ORIGINAL ARTICLE

ANATOMICAL RATIONALE FOR CHOOSING A BLADE FOR POWER-ASSISTED ADENOIDECTOMY IN CHILDREN DEPENDING ON DENTITION

DOI: 10.36740/WLek202209104

Kateryna Liakh[1,2], Yaroslav Shkorbotun[1]
[1]STATE INSTITUTION OF SCIENCE «RESEARCH AND PRACTICAL CENTER OF PREVENTIVE AND CLINICAL MEDICINE», KYIV, UKRAINE
[2]NATIONAL UNIVERSITY OF HELTHCARE NAMED AFTER P. L. SHUPYK, KYIV, UKRAINE

ABSTRACT

The aim: To study the anatomic features of the facial skull structures in children of various ages depending on dentition

Materials and methods: One hundred and forty-four children aged 2-12 years were divided into 4 groups depending on dentition. They underwent anthropometric measurements during adenoidectomy. Based on the cosine theorem, the calculated values were obtained.

Results: The distance from choana to the free edge of the retracted soft palate gradually increases from 2.01±0.61 cm in children with stable primary dentition up to 3.09±1.02 cm with mixed dentition. Palato-nasopharyngeal angle in children with stable primary dentition is 126.25±8.76°, in children with aging primary dentition – 132.81±12.21°, and in children with mixed dentition – 120.54±13.72°.

Conclusions: The optimal configuration of the blade for power-assisted adenoidectomy in children with stable primary dentition has an angle of 53.53±8.76°, and the length of the working part of 2.01±0.61 cm, in children with aging primary dentition – 47.18±12.21° and 2.10±0.71 cm, with mixed dentition – 59.45±13.72° and 3.09±1.02 cm, respectively.

KEY WORDS: power-assisted adenoidectomy, nasopharynx anatomy, soft palate, dentition, shaver blade

Wiad Lek. 2022;75(9 p1):2070-2075

INTRODUCTION

Adenoidectomy has been the most commonly used surgical measure in pediatric otolaryngology over the years [1-3]. The development of new surgical technologies is aimed at creating better conditions for adenoid tissue removal, especially in the hard-to-reach areas (vault of the nasopharynx and eustachian torus area), as well as reducing the traumatic impact of the intervention on the surrounding tissues. In recent years, power-assisted adenoidectomy has been increasingly used to remove adenoids [3-6], a convenient subtype of which is transoral endonasal-controlled combined adenoidectomy (TECCA) [7]. Numerous advantages of this technology compared to the conventional method are described in the literature [1; 2;8], first and foremost among which is the possibility of rapid removal of adenoid tissue from the vault of the nasopharynx with minimal impact on the surrounding structures [4; 7].

To perform power-assisted adenoidectomy in children, the manufacturers offer application of a 40° curved standard blade [9], which geometrically resembles a traditional adenotome and makes it possible to quickly and easily remove adenoid tissue in the main part of the nasopharynx. However, the use of such a blade not only makes it difficult to remove the adenoid tissue in the hard-to-reach areas of the nasopharynx, but can also lead to an excessive impact on the soft palate, which may be too stretched during the procedure, and can result in temporary or in some cases persistent velopharyngeal insufficiency [10-13].

The use of a 60° curved blade is offered as an alternative [14, 3] in a certain category of patients, which, according to Pagella et al. (2021), increases the cost of surgery [3].

Therefore, the issue of developing a criterion for choosing a blade for power-assisted adenoidectomy in children is important today. According to Pagella et al. (2021), such a criterion may be the length of the soft palate [3], which influences the choice of a tool with a certain bend angle, but at the same time the length of the working part of the tool is not specified.

Our hypothesis assumes that the most important determinants in choosing the blade are anthropometric characteristics of the facial skull structures in children of various ages. It should be noted that these indicators are stable for certain age groups, but when placing the patient in the position for adenoidectomy, they change and need to be clarified. Intraoperative anthropometry of the facial skull structures in the position typical for transoral endoscopic adenoidectomy with anesthesia is not described in the available literature, and these data are decisive for substantiating the optimal shape of the tool for adenoidectomy, which will maximize the benefits of power-assisted

