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CLINICAL STUDY

Lip sucking habit and associated craniofacial differences in a set of monozygotic twins

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ABSTRACT

OBJECTIVE: The objective of this study was to evaluate the influence of lip sucking on dentofacial development in a pair of 6.5-year-old monozygotic twins.

BACKGROUND: Lip sucking, which causes an imbalance in splanchnocraniums soft tissues pressures, can influence the hard tissues development, and contribute to orthodontic anomalies.

METHODS: Analysis of lateral cephalometric X-rays was performed by 9 orthodontists. Data were compared using the Mann-Whitney and Kruskal-Wallis tests. Statistical significance was defined as $p<0.05$.

RESULTS: SNA, A-NPog, and Cond-A values suggested an anterior shift of the maxilla. The 1u to SN, 1u to A-Pog, 1u to A-Pog angle, and 1u-Avert values indicated an upper incisor protrusion. While the 1l to A-Pog, 1l to A-Pog angle and 1l to Go-Me values showed a retrusion of the lower incisors, the NL-NSL implied a hard palate rotation counterclockwise. The SNA-Me indicated that the mandible of the lip-sucking patient was in a more inferior position.

CONCLUSION: Lip sucking can influence the skeletal development of maxilla, the position of upper and lower incisors and the position of mandible. Skeletal development of mandible seems to be unaffected *(Tab. 3, Fig. 1, Ref. 26)*. Text in PDF *www.elis.sk*

KEY WORDS: lip sucking, bad habit, craniofacial morphology, twin study, monozygotic twins.

Introduction

The craniofacial morphology is strongly associated with genetic and environmental factors (1). However, the separation of genetic and environmental influences in the development of malocclusion is one of the most controversial and challenging issues in orthodontics. In literature, it has been reported that some facial and dental characteristics show a high heritability, while others are influenced more by the external factors. In more detail, the vertical parameters (especially mandibular arc and plane angle) show a higher genetic influence than the horizontal ones (2, 3, 4). Moreover, environmental factors, such as parafunctional habits, by creating an imbalance of forces between the tongue, lips, and surrounding tissues, may alter the dento-skeletal development, leading to orthodontic problems (5).

Lip sucking and/or lip biting is a relatively infrequent habit, and it ranges from 2.2 to 4.8 % from birth to six years of age (6, 7). It is characterized as an automatic or repetitive non-nutritive sucking habit, which is most frequently reported during stress or in situations requiring an increased attention and mental concentration (8). Lip sucking may be also caused by a skeletal maxillary protrusion due to an inherited interference or congenitally missing teeth, allergic rhinitis, mouth breathing, and/or as a thumb-sucking substitute (7). Commonly, non-nutritive sucking discontinues around five years of age, as the interaction with other children increases. The prevalence and duration of these habits, however, are influenced by social background, with the children from higher socioeconomic groups showing a higher predominance of such habits (7).

This research is intended to demonstrate the effects of lip sucking on a set of identical twins. To our knowledge, this is the first study to evaluate the influence of lip sucking on the dentofacial development of monozygotic twins.

Material and methods

This project was approved by the Ethical committee of the St. Elizabeth Oncological Institute, Heydukova 10, 812 50, Bratislava, Slovakia no. 02-2021 / EK OÚSA. The study includes 2 male monozygotic twins aged 6.5 years, who were referred by their dentist for an orthodontic examination to our department. The extraoral examination demonstrated a symmetrical facial appearance and a convex profile and vertical growth pattern in both twins.

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Tab. 1. Results of the statistical evaluation of the Aachen analysis.

