DOI 10.26724/2079-8334-2024-2-88-142-145
UDC 616.716.1+616.314-089.23

I.L. Skrypnyk, S.A. Shnaider[1], A.E. Dienga[1], V.N. Gorokhivskiy[2], O.V. Suslova[2], O.L. Kordonets[2], N.A. Zhelizniak[2]
Bogomolets National Medical University, Kyiv, [1]State Establishment "The Institute of stomatology and maxilla-facial surgery National academy of medical sciences of Ukraine", Odesa, [2]Odesa National Medical University, Odesa

CHANGES IN CRANIOFACIAL PARAMETERS DUE TO DISTAL MOVEMENT OF PERMANENT MAXILLARY MOLARS IN PATIENTS WITH DISTAL OCCLUSION AND VERTICAL JAW GROWTH DIRECTION

e-mail: oksanadenga@gmail.com

The study is devoted to the research of changes in the parameters of the facial part of the skull due to the distal displacement of the permanent molars of the upper jaw in patients with a distal bite, with a vertical direction of jaw growth. To determine the peculiarities of the morphological structure of the facial skull, 98 teleradiographs of the head were used, performed in lateral projection. To determine the features of the structure of the facial skull in patients with distal occlusion, 15 angular and 9 linear parameters were studied. The distalization of permanent maxillary molars in patients with distal occlusion and vertical jaw growth direction leads to significant changes in craniofacial parameters. The study found an increase in anterior facial height and alterations in the angular measurements of the facial skeleton, which are indicative of clockwise rotation of the mandibular plane and counterclockwise rotation of the occlusal plane.

Key words: upper jaw, permanent molars, distal occlusion, skull, teleradiographs.

І.Л. Скрипник, С.А. Шнайдер, А.Е. Дєньга, В.Н. Горохівський, О.В. Суслова, О.Л. Кордонець, Н.А. Желізняк

ЗМІНА ПАРАМЕТРІВ ЛИЦЕВОГО ВІДДІЛУ ЧЕРЕПА ВНАСЛІДОК ДИСТАЛЬНОГО ПЕРЕМІЩЕННЯ ПОСТІЙНИХ МОЛЯРІВ ВЕРХНЬОЇ ЩЕЛЕПИ У ПАЦІЄНТІВ З ДИСТАЛЬНИМ ПРИКУСОМ, З ВЕРТИКАЛЬНИМ НАПРЯМОМ РОСТУ ЩЕЛЕП

Дослідження присвячене вивченню змін параметрів лицевого відділу черепа внаслідок дистального переміщування постійних молярів верхньої щелепи у пацієнтів з дистальним прикусом, з вертикальним напрямом росту щелеп. Для визначення особливостей морфологічної будови лицевого відділу черепа використовували 98 телерентгенограм голови, виконаних в бокових проекції. Для визначення особливостей будови лицевого відділу черепа у пацієнтів з дистальною оклюзією були вивчені 15 кутових і 9 лінійних параметри. Дисталізація постійних молярів верхньої щелепи у пацієнтів з дистальним прикусом та вертикальним напрямком росту щелеп призводить до значних змін щелепно-лицевих параметрів. Дослідження виявило збільшення висоти переднього відділу обличчя та зміни кутових вимірів лицьового скелета, які свідчать про обертання нижньощелепної площини за годинниковою стрілкою та обертання оклюзійної площини проти годинникової стрілки.

Ключові слова: верхня щелепа, постійні моляри, дистальний прикус, череп, телерентгенограми.

The work is a fragment of the research project "Development and introduction into clinical practice of methods of diagnosis, prevention and treatment of osteogenesis disorders during dental intervention in patients in wartime" state registration No. 0123U103247.

Changes in the parameters of the facial skull due to the distal movement of the permanent molars of the upper jaw in patients with a distal occlusion are an important topic of research in the field of orthodontics [6, 7]. Given the growing interest in optimizing methods of treatment of malocclusion, especially in children and adolescents, this issue is becoming particularly relevant [2, 5, 9]. Distal malocclusion, also known as retrognathia, is characterized by the misalignment of the upper teeth relative to the lower teeth, which can lead to functional and aesthetic problems [3].

The distalization of the permanent molars of the upper jaw is one of the methods of distal occlusion correction, which allows changing the position of the teeth and, accordingly, the parameters of the facial skull [8, 10]. Important factors affecting the effectiveness of this method are the patient's age, type of jaw growth, stage of bite formation, and other individual anatomical features. The vertical direction of jaw growth, in particular, has a significant impact on treatment outcomes, as it determines the spatial changes that occur during molar distalization.

The relevance of the study is due to the need to improve orthodontic treatment methods to ensure long-term stable results and improve the quality of life of patients with malocclusion.