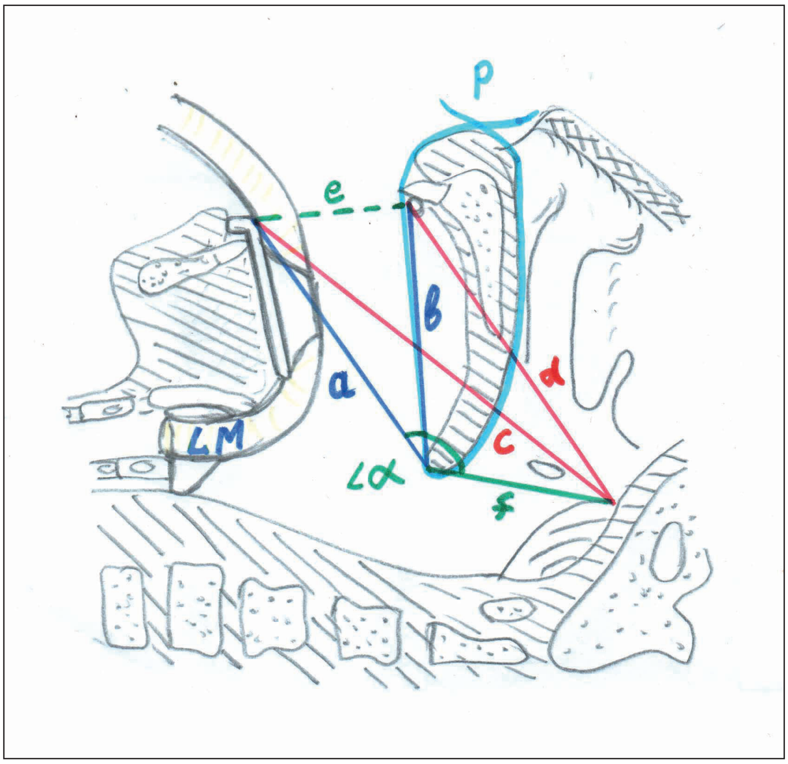

Fig. 1. Distances measured during adenoidectomy

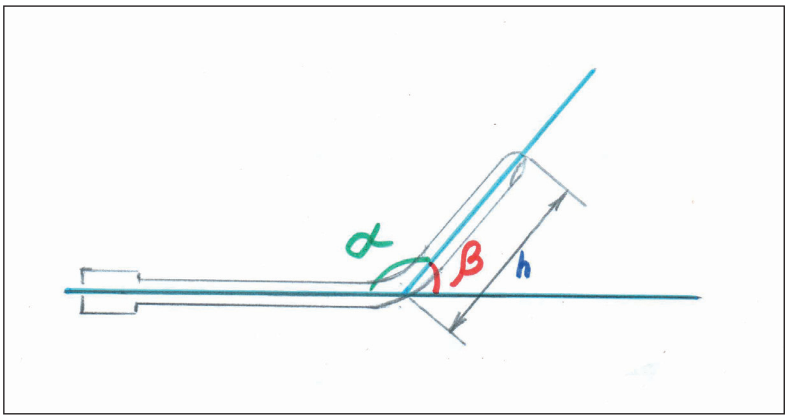

Fig. 2. Shaver blade for adenoidectomy

removal of adenoid tissues in case of adenoids and avoid stretching of the soft palate.

THE AIM

Our hypothesis is that the criterion for selecting and developing a blade for power-assisted adenoidectomy may be features of the structure of the facial skull in children of different ages, depending on the dentition. The aim of the study to investigate the spatial relation of clinically significant structures of the facial skull for transoral endoscopic adenoidectomy in children of various ages.

MATERIALS AND METHODS

One hundred and forty-four children aged 2-12 years, who underwent endoscopic modified microdebrider-assisted adenoidectomy under general anesthesia in the children's hospital of State Institution of Science «Research and Practical Center of Preventive and Clinical Medicine» State Administrative Department in 2018-2020, were under our observation.

The study followed the Declaration of Helsinki on medical protocol and was approved by obtained from the ethics committee (NMAPO named after PL Shupyk, Kjiv).

The gender distribution among the studied children was as follows: 88 boys and 56 girls (61.1% and 38.9% respectively).

Exclusion criteria in the study were as follows: congenital malformations of the facial skull; orthodontic correction and operations on the structures of the facial part of the skull in past medical history.

Depending on the dentition, according to the standard classification [15], all patients were divided into 4 groups: the first group included 22 children with stable primary dentition; the second group consisted of 60 children with aging primary dentition; the third group involved 41 children with early mixed dentition; the fourth group included 21 children with late mixed dentition.

