Uniwersytet Medyczny
im. Piastów Śląskich we Wrocławiu

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Ocena morfologii twarzoczaszki i dysfunkcji ustno-twarzowych w wybranych wrodzonych wadach części twarzowej czaszki

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„Ocena morfologii twarzoczaszki i dysfunkcji ustno – twarzowych w wybranych wrodzonych wadach części twarzowej czaszki.”

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za zaangażowanie w badania naukowe, nieustające wsparcie oraz merytoryczną, czynną pomoc w pisaniu i publikacji prac.

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Drogi synu, mężu, drodzy rodzice – to Wam dedykuję mój doktorat.

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Wstęp

Zespół Downa (ZD) jest najczęściej rozpoznawanym zaburzeniem chromosomalnym wśród noworodków. Jednocześnie jest jedną z najczęstszych przyczyn niepełnosprawności intelektualnej. U pacjentów z ZD częściej niż statystycznie stwierdza się choroby serca, chorobę Alzheimera, białaczkę, nowotwory i chorobę Hirschprunga[1]. W latach 40- stych ubiegłego wieku średnia długość życia pacjentów z trisomią chromosomu 21 wynosiła 12 lat[2]. Obecnie w krajach rozwiniętych średnia długość życia populacji z ZD wynosi 55 lat[3]. Znaczne wydłużenie średniej długości życia jest efektem przeprowadzonych badań naukowych i rozpowszechnienia uzyskanych wyników i wniosków, wprowadzenia terapii w pierwszych latach życia, poszerzonej diagnostyki i postępu w medycynie. Z drugiej strony – pacjenci z Zespołem Downa stają się populacją starzejącą, przez co obecne prace naukowe dotyczą chorób i nieprawidłowości, na które narażeni są oni w dorosłym życiu. Jest to m.in. związane z wiekiem zwiększone ryzyko wystąpienia demencji, zmian skórnych, wczesnej menopauzy, upośledzenia wzroku i słuchu, zaburzeń napadowych u dorosłych, dysfunkcji tarczycy, cukrzycy, otyłości, bezdechu sennego i problemów z układem mięśniowo-szkieletowym[4]. Postawiono również nacisk na aspekty, które wpływają na jakość ich życia. W obrębie twarzoczaszki występują nieprawidłowości, które nieleczone mogą doprowadzić do zaburzonej mowy, problemów z przełykaniem, deformacji żuchwy, zaburzeń zgryzu, a nawet niedrożności dróg oddechowych. Tematyka ta została opisana w pierwszej z prac.

Drugą grupą pacjentów, która została włączona do badań stanowią pacjenci z rozszczepem wargi lub wargi i podniebienia. Literatura podaje, że rozszczep ustno-twarzowy jest najczęstszą wrodzoną wadą rozwojową[5]. Około 50% wszystkich rozszczepów to rozszczepy wargi i podniebienia, 25-35% dotyczy tylko wargi[6]. Obecność rozszczepu wpływa na nieprawidłowości w obrębie uzębienia, tj. występowanie hipodoncji, mikrodoncji, taurodontyzmu i transpozycji zębów[7]. Poza tym występują problemy z mową, słuchem, karmieniem. Zaburzenia mowy u pacjentów z rozszczepem obejmują opóźniony rozwój mowy, zaburzenia artykulacji i dysfonię. Często występuje refluks płynów i pokarmów, a połykanie jest utrudnione[8]. Dużym problemem w tej grupie pacjentów pozostaje jakość życia z uwzględnieniem aspektów psychospołecznych. Chcąc sprawdzić, które parametry jakości życia pozostają obniżone oraz jakie pomiary cefalometryczne są najbardziej zaburzone, przeprowadzono dwa badania, które włączono do rozprawy. Pierwsze z nich, dotyczące jakości życia pacjentów z UCLP stanowi pierwszą publikację, która obejmuje polską

populację z wykorzystaniem kwestionariusza NOT-S. W ostatniej z prac położono nacisk na zbadanie wpływu operacji podniebienia na morfologię twarzoczaszki. Oceniono również wybrane parametry analizy cefalometrycznej.

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Cele pracy

Celem pierwszej pracy **“Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review”** była analiza cech morfologicznych u osób z zespołem Downa tj.: podniebienia, wad zębowych, wad szkieletowych, hipotonii mięśniowej, zaburzeń w obrębie stawu skroniowo- żuchwowego, wielkości języka na podstawie przeglądu aktualnej literatury popularnonaukowej.

Celem drugiej pracy **„Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: a preliminary report”** była ocena dysfunkcji ustno - twarzowych u dzieci z jednostronnym rozszczepem wargi i podniebienia w porównaniu z grupą kontrolną oraz ocena jakości ich życia na podstawie kwestionariusza NOT-S.

Celem trzeciej pracy **“Impact of Cleft Palate Anastomosis in Cleft Lip and Palate Patients with Coexisting Cleft Lip Anastomosis Scar Based on Cephalometric Measurements”** było przeprowadzenie analizy cefalometrycznej u pacjentów z rozszczepem wargi oraz z rozszczepem wargi i podniebienia. Praca naukowa obejmowała zbadanie wpływu operacji podniebienia na morfologię twarzoczaszki przy współistniejącej bliźnie po operacji złączenia rozszczepu warg oraz porównanie w odniesieniu do pacjentów, u których występowała wyłącznie blizna po złączeniu rozszczepu warg.