The purpose of the study was to establish the changes in the parameters of the facial skull as a result of distal displacement of the permanent molars of the upper jaw in patients with a distal bite, with a vertical direction of jaw growth.

Materials and methods. The study involved 52 patients who came to the Department of Orthodontics of the Bogomolets National Medical University at the age of 8–16 years with a distal occlusion. To determine the peculiarities of the morphological structure of the facial skull, 98 teleroentgenograms of the head performed in lateral projection were used. Lateral teleroentgenograms of the head were made on the apparatus "ORTHOPHOS" of the company "SIRONA SIDEXIS", at a focal length of 150 cm, voltage 65–75 kV, exposure time – 1.6–2.0 s, current strength – 14 mA. The head was fixed using a cephalostat. The beam was directed to the middle of the external auditory canal. To determine the structural features of the facial skull in patients with distal occlusion, 15 angular and 9 linear parameters were studied.

The direction of jaw growth was determined by the value of the total angle according to Bjork [4].

The results were processed by variational statistical methods of analysis using the Microsoft Office Excel 2016 software. Statistical processing of the experimental study results was carried out by the methods of variation analysis using the Student's test. The difference was considered statistically significant at $p<0.01$ [9].

Results of the study and their discussion. As a result of the cephalometric analysis of the lateral cephalometric radiographs of patients with distal occlusion and a vertical jaw growth pattern, it was determined that the distalization of the permanent molars of the upper jaw leads to an increase in several key craniofacial parameters. Specifically, there is an increase in the angular measurements NSMP (Nasion-Sella-Mandibular Plane), PnOcP (Palatal-Occipital Plane), and SpPMP (Sella-Posterior Nasal Spine to Mandibular Plane). In addition to these angular changes, there are also significant increases in linear measurements, including N-Gn (Nasion-Gnathion), S-Go (Sella-Gonion), A'-B' (Point A to Point B), and M'-J' (Mandibular to Jaw Junction). These changes are illustrated in Fig. 1.

The observed increase in NSMP and SpPMP parameters is intricately linked to the clockwise rotation of the mandibular plane relative to the NS (Nasion-Sella) plane. This rotation is directly attributable to the distalization of the maxillary molars, a common orthodontic intervention. As the molars move distally, the mandible undergoes a clockwise rotation, leading to a notable increase in the overall anterior facial height. Specifically, this increase is seen as an elongation of the anterior lower facial height, which directly impacts the overall facial proportions by making the lower part of the face appear longer. Additionally, the posterior facial height also experiences an increase, primarily due to the elongation of the posterior lower facial height. This change in posterior height contributes to a more balanced and proportional craniofacial structure, enhancing both functional and aesthetic outcomes of the treatment.

Moreover, the increase in the PnOcP parameter is a result of the counterclockwise rotation of the occlusal plane relative to the NS plane. This counterclockwise rotation occurs due to the distal movement of the molars, which affects the spatial orientation of the occlusal plane. As the molars shift distally, the occlusal plane tilts upward in a counterclockwise direction, leading to significant changes in the vertical dimensions of the facial skeleton. This upward rotation of the occlusal plane not only influences the dental alignment but also contributes to the overall facial aesthetics by altering the vertical height relationships within the craniofacial complex. These combined rotational movements underscore the intricate relationship between dental procedures and craniofacial morphology, highlighting the need for a thorough understanding of individual anatomical characteristics to optimize orthodontic treatment outcomes.

The data on the results of the radiographic examination of the lateral view of the heads of patients with a distal occlusion before and after the distalization of the permanent molars of the upper jaw, with a vertical type of jaw growth, are presented in Table 1.

Thus, based on the results of the conducted research, it has been established that during the distal movement of the permanent molars of the upper jaw in patients with distal occlusion and a vertical growth pattern, several significant changes occur in craniofacial parameters. Specifically, there is a counterclockwise rotation of the occlusal plane relative to the NS plane. This upward counterclockwise rotation is a direct consequence of the distal displacement of the molars, which alters the spatial orientation of the occlusal plane. Additionally, there is a clockwise rotation of the mandibular plane relative to the NS plane. This downward clockwise rotation is induced by the distalization of the molars, leading to adjustments in the vertical dimensions of the face. These rotational changes result in an increase in the overall anterior facial height. The increase in anterior facial height is closely associated with an elongation of the anterior lower facial height. This elongation modifies the facial proportions, making the lower part of the face appear longer and more pronounced. Furthermore, the posterior facial height also increases, which is linked to the elongation of the posterior lower facial height. These changes in both the anterior and posterior facial heights contribute to a more balanced craniofacial structure, which can enhance both functional and aesthetic outcomes for the patient.

