Journal of

CONTINUING DENTAL
EDUCATION

UKRAINIAN PUBLIC SCIENTIFIC SOCIETY

Volume 1 · Issue 1 · October 2022

U D J

Ukrainian Dental Journal

У К Р А Ї Н С Ь К И Й

С Т О М А Т О Л О Г І Ч Н И Й

Ж У Р Н А Л

U D J
Ukrainian Dental Journal

Ukrainian Dental Journal
official Publication of the
Ukrainian Public Scientific Society for Continuing Dental Education

CONTINUING DENTAL EDUCATION
UKRAINIAN PUBLIC SCIENTIFIC SOCIETY

Founder and Publisher
Ukrainian Public Scientific Society "Continuing Dental Education"
Address: 15, Kyrylivska str., Kyiv, 04080, Ukraine
E-mail: editor.udj@gmail.com
Website: www.journal.dental.ua
Certificate of State Registration of Print Media
Series КВ № 25041 - 14981Р from 30.11.2021
Certificate of making a publishing house subject to the State Register of publishers, manufacturers and distributors of publishing products
Series ДК №7617 from 01.06.2022
Ukrainian Dental Journal (**p-ISSN** 2786-6297; **e-ISSN** 2786-6572) is official Journal of the Ukrainian Public Scientific Society for Continuing Dental Education
DOI: 10.56569
Published: from the year 2021
Frequency: semiannual (March, October)
Manuscript Languages: English, Ukrainian
Ukrainian Dental Journal accepts articles for Open Access publication
UDC: 616.314(477)(05)

UDJ was sent to the publisher on 05.09.2022
Printing format is 60 x 84/8
Offset color printing, coated glossy papers
Volume of 5 physical and 11.2 conventional printed sheets
It's edition of 100 copies circulation
Forms of Journal is produced by LLC PoygraphFactory, Kyiv, Ukraine

Засновник і Видавець
ГС "Безперервного професійного розвитку стоматологів"
Адреса: 04080, Україна, м. Київ, вул. Кирилівська, 15
Електронна адреса: editor.udj@gmail.com
Веб-сайт: www.journal.dental.ua
Свідоцтво про державну реєстрацію друкованого ЗМІ
Серія КВ № 25041 - 14981Р від 30.11.2021
Свідоцтво про внесення суб'єкта видавничої справи до Державного реєстру видавців, виготовлювачів і розповсюджувачів видавничої продукції
Серія ДК №7617 від 01.06.2022
Український стоматологічний журнал (**p-ISSN** 2786-6297; **e-ISSN** 2786-6572) є офіційним журналом Всеукраїнської Громадської Спілки "Безперервного професійного розвитку стоматологів"
DOI: 10.56569
Рік заснування: 2021
Періодичність: кожні півроку (березень, жовтень)
Мова видання: англійська, українська
«Український стоматологічний журнал» - міжнародне рецензоване фахове наукове видання відкритого доступу
УДК: 616.314(477)(05)

Підписане до друку 05.09.2022
Формат 60 x 84/8
Друк кольоровий офсетний. Папір крейдяний глянцевий
Обсяг 5 фізичних і 11,2 умовних друкованих аркушів
Наклад 100 примірників
Друк ТОВ Поліграфкомбінат, м. Київ, Україна

ISSN 2786-6297 (print) ISSN 2786-6572 (online)
Український стоматологічний журнал
УДК: 616.314.2-073.7(045)
DOI: 10.56569/UDJ.1.1.2022.49-55

U D J
Ukrainian Dental Journal

New analysis and classification of Angle's class II malocclusion varieties during the mixed dentition period

Angle's class II malocclusion varieties

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article

Article Info

Artical History:
Paper recieved 14 June 2022
Accepted 20 July 2022
Available online 1 October 2022

Keywords:
Class II malocclusion, cephalometric analysis, Perillo, Perillo-ID, mandibular hypoplasia, mandibular retrusion, mandibular rotation, mixed dentition.

https://doi.org/10.56569/UDJ.1.1.2022.49-55

Abstract

Introduction. It is well known that Angle's class II malocclusion is the most common of all occlusal pathology. The prevalence of this malocclusion among children remains at 35-43% and tends to increase. Class II malocclusion negatively affects not only the functions of chewing, swallowing, breathing and speech, but also life in general, especially for children and adolescents. An analysis of modern scientific papers shows that variability of class II malocclusion is insufficiently covered in published classifications.