Parameter	Unit	No lip sucking (NLP)	Lip sucking (LS)	p
Skeletal				
SNA*	°	82.6 (82.2;83.0)	83.1 (82.4;84.0)	.008
SNB	°	73.5 (73.0;74.1)	73.6 (72.8;74.5)	.537
ANB*	°	9.20 (8.80;9.35)	9.60 (9.20;10.10)	.000
A-NPog*	mm	7.70 (7.35;8.20)	8.50 (8.20;8.90)	.000
WITS*	mm	5.00 (4.15.5.40)	6.00 (5.30;6.80)	.000
NBaPtG	°	82.5 (82.2;83.3)	83.2 (80.9;84.3)	.412
NPogPOr*	°	79.6 (78.5;81.0)	77.5 (73.4;79.6)	.000
MeGoPOr*	°	33.8 (31.2;34.7)	36.7 (33.9;39.1)	.000
ML-NSL*	°	39.9 (38.9;41.0)	39.7 (38.3;40.3)	.049
S-Go / N-Me *	%	59.5 (58.5;59.8)	60.4 (59.4;60.9)	.000
arGoMe	°	134.8 (133.7;136.8)	133.8 (132.1;136.9)	.220
Sum	°	399.9 (398.9;401.0)	399.7 (398.3;400.3)	.060
ANSXiPm*	°	49.5 (48.5;50.1)	49.9 (49.3;51.0)	.008
ML-NL*	°	37.9 (37.2;38.4)	40.6 (39.5;42.4)	.000
ANSPNSPOr	°	–3.00 (–4.20;–2.55)	–5.70 (–7.10;–1.45)	.100
NL-NSL*	°	2.50 (1.50;3.00)	1.30 (–2.70;–0.60)	.000
OcP-NL*	°	17.3 (15.9;18.6)	20.7 (19.5;21.9)	.000
Dental				
II*	°	127.2 (124.7;130.9)	136.3 (132.5;139.8)	.000
1u to SN*	°	99.0 (97.0;100.8)	104.6 (101.4;105.5)	.000
1u to A-Pog*	mm	6.50 (6.20;6.90)	9.80 (9.55;10.00)	.000
1u to A-Pog*	°	32.6 (31.3;34.1)	39.9 (36.6;40.7)	.000
1l to A-Pog*	mm	0.60 (0.30;0.80)	–4.90 (–5.30;–4.60)	.000
1l to A-Pog*	°	20.4 (17.1;23.2)	4.20 (1.70;6.20)	.000
1l to Go-Me*	°	93.9 (91.8;97.4)	80.5 (79.7;82.4)	.000
1u to occlusal plane	mm	0.20 (–0.65;0.50)	–0.20 (–0.55;0.60)	.542
Profile				
Lower lip to E-plane*	mm	1.30 (1.00;1.80)	–1.20 (–1.40;–0.90)	.000
Gl‘-Sn / Sn-Me‘	%	88.5 (83.6;99.2)	89.7 (88.0;91.7)	.140
Sn-sto / sto-Me‘*	%	52.5 (50.4;54.6)	63.7 (62.0;65.6)	.000
Sn-Li / Li-Me‘*	%	84.9 (81.8;88.5)	92.0 (89.0;94.1)	.000
Gl‘-Sn-Pog‘*	°	160.0(158.9;160.8)	158.3 (157.9;158.6)	.000
Cotg-Sn-Ls	°	104.7 (101.1;108.7)	105.3 (102.5;107.9)	.859

Tab. 2. Results of the statistical evaluation of the Mc Namara analysis.

Parameter	Unit	No lip sucking (NLP)	Lip sucking (LS)	p
Maxilla to cranial base				
Pn-A*	mm	–2.30 (–2.80;–1.55)	–6.90 (–8.50;–6.15)	.000
SNA*	°	82.6 (82.2;83.1)	83.1 (82.4;84.0)	.011
Mandible to Maxilla				
Cond-A*	mm	82.4 (80.9;83.6)	84.4 (82.4;86.0)	.001
Cond-Gn	mm	98.7 (97.8;100.2)	99.8 (97.9;100.9)	.145
Max-Mand *	mm	16.6 (15.5;18.4)	16.5 (14.7;17.6)	.027
SNA-Me*	mm	68.5 (67.8;69.1)	69.4 (68.7;70.2)	.000
SpP-GoMe*	°	37.9 (37.3;38.3)	40.5 (39.4;41.5)	.000
NBa-PtGn*	°	82.8 (82.1;83.5)	83.5 (82.4;85.1)	.012
Mandible to cranial base				
Pn-Pog*	mm	–19.5 (–20.6;–18.1)	–28.9 (–30.4;–25.1)	.000
Dentition				
1u-Avert.*	mm	–0.80 (–1.20;–0.30)	0.30 (–0.50;1.15)	.000
1l-APog*	mm	0.60 (0.30;0.80)	–4.90 (–5.30;–4.60)	.000

* statistically significant difference between values NLP and LS. $p < .05$.