Table I. The results of anthropometry of the structures of oropharynx and nasopharynx

Group, dentition (n- number of children)	Distance 1 (UJ-Ch) (cm)	Distance 2 (LJ-Ch) (cm)	Distance 3 (UJ-LJ) (cm)	Distance 4 (UJ-SP) (cm)	Distance 5 (LJ-SP) (cm)
Group 1 stable primary, (n=22)	5.52±0.53	6.76±0.34	2.59±0.25	4.73±0.58	5.36±0.53
Group 2 aging primary, (n=60)	5.94±0.53	7.19±0.53	2.75±0.29	4.92±0.56	5.64±0.53
Group 3 early mixed , (n=41)	6.16±0.48	7.65±0.61	2.73±0.29	5.20±0.47	5.86±0.50
Group 4, late mixed, (n=21)	6.27±0.61	8.37±0.71	2.91±0.24	5.69±0.60	6.32±0.55
Reliability	$P_{1-2}<0.01$ $P_{2-3}<0.05$ $P_{3-4}<0.001$	$P_{1-2}<0.001$ $P_{2-3}<0.001$ $P_{3-4}<0.001$	$P_{1-2}<0.05$ $P_{2-3}>0.05$ $P_{3-4}<0.05$	$P_{1-2}>0.05$ $P_{2-3}<0.01$ $P_{3-4}<0.05$	$P_{1-2}<0.01$ $P_{2-3}<0.05$ $P_{3-4}<0.01$

Table II. Calculation data on the distance and angles based on intraoperative anthropometry in adenoidectomy in children

Group, dentition (n- number of children)	Distance Ch-SP (cm)	PNPh angle α (°)	Blade angle β (°)
Group 1 stable primary, (n=22)	2.01±0.61	126.25±8.76	53.53±8.76
Group 2 aging primary, (n=60)	2.10±0.71	132.81±12.21	47.18±12.21
Group 3 early mixed , (n=41)	2.89±1.05	120.54±13.72	59.45±13.72
Group 4, late mixed, (n=21)	3.09±1.02	123.37±11.73	56.62±11.73
Reliability	P1-P2>0.05 P2-P3<0.001 P3-P4>0.05	P1-P2<0.01 P2-P3<0.001 P3-P4>0.05	P1-P2<0.05 P2-P3<0.001 P3-P4>0.05

All 144 children underwent the following intraoperative anthropometric measurements after the introduction of a suspension Davis spatula using a specially designed measuring device (the curved ruler developed by us).

Based on the measurements, the calculation of the values that characterize the optimal configuration of the tool for adenoidectomy was performed.

In particular, the angle formed between the arc of the dilator and the choana with the apex on the free edge of the soft palate after its retraction by an elastic catheter is palatine-nasopharyngeal (PNPh) angle α (Fig. 1). This angle describes the optimal degree of curvature of the tool for effective and minimally invasive removal of adenoids. Since the bending angle of the shaver blade (β) is marked by the angle of deviation of the working part of the tool from its axis (Fig. 2), that is the angle adjacent to the angle α, which we determine in the calculations, its value can be defined as follows: β = 180 ° - α. The blade angle smaller than the one we found will not make it possible to reach the vault of the nasopharynx in the perichoanal areas.

Another calculated measure (Ch-SP) is the distance between the upper edge of the choana and the free edge of the soft palate after retraction with an elastic catheter that shows the distance to be reached by the working part of the tool blade after its bending, which corresponds to the length h (Fig. 2).

The specified angle and distance were defined by calculation based on the cosine theorem using the Excel MS Office.

Statistical processing of the results obtained during the study was carried out using EZR statistical software package. The obtained data were processed by methods of variation statistics with the calculation of statistical significance of differences between study groups.

RESULTS

The data from anthropometric measurements of the structures of the oral cavity, oropharynx and nasopharynx in groups depending on dentition, which were performed intraoperatively in children after dilator fixation are presented in Table I.

Based on the data presented in Table I, there can be noted the increase in all indicators of the oropharynx as the child grows, in particular, the elongation of the lower jaw (LJ-Ch and LJ-SP) is obvious. At the same time, the change in indicators associated with the growth of the upper jaw (maxilla) is uneven. The distance from the incisors of the upper jaw to the free edge of the soft palate increases significantly in children with the formation of early mixed dentition ($P_{2-3}<0.01$), and later in the transition to late mixed dentition ($P_{3-4}<0.05$). The distance from the upper jaw to the choana, which depends not only on the longitudinal but also on the vertical growth of the upper jaw bone, significantly increases in all patients.