Table 1

Changes in the parameters of the facial cranium in patients with a distal occlusion before and after the distalization of the permanent molars of the upper jaw and with a vertical type of jaw growth, M±m

Terms / Parameters	Before treatment	After treatment
Angular:		
∠SNA	81.36±0.75	81.75±0.87
∠SNB	79.37±0.45	79.63±0.72
∠ANB	2.26±0.57	2.12±0.58
∠NAB	170.63±0.22	170.63±0.69
∠SNPg	80.25±0.38	80.62±0.82
∠NAPg	174.75±0.29	174.88±0.49
∠NSAr	123.13±0.34	123.22±0.38
∠SArGo	140.13±0.65	140.08±0.91
∠ArGoGn	126.88±0.25	126.50±0.97
∠NSMP	30.13±0.65	32.65±0.35
∠PnSpP	84.83±0.52	81.38±0.91
∠PnOcP	73.38±0.37	75.25±0.59
∠PnMP	62.38±0.67	62.75±0.55
∠SpPMP	22.50±0.34	23.47±0.41
Linear:		
N-Gn	100.44±0.93	102.74±0.57
S-Go	64.64±0.37	67.88±0.89
S-PNS	39.46±0.42	39.48±0.96
Ar-Go	37.06±0.79	37.23±0.83
N-ANS	46.96±0.46	47.10±0.78
A'-B'	56.15±0.61	58.95±0.72
M'-J'	36.48±0.42	39.29±0.74
A'-M'	46.09±0.75	46.14±0.87
B'-J'	45.93±0.97	46.30±0.53

A schematic representation of changes in angular and linear parameters in patients with a distal occlusion and a vertical type of jaw growth due to the distalization of the permanent molars of the upper jaw is shown in Fig. 2.

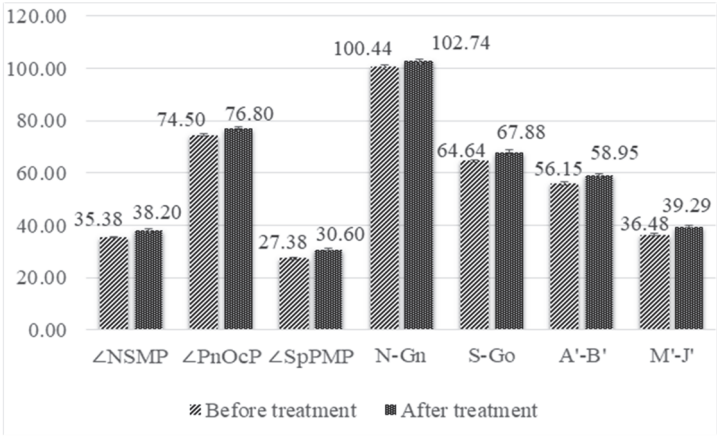

Fig. 1. Changes in the parameters of the facial cranium in patients with a vertical direction of jaw growth in the process of distalization of permanent molars of the upper jaw before and after treatment.

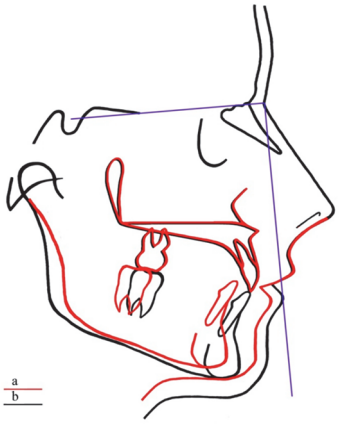

Fig. 2. Schematic representation of changes in the parameters of the facial cranium in patients with a distal overbite and vertical growth in the process of distal movement of the maxillary molars: a – before treatment; b – after treatment.

In summary, the distal movement of the upper molars in patients with distal occlusion and vertical jaw growth results in complex rotational adjustments of both the occlusal and mandibular planes. These adjustments lead to significant changes in the vertical dimensions of the facial skeleton, emphasizing the need for a comprehensive understanding of individual growth patterns and anatomical features to achieve optimal orthodontic treatment results.

The results of our study indicate significant craniofacial changes due to the distalization of permanent maxillary molars in patients with distal occlusion and vertical jaw growth patterns. The