Intraoral examination revealed a Class II dental relationship with an increased overjet in both twins. However, due to an excessive proclination of the upper and retroclination of the lower incisors, one of the twins had a much greater overjet than the other.

During the medical history examination, the parent mentioned that one of the twins had a chronic lip-sucking habit. Other types of sucking habits were not reported by the parent during the examination period or in the past. On the same day, the patients underwent a thorough orthodontic examination. Radiographs were taken with a MORITA Veraviewprocs 2D model (J Morita Mfg. Corp., Kyoto, Japan). Cephalometric analysis was performed in OnyxCeph^{3TM} 3D Pro software (Image Instruments, GmbH, Chemnitz, Germany), to determine the skeletal, dental, and soft tissue characteristics; Aachen and Mc Namara analyzes were selected.

For the purpose of this study, the cephalometric radiographs were traced independently by 9 orthodontists from two university orthodontic departments, at the Comenius University in Bratislava, Slovakia and the Marmara University in Istanbul, Turkey, who were blinded to the patients' age, sex, or other history data, especially the fact that they were siblings. To ensure more accurate results, each orthodontist performed 5 cephalometric tracings for each radiograph, with a time lag of at least 1 week between individual analysis.

IBM SPSS 23 and Excel 2016 were used for the statistical evaluation. The normality of the data distribution of measurements of parameters of both categories (with – without lip sucking) was determined according to the Kolgomorov-Smirnov test. Since most variables did not show a normal (Gaussian) distribution of the data, the results of the comparison according to the presence of the bad habit are expressed as the median (1st quartile; 3rd quartile). The parameters of the patient with and without lip sucking were compared using the Mann-Whitney ranking test. Statistical significance was defined as $p < 0.05$.

Subsequently, we subjected the pool to factor analysis (FA). The PCA method (principal components analysis) was used, the rotation was done using the varimax method, and the factor score was determined using the Bartlett method. In our study, KMO was 0.764 and the significance probability (Sig.) was less than 0.05, indicating that FA was a suitable analytical method for the given pool. After rotation, the 4 most important factors emerged, which together explain 57.2 % of the variability. Factor scores according to the presence of the lip sucking were then compared using the Mann-Whitney nonparametric test.

To interprete the large number of measurements, data analysis was conducted. The comparison was performed for each

parameter separately using the Kruskal-Wallis test and subsequently in the case of a statistically significant difference using the Tukey's Post Hoc tests. The individual measurements of some parameters showed statistically significant differences, but these differences were clinically insignificant. Therefore, we did not exclude the results of any tracing.

Results

The results of the statistical evaluation of the measurements are shown in the Tables 1 and 2. After taking into account the individual results as well as the results of the factor analysis, the differences between the twins can be grouped into the following subgroups, summarised in Table 3:

1. The parameter values **1u to SN, 1u to A-Pog, 1u to A-Pog angle a 1u-Avert.** indicated a proclination of the upper incisors.
2. The parameter values **1l to A-Pog , 1l to A-Pog angle and 1l to Go-Me** indicated a retroclination of the lower incisors.

These values also corresponded to a statistically significantly increased value of the **interincisal angle** in the case of an individual with a bad habit. The position of the upper and lower incisors as well as the lower lip, which is placed between them in the lip sucking individual, fundamentally affected the profile represented by a statistically significantly different parameters **Lower lip to E-plane, Sn-sto/sto-Me', Sn-Li/Li-Me', Gl'-Sn-Pog'**.

3. The parameter values **SNA, A-NPog, Cond-A** indicated the shift of point A anteriorly, this was quantitatively expressed by the parameter Cond-A, whose median value was 2 mm higher in the case of lip sucking. A small value of the difference does not necessarily mean an excessive sagittal growth of the jaw, however can be caused by a proclination of the upper incisors.
4. The parameter **NL-NSL** indicated a counter-clockwise rotation of the hard palate. This characteristic was also supported by the value of the **ML-NL** parameter in connection with the minimum difference in the ML-NSL parameter. It was also supported by the difference in **OcP-NL** values, although this may also originate in a completely different angulation of the occlusal plane.
5. The parameter **SNA-Me** indicated a more inferior position of the Me point bad habit patient, which could be a manifestation of a slight clockwise rotation of the mandible.