Objectives. To develop a classification of Angle's class II malocclusion forms based on the determination of angular and linear cephalometric parameters for children aged 7 to 12 years old and to analyze of their prevalence in Ukraine.

Material and Methods. 138 lateral cephalometric radiographs of children aged 7 to 12 years old with Angle's class II malocclusion were selected. Cephalometric analysis by Perillo-ID method was performed on all 138 radiographs. 68 lateral cephalometric radiographs were selected for further study.

Results. Cephalometric analysis by Perillo-ID method on 68 lateral cephalograms in children aged 7-12 years old showed a wide range of variability forms of Angle's class II malocclusion. The results of 7 angular and 4 linear parameters allowed to create a classification of Angle's class II malocclusion forms and sizes, taking into consideration the position of the lower jaw in children during the mixed dentition period.

Conclusions. Authors modified Perillo's cephalometric analysis, which allowed to create a detailed classification of Angle's class II malocclusion forms for children during the mixed dentition period. The new classification will allow to clearly differentiate the etiology of malocclusion, to differentiate the true mandible underdevelopment from its retroposition or rotation.

Introduction

In the last decade, digital 3D diagnostic methods and treatment technologies have entered the daily li fe of orthodontic clinical practice [1-3]. However, lateral and frontal cephalogram followed by 2D cephalometry remains the main method of diagnostics and decision-making regarding the method of treatment among orthodontists [4-5].

Currently, a large number of methods of 2D cephalometric analysis are known, which include many angular and linear measurements [6, 7]. However, the use of all these parameters in full manner at the same time is not just inappropriate, but also is impossible to apply for each clinical situation [8-10]. Our analysis of modern scientific articles revealed absolutely no specific method of cephalometric analysis for the diagnosis of class II malocclusion in children during the period of mixed dentition.

In clinical practice, the orthodontist nearly always faces the need to analyze lateral cephalograms simultaneously by several authors in order to obtain sufficient diagnostic information [11, 12]. It is, indeed, well known that an accurate diagnosis is the key to choosing an effective treatment. For the practicing pediatric orthodontist it is crucial to understand the relationship between the bone jaw structures as well as position and size of both jaws alongside the background of the direction of growth [13]. The possibility of correcting the direction of growth during childhood is one of treatment clinical tasks that harmonizes the face and allows the formation of normal occlusion [14, 15, 16].

Objective

To develop a new cephalometric analysis that will allow to classify the forms of anomalies of class II malocclusion in children aged 7 to 12 years.

Materials and methods

The research protocol was approved by the Commission on Bioethical Expertise and Ethics of Scientific Research of the Bogomolets National Medical University, expert opinion № 116 dated 29.11.2018.

All patients whose X-ray images were included in this study gave standard informed consent to perform skull X-ray images for cephalometry.

The study involved 138 children with class II malocclusion aged 7 to 12 years (73 girls and 65 boys), mean age being 9.2 years. Inclusion criteria: age 7-12 years, mixed dentition, class II malocclusion, clinical signs of maxilla narrowing. Exclusion criteria: class I malocclusion, class III malocclusion, permanent dentition, temporary dentition, genetic syndromes, symptom complexes associated with TMJ. All children underwent lateral cephalography for cephalometric analysis. One hundred and thirty-eight side view skull X-ray images were downloaded and analyzed in publicly available online software Web Ceph (Assembler Circle Corp., Republic of Korea) [16, 17].