increases in NSMP, PnOcP, and SpPMP parameters, along with the linear measurements N-Gn, S-Go, A'-B', and M'-J', reflect the complex biomechanical adjustments occurring in response to this orthodontic intervention. Our findings are consistent with those reported in previous studies, which demonstrated that the distal movement of upper permanent molars using midpalatal mini-implants resulted in substantial craniofacial changes, emphasizing the role of dental appliances in achieving desired orthodontic outcomes [7]. Similarly, other research highlighted the efficacy of various distalization techniques in altering molar positions and their subsequent impact on facial structures [6]. The observed rotational movements – counterclockwise rotation of the occlusal plane and clockwise rotation of the mandibular plane – are critical in understanding the spatial reorientation of craniofacial components. These rotations lead to an increase in anterior facial height, which aligns with findings that molar distalization with clear aligners influences the occlusal vertical dimension, thereby altering the vertical facial height [3]. Furthermore, our results underscore the importance of considering individual growth patterns, as the vertical direction of jaw growth significantly affects treatment outcomes. This observation is supported by studies utilizing Bjork's growth indications to evaluate skeletal morphology extremes, highlighting the need for tailored orthodontic approaches based on specific growth patterns [4]. The increase in posterior facial height observed in our study is also noteworthy. Similar findings were reported in studies on molar distalization with pendulum appliances, noting that such interventions can affect the position of unerupted canines and premolars, ultimately contributing to changes in posterior facial height [8]. The use of lateral cephalometric radiographs provided comprehensive insights into the morphological changes, reinforcing the validity of our findings. In conclusion, the distalization of permanent maxillary molars in patients with distal occlusion and vertical jaw growth results in significant craniofacial adjustments. These changes underscore the importance of personalized orthodontic treatment plans that consider individual anatomical and growth characteristics. Our findings contribute to the growing body of evidence on the efficacy of molar distalization techniques, providing valuable insights for optimizing orthodontic treatment outcomes.

Conclusions

1. The distalization of permanent maxillary molars in patients with distal occlusion and vertical jaw growth direction leads to significant changes in craniofacial parameters. The study found an increase in anterior facial height and alterations in the angular measurements of the facial skeleton, which are indicative of clockwise rotation of the mandibular plane and counterclockwise rotation of the occlusal plane.

2. The findings underscore the importance of considering individual anatomical features and growth patterns when planning orthodontic treatment for patients with distal occlusion. The vertical growth direction significantly influences treatment outcomes, making it crucial to tailor interventions to each patient’s specific morphological characteristics to achieve stable and effective results.

3. The study highlights the necessity for further research to refine orthodontic techniques and improve long-term outcomes for patients with malocclusion. By understanding the impact of molar distalization on craniofacial structures, clinicians can enhance treatment protocols and improve the overall quality of life for affected individuals.

References

1. Rohach IM, Keretsman AO, Sitkar AD. Pravylno vybranyy metod statystychnoho analizu – shlyakh do yakisnoyi interpretatsiyi danykh medychnykh doslidzhen. Naukovyy visnyk Uzhhorodskoho universytetu, seriya “Medytsyna”. 2017;2(56):124–128. [in Ukrainian].
2. Alshammari A, Almotairy N, Kumar A, Grigoriadis A. Effect of malocclusion on jaw motor function and chewing in children: a systematic review. Clin Oral Investig. 2022;26(3):2335–2351. doi: 10.1007/s00784-021-04356-y.
3. Caruso S, Nota A, Ehsani S, Maddalone E, Ojima K, Tecco S. Impact of molar teeth distalization with clear aligners on occlusal vertical dimension: a retrospective study. BMC Oral Health. 2019;19(1):182. doi: 10.1186/s12903-019-0880-8.
4. Davidovitch M, Eleftheriadi I, Kostaki A, Shpack N. The use of Bjork's indications of growth for evaluation of extremes of skeletal morphology. Eur J Orthod. 2016;38(6):555–562. doi:10.1093/ejo/cjv084.
5. De Ridder L, Aleksieva A, Willems G, Declerck D, Cadenas de Llano-Pérula M. Prevalence of Orthodontic Malocclusions in Healthy Children and Adolescents: A Systematic Review. Int J Environ Res Public Health. 2022;19(12):7446. doi: 10.3390/ijerph19127446.
6. Durgekar SG, Kolur N. Anchorage Reinforcement Post Molar Distalization. Int J Orthod Milwaukee. 2017;28(1):15–16.
7. Gibson C, Critchlow S, Patel B. Unilateral intrusion in a medically complex patient using an orthodontic mini-implant: A case report. J Orthod. 2021;48(4):435–443. doi:10.1177/1465312521996376
8. Kolokitha OE, Balli D, Zarkadi AE, Gizani S. Association between maxillary canine impaction and other dental anomalies: radiological study of a mixed dentition children's cohort from an orthodontic clinic. Eur Arch Paediatr Dent. 2023;24(3):401–407. doi:10.1007/s40368-023-00798-y
9. Londono J, Ghasemi S, Moghaddasi N, Baninajarian H, Fahimipour A, Hashemi S, Fathi A, Dashti M. Prevalence of malocclusion in Turkish children and adolescents: A systematic review and meta-analysis. Clin Exp Dent Res. 2023;9(4):689–700. doi: 10.1002/cre2.771.
10. Paranna S, Shetty P, Anandakrishna L, Rawat A. Distalization of Maxillary First Permanent Molar by Pendulum Appliance in Mixed Dentition Period. Int J Clin Pediatr Dent. 2017;10(3):299–301. doi: 10.5005/jp-journals-10005-1454.

Стаття надійшла 29.03.2023 р.