Table II presents data that determine the optimal angle (bend) and length of the working part of the shaver blade for adenoids removal without impact on the soft palate.

DISCUSSION

Current requirements for minimally invasive endoscopic surgery involve optimum effectiveness of the intervention, in the case of adenoidectomy it is the removal of lymphoid tissue of the nasopharynx in the planned areas, and minimal traumatic impact on the surrounding tissues. To achieve this goal, it is necessary to choose the tool for intervention taking into account topographic and anatomical features of not only the area of intervention (vault of the nasopharynx), but also the oral cavity and pharynx.

Given the age of children presented in most studies on adenoidectomy, this intervention is mainly performed between 2 and 12 years of age [3, 16, 17]. The peak of the Adenoidal-nasopharyngeal ratio (the ratio of the linear dimensions of the adenoids and the nasopharynx) is in the 5-8 age group [18], when the most dynamic changes in the anatomy of the facial skull occur [19, 20, 21]. When the dentition changes from stable primary to aging primary, there is a statistically significant increase in distances associated with the lower jaw growth and only in one indicator (UJ-Ch) related to the upper jaw. The above fact reflects the main processes that occur during the development of the facial skull in this period: permanent molars eruption [19], which first occurs in the lower jaw; intensive growth of the ramuses of the lower jaw and gradual change of its angle (it becomes sharper) at 3-4 years of age [15, 19], which lead to a significant increase in the distance between the medial incisors of the upper and lower jaws (UJ-LJ), that is wider mouth opening. This uneven development leads to a change in the ratio of the facial skull structures, and, as a consequence, to an increase in the angle α, which determines the curvature of the tool. The difference in the calculated angle α in patients of groups 1 and 2 is marked by a high degree of reliability ($P < 0.01$).

The assessment of changes in the measured distances in children with aging primary dentition and early mixed dentition shows continuing active growth of the lower jaw (significant increase in the distances of LJ-Ch and LJ-SP) and enhanced growth of the upper jaw (the increase in the distance of UJ-SP in particular). This can be explained by the preparatory processes for the change of incisors, which occur at the age of 5.5-6 years [22]. In addition, a slight change in the distance of UJ-Ch with a significant increase in the distance of Ch-SP draws attention, which reflects the predominance of the maxilla growth in the vertical direction over the anterior-posterior. This ratio of growth leads to a decrease in the angle α, which was found: from 132.81°±12.21 in children of group 2 to 120.54°±13.72 in children of group 3 ($P<0.001$). This can be linked to the intensive processes of pneumatization of the maxillary sinuses, which occur at the age of 7 years [23], as well as a period of intensive growth of the skull base in this age range [24], which leads to changes in the size and configuration of the posterior-upper wall of the nasopharynx.

The analysis of the changes that occur in children during the period of primary dentition shows a significant increase in all measured distances, which explains the fact that the calculated angle α does not change in two groups of children with primary dentition.

Therefore, the obtained data make it possible to determine the characteristics of the optimal tool for preserving adenoidectomy in each age group of patients: children with stable primary dentition – blade angle – 53.53±8.76°, length of the working part – 2.01±0.61 cm; children with aging primary dentition – 47.18±12.21°, and length of the working part – 2.10±0.71cm; children with early mixed dentition – 59.45±13.72°, and length of the working part – 2.89±1.05 cm; children with late mixed dentition – 56.62±11.73°, and length of the working part – 3.09±1.02 cm. As there is no significant difference between the two indicators in children with early and late mixed dentition, we consider it appropriate to recommend the blade with the following dimensions in both of the above age groups: tip angle – 59.0° and more, and length of the working part – no less than 3.1 cm.

It is clear that the obtained results reflect the most optimal configuration of the tool blade for the average patient of each age group, which almost does not have impact on the soft palate. In the actual implementation of the intervention, it is possible to use a less complementary tool with an obtuser angle and a shorter working part. However, it should be remembered that using a tool with a smaller than the above mentioned angle of the working part relative to the axis of the tool and a shorter length from the bend of the blade to the working part will lead to stretching of the soft palate. It definitely has some elasticity, but excessive aggression upon it will increase the risk of velopharyngeal insufficiency in the postoperative period. Moreover, according to N.C. Saunders et all. (2004), in most cases of persistent velopharyngeal insufficiency after adenoidectomy, such consequences could not be predicted [10].

