	9	38	49	44.2	
M	8	9	41	53	48.1	
M	9	5	44	55	50.6	
M	10	4	48	55	51.8	
M	11	7	45	62	54.0	
M	12	12	46	57	52.1	
M	13	3	49	51	50.0	
M		53	37	62	49.4	5.4
F	6	4	40	46	43.5	
F	7	4	42	50	47.0	
F	8	2	43	53	48.0	
F	9	11	40	56	46.6	
F	10	13	42	60	52.4	
F	11	10	45	61	52.4	
F	12	6	48	61	53.5	
F		50	40	61	49.9	5.4
M+F	6	8	37	53	43.8	
M+F	7	13	38	50	45.1	
M+F	8	11	41	53	48.1	
M+F	9	16	40	56	47.9	
M+F	10	17	42	60	52.2	
M+F	11	17	45	62	53.1	
M+F	12	18	46	61	52.6	
M+F	13	3	49	51	50.0	
M+F		103	37	62	49.7	5.4

The mean MMO value is 49.5 mm, slightly higher in boys, 49.8 mm, than in girls, 49.2 mm. The mean value is higher in boys for 0.6 mm, although we should expect a higher value in girls who are 6 months older than boys. The difference between the minimal and maximal mouth opening in the second group is 20 mm. It can be seen that in the third group, aged on the average 11.5 years, the mean MMO value varies with age, but it is higher than in the first two groups, ranging from 50.0 to 54.8 mm, with the average value of 52.7 mm. In this group of subjects the highest MMO value of 62 mm was recorded, which is also the highest value measured during our investigation.

The mean MMO value (Table 2) increases in boys between 7 and 8 years of age for 4 mm on the average, while the next major increase occurs between 10 and 11 years, for 2.2 mm. In girls, the first sharp increase occurs between 6 and 7 years for 3.3 mm, and the second one between 9 and 10 years for about 5.8 mm on the average. These sudden increases occur one year earlier in girls than in boys. After these sudden leaps, the increase of MMO is low, as indicated by the

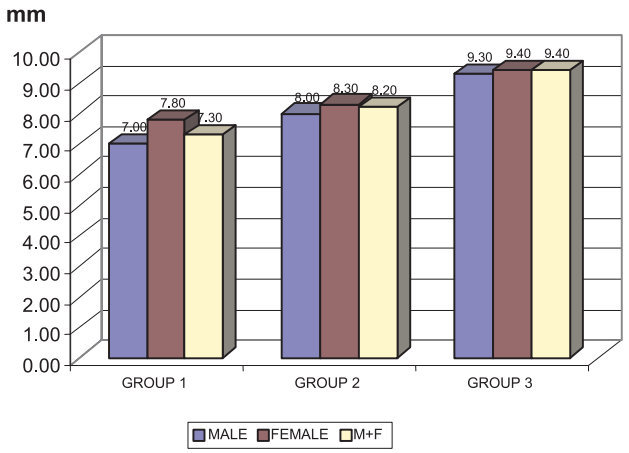

Fig. 1. Maximum prothrusion movement by group.

TABLE 3
MAXIMUM PROTHRUSION MOVEMENT BY SEX AND AGE

Age in years	Average MPM males	Average MPM females	Males + Females
6	6.6	7.0	6.8
7	6.9	8.2	7.3
8	8.2	8.5	8.3
9	8.1	7.7	7.8
10	7.5	9.2	8.8
11	8.2	9.1	8.7
12	10.2	9.8	10.1
13	7.8	–	7.8

stagnation of MMO growth, which reaches its maximum of 53.5mm in girls at age 12, and of 54 mm in boys at age 11. After this age, MMO slowly decreases, so that in boys aged 12 its mean value amounts to 52.1 mm, and those aged 13 it is only 50 mm.

The mean MMO value shows a regular yearly increase up to the age of 11, except for the age of 9. After 11 years of age, the MMO growth slowly decreases in the analysed sample. Major leaps have been recorded between 7 and 8 years (3 mm) and between 9 and 10 years (4.3 mm).