In order to improve the diagnosis of malocclusion, we have modified the cephalometric analysis by L. Perillo by incorporating the additional measurement of the angle of inclination of the occlusal plane relative to the Frankfurt horizontal (∠FH/OcL). Angles ∠NSAr, ∠NSBa, ∠SArGo, ∠ArGoMe were excluded from the analysis [18]. The modified analysis was named “Perillo-ID”.

In order to plan efficient further treatment, it is extremely important to understand the multifactorial etiology of a distal occlusion in pediatric patients and the influence of the position of the developing maxilla on the development of the mandible. It is important that the angle of inclination of the occlusal plane relative to the Frankfurt horizontal is the exact criteria for the rotation of the entire dentoalveolar complex relative to the anterior cranial base.

In order to measure the angular and linear parameters, all anatomical landmarks and reference lines were established according to generally accepted methods [19]. Landmarks used are provided in Table 1, reference lines are provided in Table 2. Cephalometric indicators according to Steiner, Downs, Rakosis, Schwarz and Jacobson were used to establish the reference normal values of respecting angles [20, 21]. Angles and their normal values are provided in Table 3. The Perillo-ID modified cephalometric analysis method created by us uses the optimal combination of reference measurements for detailed classification of the distal occlusion (see Figures 1-3).

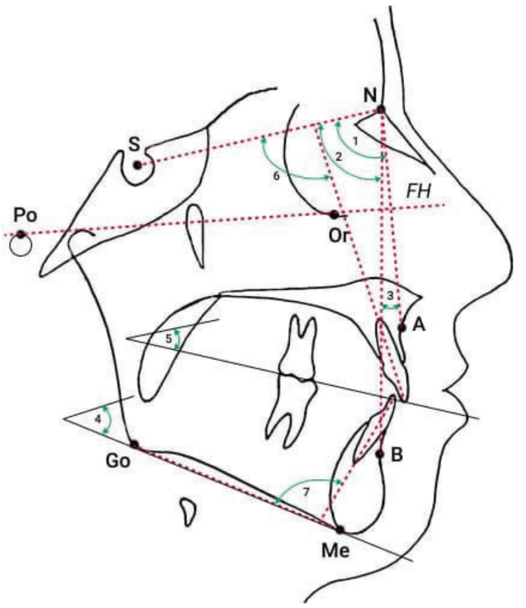

Fig. 1. Contoured bony structures of the skull and angular parameters according to cephalometric data, anatomical points of Perillo-ID analysis. ∠SNA (1), ∠SNB (2), ∠ANB (3), ∠SN/ML (4), ∠FH/OcL (5), ∠U1/SN (6), ∠L1/ML (7).

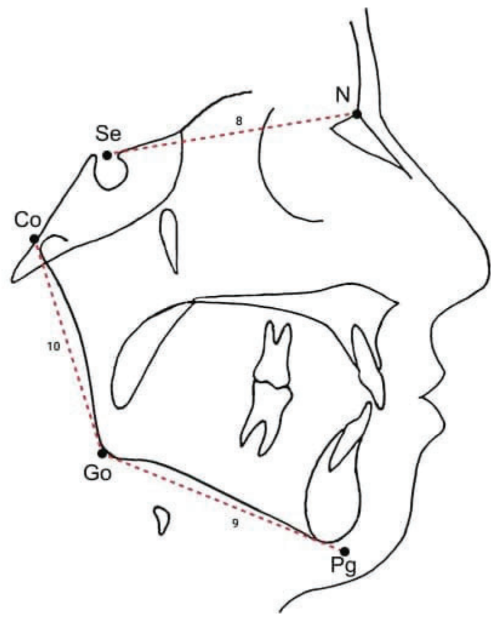

Fig. 2. Contoured bony structures of the skull and linear parameters according to cephalometric data and anatomical points of Perillo-ID analysis. SeN (8), GoMe (9), CoGo (10).

