Stomatologija. Baltic Dental and Maxillofacial Journal, 22: 54-7, 2020

Heritability of mandibular asymmetries in sagittal direction: A cephalometric study

Ingrida Rakauskaite[1], Vilma Svalkauskiene[1], Zygimantas Labanauskas[1], Donata Juozėnaitė[1], Giedrė Trakinienė[1], Justina Vaiciuniene[2]

SUMMARY

Aim of the work. If we figure out mandible asymmetry etiology, we can inspire further scientific research, create more effective treatment schemas and recommend means of prophylaxis that could stop mandible asymmetry development. The aim of this work was to analyze monozygotic and dizygotic twins' mandibular asymmetry in sagittal direction using cephalometric data and to analyze its dependence of genetic and environmental factors.

Material and methods. Study sample consisted of 80 dizygotic (DZ) and 80 monozygotic (MZ) twins of same sex. 3 cephalometric measurements were made to determine mandible asymmetry in sagittal direction. Indexes of mandibular asymmetry (IMA1, IMA2) were calculated. Data analysis was done using Microsoft Excel (2013). Genetic and environmental factors influencing mandible asymmetry was determined.

Results. Mandibular dental asymmetry was bigger in monozygotic twins' group but the results were not statistically significant. Mandibular skeletal asymmetry was significantly bigger in dizygotic twins' group: IMA1(DZ)=3.05±1.94, IMA1(MZ)=1.92±1.05, p=0.005. IMA2(DZ)=3.12±2.04, IMA2(MZ)=1.88±1.04, p=0.004. Distance between distal borders of the ramus is mostly determined by genetic factors.

Conclusions. 1. Mandibular skeletal asymmetry was significantly bigger in dizygotic twins' group. Mandibular dental asymmetry and symmetry did not differ in groups significantly. 2. Skeletal mandible's asymmetry is more determined by genetics than environmental factors, but lower molars' sagittal position is determined more by environment.

Key words: facial asymmetry, cephalometry, mandible, twins, orthodontics.

INTRODUCTION

A small degree of asymmetry occurs on the face of many people. This is a natural phenomenon (1). Examination of asymmetry is important in assessing facial aesthetics and irregular occlusion (2). It has also been investigated that the lower jaw asymmetry affects the function of the lower jaw joint function (3). Most orthodontic problems, other than those caused by trauma, are not strictly genetic or environmental (4). However, whether genes or the environment determine the morphology of the face and jaw, remains one of the most important and controversial problems in orthodontics (5).

Twin studies are well known and widely used to investigate the inheritance of a variety of properties (6). The twin method is based on the fact that monozygotic twins have an identical set of genes, so that phenotypic differences are mainly due to environmental factors. Meanwhile, dizygotic twins have only 50 percent. Uniform genes and their phenotypic differences are due to both additive genes and environmental effects (7). Conventional cephalograms are traditionally included in an orthodontic treatment plan, but are rarely used as an asymmetry tool. However, Meloti states in his study that the results obtained by lateral cephalometry correspond to those established by other diagnostic methods. This leads to the conclusion that lateral cephalometric radiography is an acceptable way to identify skeletal and dentoalveolar changes with irregular occlusion and does not require additional costs (8). Computerized tomography is considered to be an optimal diagnostic tool for evaluating asymmetry, but this method is more expensive and its radiation dose is higher than other methods (9).

Only a few studies (8, 10) were conducted using lateral cephalometry to determine the ratio of lower

[1]*Clinic of Orthodontics, Faculty of Odontology, Lithuanian University of Health Sciences, Kaunas, Lithuania.*
[2]*Private practice*

Address correspondence to Vilma Svalkauskiene, Clinic of Orthodontics, Faculty of Odontology, Lithuanian University of Health Sciences, J. Lukšos-Daumanto g. 6, LT-3009 Kaunas, Lithuania.
E-mail address: vilma.svalkauskiene@gmail.com

molar teeth and asymmetry of the lower jaw in the sagittal direction, but none of them examined the influence of genetics and environmental factors. The aim of this study was to examine monozygotic and dizygotic twins' mandibular asymmetry in sagittal direction using cephalometric data and to determine its dependence of genetic and environmental factors.

MATERIAL AND METHODS

For this research, twins were selected from the database of the Twins Centre of the Lithuanian University of Health Sciences. Ethical approval for this study was acquired from the Lithuanian University of Health Sciences Bioethics Committee (BEC-OF-04).