That is why, in our opinion, when choosing and developing tools for adenoidectomy it is necessary to take into account the anatomical features of each age group, which will reduce the impact on the soft palate and facilitate the surgeon's technical performance of the intervention.

STUDY LIMITATIONS

The study has established the structure features of oropharynx and nasopharynx in children depending on dentition, which can influence the choice of shaver blade. However, the measurements were carried out only along the median line, not including the transverse dimensions of these structures. In addition, the research results are limited by the sample size (144 children, divided into 4 groups).

CONCLUSIONS

1. In children aged 2-12 years, the growth of parts of the facial skull is uneven, with a significant increase in the rate of change in size after the transition from aging primary to early mixed dentition.
2. Intraoperative measurements and calculations of distances between certain structures of the facial skull during adenoidectomy in children aged 2-12 years showed that the distance from the choana to the free edge of the retracted soft palate in the midline gradually

increases from 2.01±0.61 cm in children with stable primary dentition up to 3.09±1.02 cm with mixed dentition.

3. The change of PNPh angle with age is different: in children with stable primary dentition it is 126.25±8.76°, then, in the period of aging primary dentition, it becomes obtuser – 132.81±12.21°, and in children with mixed dentition, nasopharyngeal angle becomes more acute again – 120.54±13.72°.
4. The optimal blade configuration for power-assisted adenoidectomy in children with stable primary dentition has an angle of 53.53±8.76°, and the length of the working part of 2.01±0.61cm; in children with aging primary dentition – 47.18±12.21° and 2.10±0.71 cm, with mixed dentition – 59.45±13.72° and 3.09±1.02 cm, respectively.