Maximum protrusion movement (MPM)

MPM was measured on both left and right side of the mandibular arch. The value of the protrusion movement (Figure 1) increases with age and with the number of permanent teeth. On the average, MPM in all the groups is slightly higher in girls than in boys. At the average age of 6.7 years the average MPM is 7.3 mm.

TABLE 4
MAXIMUM LATERAL MOVEMENT

Group	Sex	No. of subjects	Average age	Average MLMR	Average MLML	Average MLMR+MLML
1	M	14	6.8	8.6	8.3	8.4
1	F	9	6.7	8.9	8.9	8.9
1	M+F	23	6.7	8.7	8.5	8.6
2	M	19	9.0	9.4	10.1	9.7
2	F	21	9.5	9.6	10.2	9.9
2	M+F	40	9.3	9.5	10.2	10.0
3	M	20	11.9	10.7	11.3	11.0
3	F	20	11.0	11.5	12.0	11.7
3	M+F	40	11.5	11.1	11.6	11.3

At the average age of 9.3 the average MPM value is 8.2 mm, at age 11.5 years it is 9.4 mm. In other words, MPM increases on the average for 2.1 mm from the age of 6.7 to 11.5 years.

Table 3 shows MPM values by age and sex. The average MPM value in boys (8.2 mm) is lower than in girls (8.6 mm). The highest average MPM values were found in both boys and girls at age 12, 10.2 mm and 9.8 mm respectively. In girls aged between 9 and 10, a sudden increase in MPM value occurs for 1.5 mm on the average, while in boys it occurs between 11 and 12 years and amounts to 2 mm. The growth stagnation preceding this sharp increase occurs at age 9 in girls and at age 10 in boys.

Maximum lateral movement (MLM)

Table 4 presents the values of maximum lateral movement in mm, as well as average left (MLML) and right (MLMR) values, while the mean left and right MLM values are listed in the last column.

The average left MLM values are always higher than the right ones except for the first group. They reach their maximum at age 11 in girls (12.0 mm), and at age 11.9 years in boys (11.3 mm). MLM values increase clearly from the age of 6.8 to 11.5 years on the average for 2.9 mm. The comparison between the minimal MLM value in the first group and the maximal MLM value in the third group shows that the increase amounts to 3.7 mm. The maximum average MLM values recorded (Table 5) were to the left, amounting in girls aged 11 to 12.1 mm and in boys aged 13 to 12.0 mm.

At age 10, MLMR equals MLML in both boys and girls, although its value is higher in girls than in boys. This finding is in favour of the stability and balance of mandibular movements.

MLM values increase with age and the number of the subject's permanent teeth, and reach their maximum earlier in girls than in boys. The average left MLM values are always higher than the right ones after the age of 6.7 years, and they are also higher in girls than in boys.

When we compare these results to those obtained by Percač[17] in the sample aged between 16 and 19 years with almost complete growth and development, we can say that all the values increase during the second bite lifting, and many of them get stabilised at about 11 years of age. Our results show differences in MLM values with regard to both its direction (left/right) and sex, while Percač[17]

TABLE 5
MAXIMUM AVERAGE LATERAL MOVEMENT VALUES RECORDED

Age in years	Average MLM R male	L	Average MLM R female	L	Average MLM R M+F	L
6	8.3	7.5	8.5	8.0	8.4	7.8
7	8.4	8.6	9.3	9.5	8.7	8.8
8	9.2	9.6	9.5	10.0	9.3	9.6
9	9.6	10.8	9.3	10.1	9.4	10.3
10	10.0	10.0	10.8	10.8	10.6	10.6
11	9.3	10.7	11.4	12.1	10.5	11.5
12	11.3	11.3	10.8	12.0	11.2	11.6
13	10.0	12.0	–	–	10.0	12.0
Total	9.6	10.1	10.2	10.7	9.9	10.4

did not find any differences either by sex or by lateral movement direction.