Study Sample

The inclusion criteria for the sample: 1) twins with determined zygosity, 2) good quality cephalograms with teeth in centric occlusion, 3) all permanent teeth (except for third molars), 4) twins in pairs were same sex, 5) no previous orthodontic treatment. Twins not matching these criteria were excluded from the study. 80 monozygotic and 100 dizygotic twins matched the criteria, but for statistical purposes, the same number of subjects in each group were selected. Study samples consisted of 40 pairs of dizygotic and monozygotic twins. 28 women and 52 men (DZ group) and 54 women 26 men (MZ group). The youngest subjects of DZ group were 13 years and 5 months old, oldest – 27 years 2 months. While in MZ group the youngest were 12 years and 1 month, oldest – 39 years 7 months old.

Each subject's zygosity was determined using 15 specific DNA markers. The accuracy of this method is 99,99%. Zygosity determination is described more in detail in previous studies (5, 11).

Cephalometric analysis

The cephalometric analysis was performed by measuring the distances between the landmarks using Dolphin Imaging 11.7 Premium (Patterson Dental Supply, Chatsworth, USA). We used 6 landmarks describing position of the mandible ramus and lower molars: RA (*ramus anterior*), RP (*ramus posterior*), D7LA (the most distal point of the anterior image of the second lower molar crown), D7LP (the most distal point of the posterior image of the second lower molar crown), D6LA (the most distal point of the anterior image of the first lower molar crown), D6LP (the most distal point of the posterior image of first lower molar crown) (8).

We measured 3 distances: RA-RP, D7LA-D7LP and D6LA-D6LP (Figure). Based on the data collected, the index of mandibular asymmetry (IMA) was calculated. The following formula is used to find the value of IMA according to the first lower molar teeth: IMA1=(RA-RP)-(D6LA-D6LP). For the purpose of finding out the value of the IMA according to the second lower molars we used: IMA2=(RA-RP)-(D7LA-D7LP). If IMA is more than 0.5 mm (>0.5), this means mandible skeletal asymmetry. When IMA is less than -0.5 mm (<-0.5) this indicates dental asymmetry. If the IMA value is between -0.5 mm and 0.5 mm (-0,5≤IMA≤0.5) it is considered as skeletal and dental symmetry (8).

Statistical analysis

The accuracy of the measurements was assessed by remeasuring randomly selected 20 (10 monozygotic and 10 dizygotic) lateral cephalographs. To determine intra-observer method error we used Bland-Altman formula (12).

Statistical data analysis was performed using data collection and analysis software Microsoft Office Excel (2013). Quantitative variable – mean and qualitative – standard deviation (SD) were counted for each group. The Student's t test was used to compare the quantitative values of two

Table 1. Measurements used in the study

Measurement	DZ	MZ	p
	Mean±SD	Mean±SD	
RA-RP	3.48± 2.10	2.52±1.69	0,003
D7LA-D7LP	2.44±1.59	2.26±1.60	0,474
D6LA-D6LP	2.44±1.50	2.20±1.56	0,335
IMA1	1.04±2.26	0.32±1.67	0.033
IMA2	1.04±2.39	0.27±1.72	0.028

p<0.05.

Table 2. Number of subjects in each group and their percentage after evaluation of IMA indexes

	DZ		MZ
IMA1	N	%	N
Dental asymmetry	19	23.75	25
Skeletal asymmetry	35	43.75	33
Symetric	26	32.5	22
Overall	80	100	80
IMA2			
Dental asymmetry	16	20	26
Skeletal asymmetry	35	43.75	34
Symetric	29	36.25	20
Overall	80	100	80