Table 1. Table shows skeletal and teeth landmarks used by the Perillo-ID cephalometric analysis.

Landmark	Abbreviation	Definition
Nasion	N	Most anterior point on frontonasal suture
Sella turcica	S	Midpoint of sella turcica
Sella turcica entrance	Se	The center of the entrance to the sella turcica
Orbitale	Or	Most inferior point on margin of orbit
Porion	Po	Most superior point of outline of external auditory meatus
Subspinale (A point)	A	Most concave point of anterior maxilla
Supramentale (B point)	B	Most concave point on mandibular symphysis
Condylion	Co	Most posterior/superior point on the condyle of mandible
Gonion	Go	Most posterior inferior point on angle of mandible. Can also be constructed by bisecting the angle formed by intersection of mandibular plane and ramus of mandible
Pogonion	Pg	Most anterior point of mandibular symphysis
Menton	Me	Lowest point on mandibular symphysis
Upper Molar	UM	Point on the mesiobuccal cusp of the crown of the upper first molar
Upper incisor incisal edge	UIE	The incisal edge of the most prominent maxillary incisor
Lower incisor incisal edge	LIE	The incisal edge of the most prominent mandible incisor
Root apex of the upper incisor	UA	The root apex of the most prominent maxillary incisor
Root apex of the lower incisor	LA	The root apex of the most prominent mandible incisor