Tab. 3. Subgroups of characteristics with parameters describing the pattern.

Characteristic in lip sucking	Parameter	No lip sucking (NLP)	Lip sucking (LS)
Upper incisor protrusion	1u to SN	99.0 (97.0;100.8)	104.6 (101.4;105.5)
	1u to A-Pog	6.50 (6.20;6.90)	9.80 (9.55;10.00)
	1u to A-Pog angle	32.6 (31.3;34.1)	39.9 (36.6;40.7)
	1u-Avert	–0.80 (–1.20;–0.30)	0.30 (–0.50;1.15)
Lower incisor retrusion	1l to A-Pog	0.60 (0.30;0.80)	–4.90 (–5.30;–4.60)
	1l to A-Pog angle	20.4 (17.1;23.2)	4.20 (1.70;6.20)
	1l to Go-Me	93.9 (91.8;97.4)	80.5 (79.7;82.4)
Anterior position of point A	SNA	82.6 (82.2;83.0)	83.1 (82.4;84.0)
	A-NPog	7.70 (7.35;8.20)	8.50 (8.20;8.90)
	Cond-A	82.4 (80.9;83.6)	84.4 (82.4;86.0)
Counterclockwise rotation of maxilla	NL-NSL	2.50 (1.50;3.00)	1.30 (–2.70;–0.60)
	ML-NL	37.9 (37.2;38.4)	40.6 (39.5;42.4)
	OcP-NL	17.3 (15.9;18.6)	20.7 (19.5;21.9)
Clockwise rotation of mandible	SNA-Me	68.5 (67.8;69.1)	69.4 (68.7;70.2)

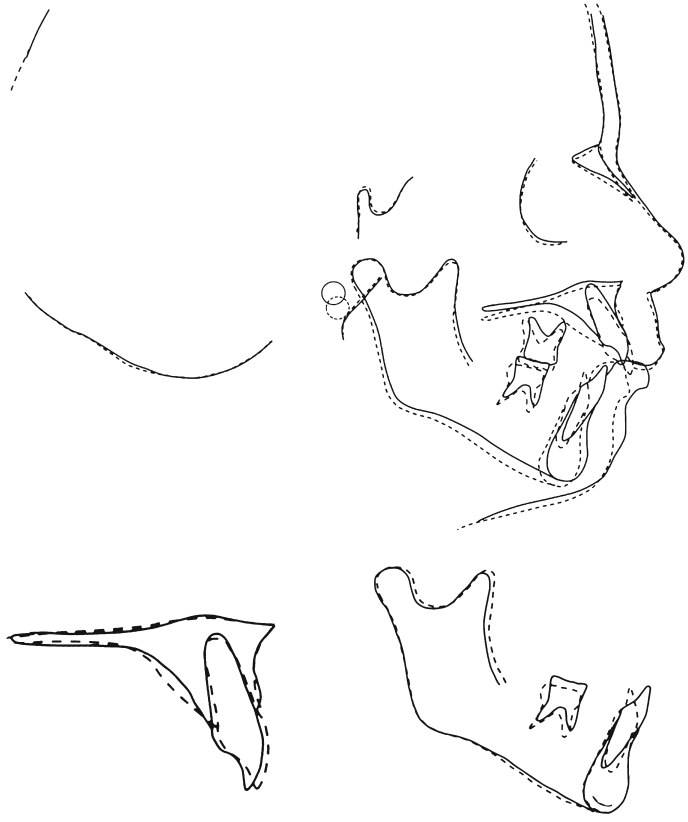

Fig. 1. Superimposition of twins' cephalometric radiographs.