Conclusion

The values of mandibular border positions in eugnathic subjects during the second bite-lifting phase vary with age and with the number of present permanent teeth in occlusion.

The average maximum mouth opening increases from group to group with age and with the number of permanent teeth in the mouth. The maximum value is reached at the average age of 11.5 years and amounts to 52.7 mm.

The maximum protrusion movement is on the average higher in girls than in boys and it increases with age. Its maximum value of 9.4 mm is reached at age 11.5 years, when it stagnates.

The maximum left and right lateral movement increases with the chronological age. The average value of the right lateral movement is always lower than the average value of the left movement. The maximum lateral movement is always higher in girls than in boys. It reaches its peak at age 11.5 years, which for the right movement is 11.1 mm and for the left one is 11.6 mm.

About 12 years of age all values of mandibular border movements stagnate and begin to decrease slowly. Generally, all the values are higher in girls than in boys, which speaks in favour of the assumption that mandibular border positions are determined by sex, hormonal activity, growth and intercuspidation. Also, girls show a higher TMJ flexibility as well as a higher mandibular mobility.

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GRANIČNI POLOŽAJI MANDIBULE KOD EUGNATIH ISPITANIKA ZA FAZE DRUGOG PODIZANJA ZAGRIZA

S A Ž E T A K

Istraživanjem na području Međimurja u pregledanih 9680 djece pronađena su 103 eugnata ispitanika čija je denticija bila u okluziji za faze drugog podizanja zagriza. Svi su ispitanici eugnati najbliže klasi I po Angleu, bez karijesa, bez ispuna i bez izvađenih zuba. Podijeljeni su u tri unaprijed definirane grupe koje su međusobno komparirane. Svrha istraživanja je bila da se provede klinička funkcijska analiza za faze drugog podizanja zagriza, da se utvrde vrijednosti graničnih položaja mandibule, da se kod toga utvrde razlike uvjetovane spolom i uzrastom. Poznavanje tih činjenica daje mogućnost preciznog tretmana u dječjoj protetici i pedodonciji. Utvrđeno je da se sve mjerene vrijednosti graničnih kretnji mandibule mijenjaju. Mijenjaju se s dobi i brojem prisutnih trajnih zubi u okluziji. Prosječna vrijednost maksimalnog otvaranja usta, s 6,7 godina iznosi 44,7 mm, a s 9,3 godine 49,5 mm. Maksimum postiže s 11,5 godina prosječne starosti ispitanika i iznosi 52,7 mm. Maksimalna protruzijska kretnja, s 6,7 godina prosječne starosti iznosi 7,3 mm, a s 9,3 godina 8,2 mm u prosjeku. U prosjeku je veća kod djevojčica nego kod dječaka. Najveću vrijednost postiže s 11,5 godina, kada iznosi 9,4 mm. Nakon toga prestaje se povećavati.

Prosječna vrijednost maksimalne desne lateralne kretnje, nakon 6. godine starosti i kod dječaka i kod djevojčica uvijek je manja od lijeve, osim u fazi smirivanja s 10 godina starosti kada je lijeva jednaka desnoj. Maksimalna lateralna kretnja je kod djevojčica uvijek veća nego kod dječaka. Najveća je s 11,5 godina i desna iznosi 11,1 mm, a lijeva 11,6 mm u prosjeku. U promatranoj dobi, za vrijeme drugog podizanja zagriza, vrijednosti graničnih položaja mandibule u pravilu su veće kod djevojčica nego kod dječaka što govori u prilog da su te vrijednosti uvjetovane spolom, hormonalnom aktivnosti, rastom organizma i interkuspidacijom. Kod djevojčica je prisutna veća pomičnost u TMZ-u i veća mobilnost mandibule. Oko 12. godine starosti sve se vrijednosti graničnih kretnji mandibule prestaju povećavati i počinje njihov lagani pad.