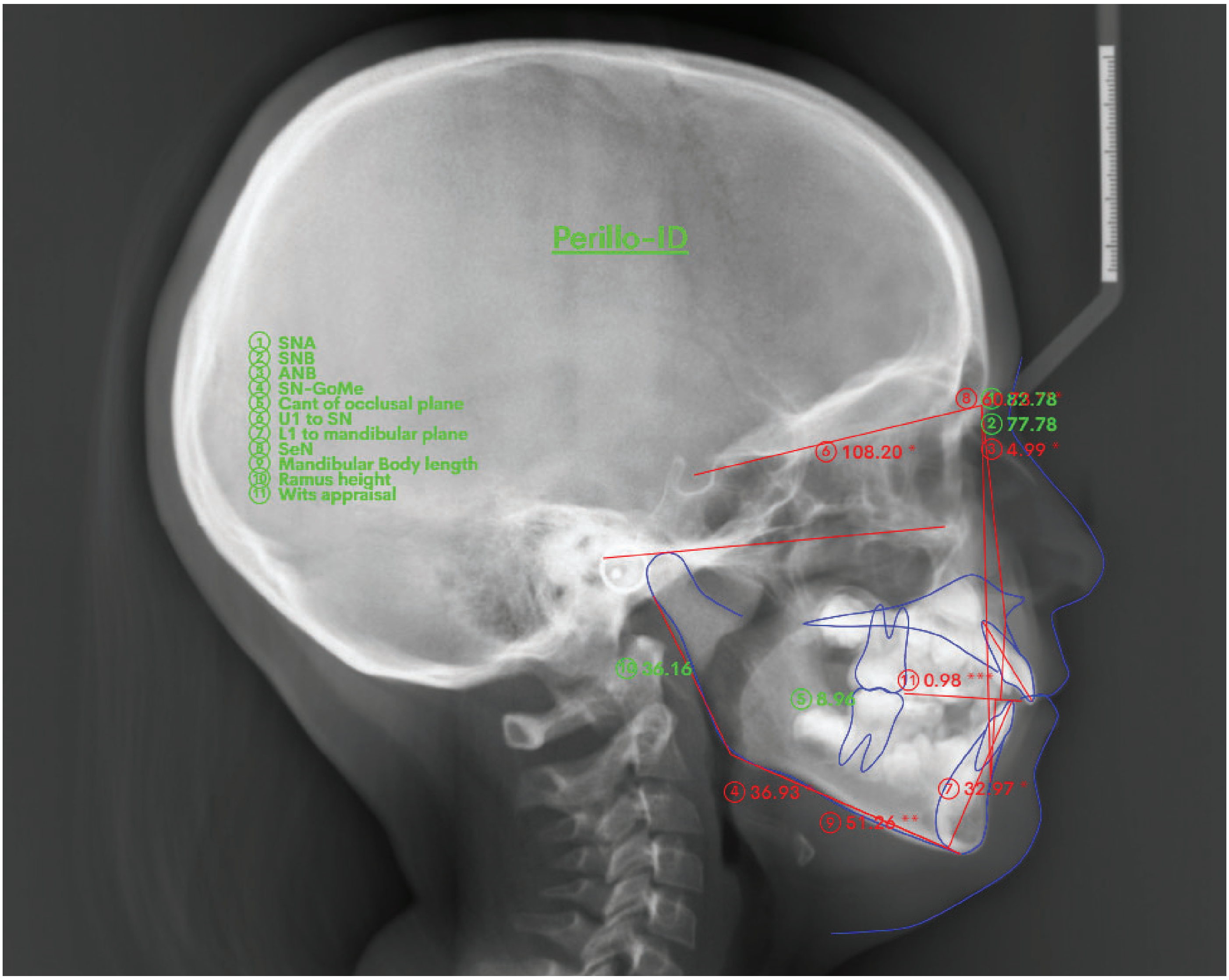

Fig. 3. X-ray image of skull lateral view. Contoured bony/soft tissue structures and reference lines forming Perillo-ID cephalometric analysis. Cephalometric measurements by Perillo-ID cephalometric analysis.

Table 2. Table shows reference lines used by the Perillo-ID cephalometric analysis.

Line	Definition
S-N	Line of the anterior cranial base from the sella turcica to nasion point
Se-N	Line from point nasion to point sella turcica entrance
N-A	Line from point nasion to point subspinale
N-B	Line from point nasion to point supramentale
FH	Frankfurt Horizontal - line from point porion to point orbitale
OcL	Occlusional Line - line passing through the point on the mesiobuccal cusp of the crown of the upper first molar and one-half the overbite of the incisors
ML	Mandibular Line connecting the point gonion and point menton
U1	Axis maxillary incisor - line connecting the incisal edge and root apex of the most prominent maxillary incisor
L1	Axis mandibular incisor - line connecting incisal edge and root apex of the most prominent mandibular incisor
AO	Perpendicular line connecting point A to the occlusal plane (creating intersection respecting point AO)
BO	Perpendicular line connecting point B to the occlusal plane (creating intersection respecting point BO)
Co-Go	Line from point condylion to point gonion

Table 3. Table shows reference lines and angles normal measurements used by the Perillo-ID cephalometric analysis.

Abbreviation	Definition	Normal range
Angular (angle between)		
∠SNA (°)	Sella turcica – Nasion – A point	82° ± 2°
∠SNB (°)	Sella turcica – Nasion – B point	80° ± 2°
∠ANB (°)	A point – Nasion – B point	2° ± 2°
∠SN/ML (°)	Sella-Nasion line – Mandibular Line	32° ± 2°
∠FH/OcL (°)	Frankfurt horizontal – Occlusional Line	9,3° ± 3,8°
∠U1/SN (°)	Axis maxillary incisor – Anterior Cranial Base	102° ± 2°
∠L1/ML (°)	Axis mandible incisor – Mandibular Line	90° ± 2°
Linear (distance between)		
SeN (mm)	Sella turcica entrance – Nasion	individually
GoMe (mm)	Gonion – Menton	SeN + 3mm
CoGo (mm)	Condylion – Gonion	CoGo:GoMe=5:7
AOBO (Wits) (mm)	Point AO - Point BO (depicts the anteroposterior relation between the both jaws)	1mm ± 1 mm

Perillo-ID cephalometric analysis was performed on all lateral cephalograms, all data was organized into Excel table(.xlsx). All data was analyzed and statistically processed. Distribution patterns of different cephalometric outcomes were established and structured for further comparative analysis. Probability plots were used as graphical technique to assess distribution deviation from normal. Differences among distribution patterns were compared using Z-test statistical approach, by calculating parameters of dispersion and the square root values applied for data points numbers [22].