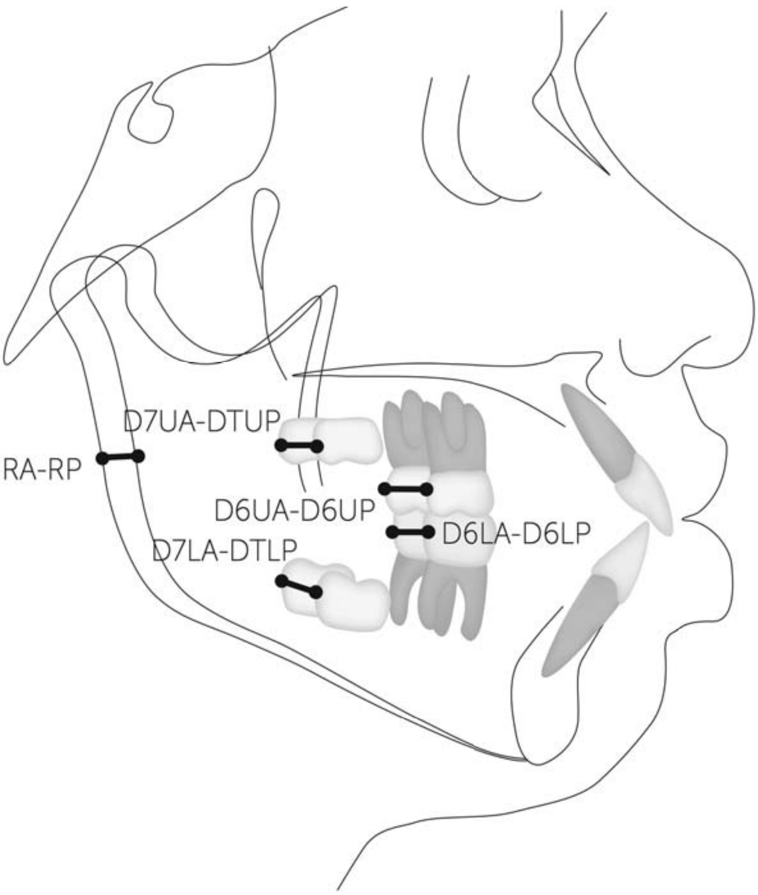

Fig . Distances measured in the study (8).

independent samples. Differences between groups were considered statistically significant when the threshold level was p<0.05.

Table 3. Mean and Standard deviations of subjects in each group after evaluation of IMA indexes

IMA1	DZ	MZ	p
	Mean ± SD	Mean ± SD	
Dental asymmetry	-1.21±0.60	-1.48±0.84	0.7818
Skeletal asymmetry	3.05±1.94	1.92±1.05	0.0046
Symmetrical	-0.03±0.31	-0.04±0.23	0.5809
IMA2	**Mean ± SD**	**Mean ± SD**	**p**
Dental asymmetry	-1.56±0.96	-1.63±0.72	0.2192
Skeletal asymmetry	3.12±2.04	1.88±1.04	0,0044
Symmetrical	-0.05±0.31	0,00±0.28	0,9035

p<0.05.

Table 4. Pearson inter-class correlation coefficients for each measurement between groups and distributions of genetic and environmental factors

Measurement	rDZ	rMZ	h^2	c^2
RA-RP	-0.04	0.32	0.721	-0.399
D7LA-D7LP	0.53	0.32	-0.424	0.744
D6LA-D6LP	0.62	0.53	-0.164	0.697
IMA1	0.03	0.26	0.453	-0.196
IMA2	0.06	0.22	0.316	-0.099

h^2 – genetic factors, c^2 – environmental factors.

The Pearson's intra-pair correlation coefficients were calculated for monozygotic (rMZ) and dizygotic (rDZ) twins groups. The influence of genetic and environmental factors on mandible asymmetries was evaluated using Lundstrom's approach. The heritability (h^2) was calculated using formula h^2=2(rMZ-rDZ). Accordingly, the coefficient of the influence of environmental factors (c^2) was calculated using the formula c^2=2(rDZ-rMZ) (13).

RESULTS

The reliability of measurements made by the researcher was tested by tracing and measuring 20 randomly selected lateral cephalograms twice with a 1-month time interval. We didn't find any statistically significant differences between measurements.

All distances and the asymmetry index for the first and second lower molars are larger in the DZ twin group. The RA-RP measurement and mandible asymmetry indices IMA1 and IMA2 were statistically significantly different between the DZ and MZ twin groups. Although distances between the first and second lower molars (D6LA-D6LP; D7LA-D7LP) were different, it didn't show statistically significant difference (Table 1).

Considering types of asymmetries between groups, the results showed that in both – DZ and MZ groups the skeletal asymmetry was the most common type. According to the measurements of the first and second lower molars dental asymmetry occurred more often in monozygotic twins (Table 2).

Dental asymmetry was higher in the monozygotic group, but the results were not statistically significant between the groups. Skeletal asymmetry was statistically significantly higher for the dizygotic subjects (Table 3).

Pearson inter-class correlation coefficients were calculated separately for MZ twins (rMZ) and DZ twins (rDZ) groups. We found that the greatest influence of genetics is on the distance between the distal edges of the ramus branches (RA-RP), while the teeth position is mostly determined by environment. The greatest influence of environmental factors was on the distance between the first and second lower molars (D6LA-D6LP; D7LA-D7LP) (Table 4).

DISCUSSION

So far, asymmetry of the lower jaw has not been investigated between twins using cephalograms, so it is impossible to compare the results (influence of genetics and environmental factors on the lower jaw asymmetry) between this and other studies. On the other hand our results agree with the previously published researches, that mandible's skeletal variables are more determined by genetics than dental ones (5). In addition, it could be contemplated that skeletal asymmetry is also more genetically determined and that coincides with our results.