When analyzing the data, the values of several parameters with the statistically significant differences could not be reasonable evaluated; specifically, **NPogPOr, MeGoPOr, Pn-A, Pn-Pog and SpP-GoMe**. Their common denominator is the dependence on the position of the point P. When comparing the cephalometric x-rays of the twins, it was evident that there was a significant difference in the position of the Porion that determined this point. We assumed that during the time of taking the images, after the fixation of the cephalostat, its vertical shift occurred by changing the patient's body posture. Therefore, we did not include these parameters in our evaluation.

To better visualize the changes shown by the cephalometric examination, a superimposition was made with an emphasis on the related skeletal and dental structures, as well as the soft tissue profile (Fig. 1). We also performed a cephalometric analysis of the schemes to ensure that the superimposition was correct, and the results were within the statistical analysis's range. Its application demonstrated that lip sucking had no effect on neurocranium structures, and that morphological differences between genetically identical twins were minimal. However, the confirmed changes of the splanchnocranium in the cephalometric analysis were evident in the superimposition as well. The analysis revealed a slightly inferior position of the entire maxilla, particularly the posterior part, which corresponded to its counterclockwise rotation. This resulted in a lower position of the occlusal plane, which was represented in the diagram by the position of the second deciduous molars due to the unerupted first permanent molars. The body of the mandible is also located inferiorly, with the superimposition displaying a more obvious posterior rotation than we would expect from the cephalometric analysis.

Discussion

Twin studies have provided an effective indicator to assess the relative contribution of genetic and environmental factors to the physical constitution (9–13). The degree of individual variation is very narrow, especially in the lengths of the cranial base, maxillary, and mandibular length. Thus, any differences in the skeletal and dental values, apart from the error of the measurement, which in this study is minimized due to the multiple tracings performed, indicate a change due to environmental influence (14).

According to the systematic review of Schmid et al (15), there is a lack of strong evidence of the impact of sucking habits on orofacial structures. In literature, only two reports describe a pair of monozygotic twins with dental and craniofacial differences due to environmental influences. More specifically, Willmot (16) described a set of monozygotic twins, one of whom has a thumb sucking habit, and one, who did not indulge in the habit. While, Smith (17) presented a pair of twins, one with a cleft palate and the other without, and thus an environmental etiology of the cleft palate can be concluded. To our knowledge, this is the first research to demonstrate a pair of monozygotic twins, one of which has a history of lower lip sucking. The cephalometric tracings were made in detail and were superimposed using the natural reference structures proposed by Skieller et al (18) and Björk and Skieller (19). Though identical twins' cephalometric values are negligible, their profile superimposition is highly accurate, and it can even be used as a validation of their monozygoticity (13).

As in thumb sucking individuals, in our study, the SNA value was significantly increased in the lip sucking twin, probably due to remodeling of alveolar bone on the labial side of the upper incisors caused by the effect of the lower lip (16, 17, 20) In contrast, the SNB value showed no statistical significance between the twins. Studies examining the effect of thumb sucking on the SNB values of young individuals have not reached a consensus. In more detail, Moore and Mc Donald (21) indicated no effect on the SNB in children with digit sucking habit, while Singh et al (22) found a significant increase.

Furthermore, the lip-sucking individual showed a skeletal Class II tendency, as evidenced by a significant increase in ANB angle and Wits. However, since the control twin was also diagnosed with a skeletal Class II tendency, even though to a significantly lesser degree, the underlying dominant factor is considered to be genetic.

The lip sucking twin's maxilla was observed to rotate counterclockwise (NL-NSL, ML-NL, OcP-NL) in our study. Until now it is still a question how much is the development of maxilla influenced by genetics. A change in mandibular plane angle during phylogenesis was observed (23). In our case, it is reasonable to assume that the prolonged positioning of the lip between the upper and lower incisors, combined with a slight clockwise rotation of the mandible (SNA-Me) lead to a more inferior position of the posterior region of the palate and a lower position of the posterior part of the occlusal plane. In contrast, the lip sucking individual in the anterior region showed only a slightly inferior position of the palate.

Except for the clockwise rotation of the mandible, several other parameters indicate a dentoalveolar anterior open bite tendency of the lip sucker. Our finding comes in agreement with the previous studies, which concluded that sucking habits resulted in anterior open bite (22, 24). Our results, however, contradicted the findings of Fukumitsu et al (20), who concluded that lip sucking resulted in a low-angle facial pattern.