Pediatric patients with an increased ∠SNA, which indicated an anterior position (protrusion) of the maxilla relative to the anterior cranial base were excluded from further study as well as pediatric patients with an increased ∠FH/OcL which indicated rotation of the whole dental complex.

The remaining 68 cephalograms were further analyzed to identify the etiological factors of class II malocclusion development to form a classification - IDC (Ivanova-Dakhno Classification).

Results

According to the results of originally developed and proposed Perillo-ID cephalometric analysis, 68 cephalograms were analyzed which allowed us to create the IDC of class II malocclusion in pediatric patients during the period of mixed dentition (Table 4).

IDC is based on the complex analysis and comparison of the deviation of four cephalometric parameters from their normal values: GoMe, CoGo, ∠SNB, and ∠SN/ML (Table 5). Linear measurements are compared to according age normal.

Table 4. IDC of class II malocclusion in pediatric patients during the period of mixed dentition

First group (I)	patients with true mandible underdevelopment (hypoplasia)	I.a – mandibular hypoplasia with normal position of mandible I.b – mandibular hypoplasia with clockwise mandible rotation I.c – mandibular hypoplasia with mandible retroposition
Second group (II)	patients with mandible malposition	II.a – mandible retroposition II.b – clockwise mandible rotation II.c – mandible retroposition with clockwise mandible rotation
Third group (III)	combined, patients with all of the above signs: mandible hypoplasia, clockwise mandible rotation and mandible retroposition	

Table 5. Main cephalometric parameters in IDC for pediatric patients.

Group	Subgroup	GoMe (mm)	CoGo (mm)	∠SNB (°)	∠SN/ ML (°)
I	I.a	< N	≤ N	= N	= N
	I.b	< N	≤ N	= N	> N
	I.c	< N	≤ N	< N	= N
II	II.a	= N	= N	< N	= N
	II.b	= N	= N	= N	> N
	II.c	= N	= N	< N	> N
III		< N	≤ N	< N	> N

According to Ivanova-Dakhno Classification, patients with mandible hypoplasia were included in group I, as evidenced by the GoMe and CoGo measurements deviations. Subgroups were distributed the following way:

I.a group consisted of children who had a mandible hypoplasia and normal measurements of angles ∠SNB and ∠SN/ML.

I.b group consisted of children who had a mandible hypoplasia and increased angle ∠SN/ML, angle ∠SNB within normal values.

I.c group consisted of children who had a mandible hypoplasia and decreased angle ∠SNB, angle ∠SN/ML within normal values.

Group II consisted of children with mandible malposition (decreased angle ∠SNB, increased angle ∠SN/ML) and normal mandible size.

II.a group consisted of children who had decreased angle ∠SNB, angle ∠SN/ML within normal values and normal mandible size.

II.b group consisted of children who had angle ∠SNB within normal values, normal mandible size and increased angle ∠SN/ML.

II.c group consisted of children who had normal mandible size, decreased angle ∠SNB and increased angle ∠SN/ML.

Group III consisted of children who had mandible hypoplasia, decreased angle ∠SNB and increased angle ∠SN/ML.

In order to assess the relative prevalence and frequency distribution of Angle's class II malocclusion according to IDC, the statistical analysis of all 68 cephalograms was performed by Perillo-ID method, the results of which are presented in Table 6.

The largest number of patients were assigned to group III - 29 children (42.64%), including 16 girls (23.53%) and 13 boys (19.11%), who had a decreased angle ∠SNB, increased angle ∠SN/ML and mandible hypoplasia.