REFERENCES

1. Kozcu S.H., Demirhan E., Ukurova I. Curettage adenoidectomy versus endoscopic microdebrider adenoidectomy in children: A randomized controlled trial. International Journal of Pediatric Otorhinolaryngology. 2019; 119: 63-69.
2. Singh S., Padiyar B.V., Sharma N. Endoscopic –Assisted Powered Adenoidectomy versus Conventional Adenoidectomy: A Randomized Study. Dubai Medical Journal. 2019;2: 41-45.
3. Pagella F., Lizzio R., Pusateri A. et al. Adenoidectomy: Anatomical variables as predictive factors of intraoperativeadenoid residues. International Journal of Pediatric Otorhinolaryngology. 2021; 140. doi: 10.1016/j.ijporl.2020.110493.
4. Schupper A.J., Nation J., Pransky S. Adenoidectomy in Children: What Is the Evidence and What Is its Role? Current Otorhinolaryngology Reports 2018; 6: 64–73.
5. Salama Al shujairi J.F. Causes of nasal obstruction after adenoidectomy International Journal of Current Research. 2019; 11(6): 4533-4537.
6. Rajan N., Saxena S.K., Parida R.K., Sivaraman Ganesan A.A. Comparison of middle ear function and hearing thresholds in children with adenoid hypertrophy after microdebrider and conventional adenoidectomy: a randomised controlled trial. European Archives of Oto-Rhino-Laryngology. 2020; 277: 3195–3203.
7. Pagella F., Pusateri A., Ganzi P. et al. The evolution of the adenoidectomy of different powerassisted techniques. International Journal of Immunology and Pharmacology. 2011; 24(4): 55-59.
8. Yang L., Shan Y., Wang S. et al. Endoscopic assisted adenoidectomy versus conventional curettage adenoidectomy: a meta-analysis of randomized controlled trials Open Access Research First Online. 2016: 426. doi:10.1186/s40064-016-2072-1.
9. Medtronic ENT Product Catalog. 2021, 31p. https://www.medtronic.com/content/dam/medtronic-com/products/ear-nose-throat/documents/ent-product-catalog.pdf [date access 03.07.2022]
10. Saunders N.C., Hartley B.E.J., Sell D., Sommerlad B. Velopharyngeal insufficiency following adenoidectomy. Clin. Otolaryngol. 2004; 29: 686–688.
11. Kassem F., Ebner Y., Nageris B. et al. Cephalometric findings among children with velopharyngeal dysfunction following adenoidectomy-A retrospective study. Clin Otolaryngol. 2017; 42(6):1289-1294.
12. Khami M., Tan S., Glicksman J.T., Husein M. Incidence and Risk Factors of Velopharyngeal Insufficiency Postadenotonsillectomy Otolaryngol Head Neck Surg. 2015; 153(6): 1051-1055.
13. Dimatosa C., Nevesa L.R., Beltrameb J.M. et al. Impact of adenotonsillectomy on vocal emission in children Srp Arh Celok Lek. 2020;148(9-10):560-564.
14. Shkorbotun V.O., Liakh K.V., Shkorbotun Y.V Modyfikovana endoskopichna adenotomiya u ditey z vykorystannyam kutovoho mikrodebrydera. [Modified endoscopic adenotomy in children using an angular microdebrider] Zhurnal vushnikh, nosovykh I horlovykh khvorob. 2011; 3: 238-239. (In Ukrainian).
15. Corotych N.N. Metodicheskiye ukazaniya dlya samostoyatel'noy raboty studentov vo vremya podgotovki k prakticheskim(seminarskim) zanyatiyam i na zanyatiyakh [Methodical instructions for independent work of students during preparation for practical (seminar) classes and in the classroom]. Poltava. 2019, 85p. (In Russian).
16. Kischuk V.V., Rautskikh P.A. Morfofunktsional'ni zminy slyzovykh zaloz glotkovogo myhdalyka pry yoho patolohiyi [Morphofunctional changes of the mucous glands of the adenoid in its pathology] Visnyk morpholohii. 2015; 1(21): 34-37. (In Ukrainian).
17. Ten I.V., Caloidina D.S., Taukelina S.A. Adenotomia; za I protiv. [Adenotomy: pros and cons] Vestnic AGIUV. 2017; 2: 11-16. (In Russian).
18. Cohen O., Betito H.R., Adi M. Et al. Development of the Nasopharynx: A Radiological Study of Children. Clinical Anatomy. 2020; 33(7): 1019-1024.
19. Fischev S.B., Klimov A.G., Sevastianov A.V. et al. Stroyeniye i razvitiye zubochelyustnoy sistemy u detey [The structure and development of the dentition in children] St. Petersburg. 2019, 701p. (In Russian).
20. Tkachenko P.I. Metodicheskiye ukazaniya dlya samostoyatel'noy raboty studentov vo vremya podgotovki k prakticheskim(seminarskim) zanyatiyam i na zanyatiyakh [Methodical instructions for independent work of students during preparation for practical (seminar) classes and in the classroom]. Poltava. 2019, 64p. (In Russian).
21. Golbin D.A., Cherkaev V.A. Variabel'nost' i vozrastnyye osoyennosti anatomii sredinnykh struktur perednikh otdelov osnovaniya cherepa. [Variability and age characteristics of the anatomy of the median structures of the anterior skull base]. Voprosy neirokhirurgii. 2018;1: 102-110. (In Russian).
22. Galych L.V. Metodychni vkazivky dlya samostiynoyi roboty studentiv z dystsypliny "Ortodontiya" 3 kurs. [Methodical instructions for independent work of students in the discipline "Orthodontics" 3rd year]. Sumy. 2017, 56p. (In Russian).
23. Trushel N.A., Gryntsevich R.G. Dinamika razvitiya verkhnechelyustnoy i lobnoy pazukh cheloveka. [Dynamics of development of the maxillary and frontal sinuses of a person] Aktualnye problem sovremennoy meditsiny I farmatsii. Sbornic materialov LXXIII Mezhdunarodnoy nauchno-prakticheskoy konferentsii studentov I molodykh ychenykh. 2019, 89p. (In Russian).
24. Esakov S.A. Vozrastnaya anatomiya i fiziologiya (kurs lektsiy) [Age anatomy and physiology (course of lectures)]. Izhevsk. 2010, 78p. (In Russian).

We gratefully thank Prof. V. Shkorbotun and Prof. A.Kosakovsky for their support and advice. We are also grateful to our clinical team for their patience and help.

ORCID and contributionship:
Kateryna Liakh: 0000-0003-4863-948X[A-D,F]
Yaroslav Shkorbotun: 0000-0002-3103-7194[B,E]

Conflict of interest:
The Authors declare no conflict of interest.

CORRESPONDING AUTHOR
Kateryna Liakh
Research and Practical Center of
Preventive and Clinical Medicine
5 Verkhnia st., 01014 Kjiv, Ukraine
tel: +380677570585
e-mail: ketlor@ukr.net

Received: 02.08.2021
Accepted: 29.06.2022

A - Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis,
D – Writing the article, **E** – Critical review, **F** – Final approval of the article