The ArGoMe and Sum angles showed no major variations, suggesting that the open bite pattern is mostly due to dentoalveolar changes rather than skeletal changes. As the result, it appears that the mandible's position, rather than its shape, changes. This is possibly attributed to the high heritability of the vertical parameters (especially the gonial and mandibular arc angles) (2, 24).

Lip sucking habit seems to cause a proclination of the upper incisors, according to the cephalometric analysis and the maxillary superimposition. However, Willmot (16), found no proclination of the upper incisors in the thumb-sucking twin. Lower incisors inclination (1l to Go-Me), on the other side, showed a significant decrease (80.5 degrees) as compared to the control twin (93.9 degrees). According to Afzelius-Alm et al (25), children with a thumb-sucking habit may have either proclined or retroclined lower incisors. This is determined by the inclination of the angle formed between the sucking finger and the buccal surface of lower incisors, as well as the thickness of the lip. In our case, a retroclination of the lower anterior teeth was observed due to the narrow angle between the lower lip and the lower incisors during lower lip sucking, and the constant pressure on the lower incisors from the lower labialis and mentalis muscles.

Deciduous molar loss is more common in children, who thumb-suck and have retroclined incisors (25). As in the present case, lower primary first molars were lost in the lip-sucking individual, which may have enhanced the twin's lower incisors further retroclination.

According to soft tissue examination, the lip sucker had a straight external mentum lining and lower lip vermillion, this could be possibly attributed to the constant stretching of the lower lip. In contrast, the control twin had a more concave profile with the lower lip being ahead of the E-line.

The treatment plan may include a functional appliance, such as a lip bumper, which might suppress the habit and increase the labialis and mentalis muscle activity (26). In the patients that have entered the skeletal peak stage and show a Class II skeletal pattern, a Teuscher appliance that controls the patient's vertical axis through the occipital headgear and includes a lip bumper can be advantageous, as well. However, to prevent any post-treatment relapse, it is critical to inform, advise and educate the patient on how to avoid repeating the habit.

Conclusion

Our study demonstrated the ability of long-term persisting lip sucking bad habit to affect craniofacial development. In monozygotic twins, we confirmed the development of the skeletal changes of the maxilla in terms of maxillary plane counterclockwise rotation and a slightly more anterior position of point A. We also observed an overjet increase due to protrusion of the upper incisors and retrusion of the lower incisors. Although the mandible did not show a statistically significant change in skeletal proportions, it was just rotated slightly clockwise as the result of the bad habit.

Learning points

Lip sucking can contribute to development of a Class II skeletal relationship, a counterclockwise rotation of maxillary plane and a matrix clockwise rotation of mandible.

Protrusion of upper and retrusion of lower incisor develops as the consequence of lip sucking habit.

Skeletal development of mandible seems to be unaffected by lip sucking.

References

1. Graber TM, Vanarsdall RL. Orthodontics: Current principles and techniques. St. Louis, Mosby, 1994: 19.

2. Šidlauskas M, Šalomskienė L, Andriuškevičiūtė I et al. Heritability of mandibular cephalometric variables in twins with completed craniofacial growth. Eur J Orthod 2016; 38 (5): 493–502.

3. Hunter WS. A study of the inheritance of craniofacial characteristics as seen in lateral cephalograms of 72 like-sexed twins. Rep Congr Eur Orthod Soc 1965; 41: 59–70.

4. Manfredi C, Martina R, Grossi GB, Giuliani M. Heritability of 39 orthodontic cephalometric parameters on MZ, DZ twins and MN-paired singletons. Am J Orthod Dentofacial Orthop 1997; 111 (1): 44–51.

5. Silva M, Manton D. Oral habits – part 1: the dental effects and management of nutritive and non-nutritive sucking. J Dent Child (Chic) 2014; 81 (3): 133–139.

6. Barnwell YM. A review of: Oral Myofunctional Disorders, by Richard H. Barrett and Marvin L. Hanson. Inter J Oral Myol 1975; 1 (2): 83–84.