Group I consisted of 26 children (38.23%), including 11 girls (16.17%) and 15 boys (22.06%), who had mandible hypoplasia.

Group II consisted of 13 children (19.11%), including 5 girls (7.35%) and 8 boys (11.76%), who had mandible retroposition indicated by decreased angle ∠SNB and increased angle ∠SN/ML as well as normal mandible size.

According to the results of this study, we can conclude that the most common pathology among children aged 7-12 years living in the city of Kyiv and Kyiv region is mandible hypoplasia, clockwise mandibular rotation and mandible retroposition, which corresponds to group III according to our Ivanova-Dakhno Classification.

Discussion

The global distributions of Class II malocclusions in mixed dentition stage is 23.11%. However, it ranges from 1.6% in Nigeria to 63% in Belgium [23]. In Ukraine, Class II affects nearly 44% of children up to 12 years old making this malocclusion class one of the most commonly-treated malocclusions [24].

Until now there is no consensus about the effectiveness of early

Table 6. Distribution of the cases studied with Angle's class II malocclusion in percentage as a result of cephalometric analysis of Perillo-ID.

Groups	Number of patients	Sex Female		Male	
		n	%	n	%
I	26	11	16,18%	15	22,06%
I.a	4	0	0%	4	5,88%
I.b	3	2	2,94%	1	1,47%
I.c	19	9	13,24%	10	14,71%
II	13	5	7,35%	8	11,76%
II.a	8	3	4,41%	5	7,35%
II.b	0	0	0%	0	0%
II.c	5	2	2,94%	3	4,41%
III	29	16	23,53%	13	19,12%

orthodontic treatment aiming to correct Class II malocclusion in children during the mixed dentition period. Data of randomized clinical trials published earlier showed that skeletal correction of Class II malocclusion during mixed dentition did not provide any additional benefits and was not sustained during subsequent later treatment [25-27].

Today pediatric orthodontists use complex approach to early treatment of Class II malocclusion. Their methods include a vast variety of methods and devices while the advantages and results of the latter are closely researched [28].

As we known, the diagnosis of class II malocclusions in young children should be based on facial, occlusal and cephalometric data [4, 5, 8, 10, 18]. The main problem resides that most cephalometric studies use numbers to describe a malocclusion and these numbers from the adolescent population are translated into growing children [13, 14, 15]. However, our modified cephalometric study answer about maxillofacial growing pattern in young children.

The substantial advantage of incorporation of early treatment protocol of Class II malocclusion includes: normalization of the skeletal pattern and growth; reduction of the length of any future phase treatment; simpler and quicker any future courses of orthodontic treatment; need for future extraction of permanent teeth is reduced.

Limitation of present study associated with relatively small initial study sample, but it should be noted that research is preliminary by its nature and aimed at development of adapted cephalometric analysis and corresponding classification for the class II malocclusion forms among children aged 7 to 12 years. Further study will be provided in the manner of large-scale quantitative research in order to evaluate validity, clinical significance and predictability of treatment outcome while using proposed Ivanova-Dakhno Classification for the initial verification and differential diagnosis of Angles's class II malocclusion forms.

This way, the main takeaway of this study is the thesis that achieving an advantage from the early treatment of Class II malocclusion is possible only with an in-deep understanding of not only the etiology of this pathology, but also of the scenario that forms the malocclusion. This is why we introduced the Perillo-ID cephalometric analysis, which allows pediatric orthodontists to undoubtably identify sizes, positions, and rotations of a mandible. Created by us based on the cephalometric analysis, the IDC Classification of Angles's class II malocclusion is meant to assist clinicists to understand the development patterns of this malocclusion to select the single best possible method for early treatment specific for every single clinical case with early mixed dentition Class II malocclusion.