Meloti and co-authors in their study (8), investigated the asymmetries of mandibles, which occurs in Angle I, Angle II, and asymmetric Angle II (one-sided Angle II). Alavi *et al.* the asymmetry of mandible, which occurs in patients with correct occlusion and with an occlusion of Angle II subclasses, had studied (10). Unfortunately, we didn’t categorize our study sample according to Angle classes, so it is not appropriate to compare the results.

Meloti *et al.* stated in their work that there is no difference between the results obtained with the cephalographs and those obtained by computed tomography (8). On the other hand, Damstra (14) states that there is the advantage of computed tomography against lateral head radiographs. In our study, twins were not studied by computed tomography so it is not accurate to compare results with researches that evaluated computed tomographies.

The advantage of this study is that the influence of genetics and environmental factors on the asymmetry of the lower jaw has been evaluated on lateral cephalographs. This could not be found in other studies, and this makes the work new and relevant. On the other hand, further analysis could be made grouping subjects by Angle classes and increasing the study sample.

CONCLUSIONS

1. The skeletal asymmetry of the lower jaw was statistically significantly higher in the dizygotic group. There was no statistically significant difference between groups in dental asymmetry and skeletal and dental symmetry.
2. Genetic factors have the greatest influence on the asymmetry of sagittal position of the ramus. However, environmental factors have the greatest influence on sagittal asymmetry of the lower molars.

STATEMENT OF CONFLICTS OF INTEREST

The author denies a conflict of interest.

REFERENCES

1. Thiesen G, Gribel B, Freitas M. Facial asymmetry: a current review. Dental Press Journal of Orthodontics. 2015; 20(6):110-125.
2. Al Taki A, Ahmed M, Ghani H, Al Kaddah F. Impact of different malocclusion types on the vertical mandibular asymmetry in young adult sample. European Journal of Dentistry. 2015; 9(3):373.
3. Yanez-Vico R, Iglesias-Linares A, Torres-Lagares D, Gutierrez-Perez J, Solano-Reina E. Association between condylar asymmetry and Temporo- mandibular disorders using 3D-CT. Medicina Oral Patología Oral y Cirugia Bucal. 2012:852-858.
4. Mossey P. The Heritability of Malocclusion: Part 2. The Influence of Genetics in Malocclusion. British Journal of Orthodontics. British Journal of Orthodontics. 1999;26(3):195-203.
5. Šidlauskas M. Genetic and environmental infuences on mandibular morphology and relationship to cranial base and maxila, cephalometric twin study [doctoral dissertation]. Kaunas: Lithuanian University of Health Sciences; 2015.
6. Roosenboom J, Hens G, Mattern B, Shriver M, Claes P. Exploring the Underlying Genetics of Craniofacial Morphology through Various Sources of Knowledge. BioMed Research International. 2016:1-9.
7. Švalkauskienė V. Genetinių ir aplinkos veiksnių įtaka dantų lankų morfologijai, dvynių tyrimas [disertacija]. Kaunas: Lietuvos sveikatos mokslų universitetas; 2015.
8. Meloti A, Gonçalves R, Silva E, Martins L, Santos-Pinto A. Lateral cephalometric diagnosis of asymmetry in Angle Class II subdivision compared to Class I and II. Dental Press Journal of Orthodontics. 2014;19(4):80-88.
9. Palomo JM, Hunt DW Jr, Hans MG, Broadbent BH Jr. A longitudinal 3-dimensional size and shape comparison of untreated Class I and Class II subjects. Am J Orthod Dentofacial Orthop. 2005;127(5):584-91.
10. Alavi D, BeGole E, Schneider B. Facial and dental arch asymmetries in Class II subdivision malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics. 1988;93(1):38-46.
11. Sidlauskas M, Salomskienė L, Andriuskeviciute I, Sidlauskiene M, Labanauskas Z, Vasiliauskas A, Kupcinskas L, Juzenas S, Sidlauskas A. Heritability of mandibular cephalometric variables in twins with completed craniofacial growth. European journal of orthodontics. 2015; 38(5), 493-502.
12. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet. 1986 Feb 8; 1(8476):307–10.
13. Lundström A, McWilliam J. Comparison of some cephalometric distances and corresponding facial proportions with regard to heritability. European journal of orthodontics. 1988 Feb; 10(1):27–9.
14. Damstra J, Fourie Z, Ren Y. Evaluation and comparison of postero-anterior cephalograms and cone-beam computed tomography images for the detection of mandibular asymmetry. The European Journal of Orthodontics. 2011;35(1):45-50.

Received: 15 03 2019
Accepted for publishing: 24 06 2020