7. Yokoi K, Yamauchi T, Suzuki Y, Fukuda O, Kurosu K. A clinical observation on oral habits for ten years. Part 1, Appearance and changes in the year. Jpn J Ped Dent 1986; 24: 450–458.

8. Kang KW, Corey LA, Evans MM, Christian JC, Norton JA Jr. Dominance and environmental variances: their effect on heritabilities estimated from twin data. Hum Hered 1977; 27 (1): 9–21.

9. Infante PF. An epidemiologic study of finger habits in preschool children, as related to malocclusion, socioeconomic status, race, sex, and size of community. ASDC J Dent Child 1976; 43 (1): 33–38.

10. Mossey PA. The heritability of malocclusion: part 2. The influence of genetics in malocclusion. Br J Orthod 1999; 26 (3): 195–203.

11. Visscher PM, Goddard ME. A general unified framework to assess the sampling variance of heritability estimates using pedigree or marker-based relationships. Genetics 2015; 199 (1): 223–232.

12. Sreedevi G, Srinivas B, Reddy TP, Prasad CM, Kumar BS, Satish R. Heritability of thirty cephalometric parameters on monozygotic and dizygotic twins: twin study method. J Contemp Dent Pract 2013; 14 (2): 304–311.

13. Kraus BS, Wise WJ, Frei RH. Heredity and the craniofacial complex. Am J Orthod 1959; 45: 172–217.

14. Tiro A, Dzemidzic V, Salaga-Nefic S, Redzic I, Nakas E. Heritability of Craniofacial Characteristics in Twins – Cephalometric Study. Med Arch 2019; 73 (3): 205–208.

15. Schmid KM, Kugler R, Nalabothu P, Bosch C, Verna C. The effect of pacifier sucking on orofacial structures: a systematic literature review. Prog Orthod 2018; 19 (1): 8

16. Willmot DR. Thumb sucking habit and associated dental differences in one of monozygous twins. Br J Orthod 1984; 11 (4): 195–199.

17. Smith DI. Cleft lip and palate in one of monozygotic twins. Dent Pract Dent Rec 1967; 18 (3): 107–112.

18. Skieller V, Björk A, Linde-Hansen T. Prediction of mandibular growth rotation evaluated from a longitudinal implant sample. Am J Orthod 1984; 86 (5): 359–370.

19. Björk A, Skieller V. Normales und anomales Wachstum des Unterkiefers. Eine Synthese longitudinaler kephalometrischer Implantatstudien während eines Zeitraums von 25 Jahren [Normal and abnormal growth of mandible. A longitudinal cephalometric implantation study over a 25-year period]. Inf Orthod Kieferorthop 1984; 16 (1): 55–108.

20. Fukumitsu K, Ohno F, Ohno T. Lip sucking and lip biting in the primary dentition: two cases treated with a morphological approach combined with lip exercises and habituation. Int J Orofacial Myology 2003; 29: 42–57.

21. Moore MB, McDonald JP. A cephalometric evaluation of patients presenting with persistent digit sucking habits. Br J Orthod 1997; 24 (1): 17–23.

22. Singh TS, Sridevi E, Sankar AJS, Kakarla P, Vallabaneni SSK, Sridhar M. Cephalometric Assessment of Dentoskeletal Characteristics in Children with Digit-sucking Habit. Int J Clin Pediatr Dent 2020; 13 (3): 221–224.

23. Dostalova T, Eliasova H, Gabcova D, Feberova J, Kaminek M. Contemporary skull development – palatal angle analysis. Bratisl Med J 2015; 116 (3): 143–146.

24. Cozza P, Baccetti T, Franchi L, Mucedero M, Polimeni A. Sucking habits and facial hyperdivergency as risk factors for anterior open bite in the mixed dentition. Am J Orthod Dentofacial Orthop 2005; 128 (4): 517–519.

25. Afzelius-Alm A, Larsson E, Löfgren CG, Bishara SE. Factors that influence the proclination or retroclination of the lower incisors in children with prolonged thumb-sucking habits. Swed Dent J 2004; 28 (1): 37–45.

26. Germeç D, Taner TU. Lower lip sucking habit treated with a lip bumper appliance. Angle Orthod 2005; 75 (6): 1071–1076.

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