Conclusions

Our Perillo-ID cephalometric analysis used to create the Ivanova-Dakhno Classification of the Angles's class II malocclusion fully allows pediatric orthodontists to analyze the scenario of the development of distal occlusion in children 7-12 years. This analysis provides pediatric orthodontists the necessary tools and data to make a differential diagnosis and choose an effective treatment.

Conflict of interest

The authors hereby confirm absence of association with any organization or company that may have any financial or non-financial interest in the materials of research discussed in this article.

Funding

No funding was received to assist in preparation and conduct of this research, as well as in composition of this article.

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ISSN 2786-6297 (print) ISSN 2786-6572 (online)
Український стоматологічний журнал
УДК: 616.314.2-073.7(045)
DOI: 10.56569/UDJ.1.1.2022.49-55

U D J
Ukrainian Dental Journal

Новий цефалометричний аналіз та класифікація патології прикусу класу II за Енглем в періоді змішаного прикусу

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A – розробка концепції та дизайну дослідження, B - збір та або систематизація даних дослідження, C - аналіз та тлумачення даних дослідження, D - написання публікації, E - критичне доопрацювання тексту публікації, F- остаточне затвердження.

Стаття:

Історія статті:
Надійшла до редакції 14 червня 2022
Прийнята до друку 20 липня 2022
Доступна онлайн 1 Жовтня 2022

Ключові слова:
Патологія прикусу, II клас за Енглем, цефалометричний аналіз, Perillo, Perillo-ID, гіпоплазія нижньої щелепи, ретрузія нижньої щелепи, ротація нижньої щелепи, змішаний прикус.

Анотація

Вступ. Загальновідомо, що неправильний прикус по II класу за Енглем є найпоширенішим серед усіх оклюзійних патологій. Поширеність такої патології прикусу серед дітей залишається на рівні 35-43% і має тенденцію до зростання. Аномалія прикусу II класу негативно впливає не тільки на функції жування, ковтання, дихання і мови, а й на якість життя в цілому, особливо дітей та підлітків. Аналіз сучасних наукових праць показує, що варіабельність неправильного прикусу II класу за Енглем недостатньо висвітлена в опублікованих класифікаціях.

Мета. Розробити класифікацію форм неправильного прикусу II класу за Енглем на основі визначення кутових та лінійних цефалометричних показників у дітей 7-12 років та проаналізувати їх поширеність в Україні.

Матеріали та методи. Відібрано 138 бічних цефалометричних рентгенограм дітей віком від 7 до 12 років з неправильним прикусом по II класу за Енглем. На всіх 138 рентгенограмах проведено цефалометричне вимірювання методом Perillo-ID. Для подальшого дослідження відібрано 68 бічних цефалометричних рентгенограм.

Результати. Цефалометричний аналіз за методом Perillo-ID на 68 бічних цефалограмах у дітей 7-12 років показав широкий діапазон варіабельності форм неправильного прикусу по II класу за Енглем. Результати семи кутових та чотирьох лінійних параметрів дозволили створити класифікацію форм неправильного прикусу II класу за Енглем з урахуванням положення і розміру нижньої щелепи у дітей у періоді змішаного прикусу.

Висновки. Автори модифікували цефалометричний аналіз Perillo , що дозволило створити детальну класифікацію форм неправильного прикусу II класу за Енглем у дітей в період змішаного прикусу. Нова класифікація дозволить чітко диференціювати етіологію неправильного прикусу, диференціювати справжній недорозвиток нижньої щелепи від її ретропозиції або ротації.

Заява про конфлікт інтересів
Цим автори підтверджують відсутність зв’язку з будь-якою організацією чи компанією, яка може мати будь-який фінансовий або нефінансовий інтерес до матеріалів дослідження, розглянутого в цій статті.

Заява про фінансування
Не було отримано жодного фінансування для допомоги в підготовці та проведенні цього дослідження, а також для написанні цієї статті.

https://doi.org/10.56569/UDJ.1.1.2022.49-55