Streszczenie

W pierwszej pracy “Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review” opisane zostały nieprawidłowości oraz cechy charakterystyczne występujące w trisomii 21, które znacznie wpływają na funkcjonowanie narządu żucia. Do najbardziej istotnych zaburzeń należą: makroglosja rzekoma, hipotonia mięśniowa, podniebienie gotyckie.
Przeprowadzono analizę cech morfologicznych twarzoczaszki u osób z zespołem Downa na podstawie przeglądu aktualnego piśmiennictwa. Do analizy użyto baz danych: Pubmed, Scopus, Infona, Dentistry&Oral Sciences Source. Przeanalizowano 199 pozycji piśmiennictwa, do analizy włączono 11 artykułów dotyczących dzieci i dorosłych z zespołem Downa. Uwzględniono budowę podniebienia, wady zębowe i szkieletowe, wielkość języka, hipotonię mięśniową oraz dysfunkcję stawów skroniowo-żuchwowych.

Druga i trzecia praca dotyczą pacjentów z rozszczepem wargi lub rozszczepem wargi i podniebienia. Rozszczep jest wadą rozwojową twarzy o wieloczynnikowej etiologii, która obejmuje czynniki genetyczne i środowiskowe. Przerwanie ciągłości tkanek w jamie ustnej i nosowej niewątpliwie upośledza podstawowe funkcje fizjologiczne. Wpływa to negatywnie na jakość życia pacjentów.

W drugiej pracy “Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: a preliminary report” grupę badaną stanowili pacjenci z rozszczepem wargi i podniebienia (UCLP, n=35), grupa kontrolna dopasowana została pod kątem wieku i płci (n=35). W badaniu wzięły udział dzieci w wieku 7-13 lat. Wykorzystano kwestionariusz NOT-S, który składa się z dwóch części: wywiadu i badania, z których każda obejmuje sześć domen.
W wywiadzie NOT-S istotnie statystycznie częściej w grupie badanej występowały zaburzenia funkcji takich jak: oddychanie, żucie i połykanie, ślinienie się i suchość w jamie ustnej, natomiast w badaniu NOT-S nieprawidłowości dotyczyły domen: twarz w spoczynku, wyraz twarzy, mowa. Porównując NOT-S Total score, stwierdzono, że w grupie badanej statystycznie istotnie częściej niż w grupie kontrolnej występowały zaburzenia co najmniej jednej funkcji. Średnie wyniki w grupie badanej były o 3,7 punktu wyższe niż w grupie kontrolnej.

W trzeciej pracy „Impact of Cleft Palate Anastomosis in Cleft Lip and Palate Patients with Coexisting Cleft Lip Anastomosis Scar Based on Cephalometric Measurements" poddano analizie zdjęcia cefalometryczne pacjentów z jednostronnym rozszczepem wargi i podniebienia (UCLP, n = 30) oraz pacjentów z jednostronnym rozszczepem wargi (UCL, n = 30). Wszystkie zdjęcia cefalometryczne zostały zapisane elektronicznie i poddane analizie przez jednego autora tego badania. Analizę cefalometryczną wykonano za pomocą Webceph. Wszystkie punkty cefalometryczne zostały wprowadzone manualnie przez autorów.

W artykule omówione zostały wyniki analiz cefalometrycznych, z uwzględnieniem komponent, które wpływają na nagryz pionowy oraz nagryz poziomy. Porównano uzyskane wyniki w dwóch grupach w celu oceny wpływu operacji zespolenia rozszczepu podniebienia na morfologię twarzoczaszki przy współistniejącej bliźnie po zespoleniu rozszczepu wargi w porównaniu do pacjentów, u których występowała tylko blizna po zespoleniu rozszczepu wargi.

Wyniki ukazują istotnie wyższy stopień prognacji szczęki (SNA) występujący w grupie pacjentów z rozszczepem wargi w porównaniu do grupy pacjentów z rozszczepu wargi i podniebienia. U pacjentów z UCLP i UCL średnie wartości kąta ANB, który opisuje położenie żuchwy w relacji do szczęki były zmniejszone. W obu grupach przedstawiono retroklinację górnych siekaczy. Zaobserwowano doprzednie ułożenie górnej wargi w stosunku do linii estetycznej E u pacjentów z rozszczepem wargi.

Summary

The first paper "Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review" describes the abnormalities and characteristics present in trisomy 21 that significantly affect the function of the masticatory organ. The most significant abnormalities include pseudomacroglossia, muscular hypotonia, and gothic palate.
An analysis of craniofacial morphological features in individuals with Down syndrome was performed based on a review of the current literature. Databases used for the analysis were: Pubmed, Scopus, Infona, Dentistry&Oral Sciences Source. A total of 199 literature items were analyzed, 11 articles on children and adults with Down syndrome were included in the analysis. Palatal structure, dental and skeletal defects, tongue size, muscular hypotonia, and temporomandibular joint dysfunction were included.

The second and third papers deal with patients with cleft lip or cleft lip and palate. Cleft is a facial malformation with a multifactorial etiology that includes genetic and environmental factors. The disruption of tissue continuity in the oral and nasal cavities undoubtedly impairs basic physiological functions. It adversely affects the quality of life of patients.

In the second study "Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: A preliminary report" the study group consisted of patients with cleft lip and palate (UCLP, n=35), the control group was matched for age and gender (n=35). Children aged 7-13 years participated in the study. The NOT-S questionnaire was used, which consists of two parts: interview and survey, each covering six domains.
In the NOT-S interview, abnormalities of functions such as breathing, chewing and swallowing, drooling and dry mouth were statistically significantly more frequent in the study group, while in the NOT-S examination, abnormalities concerned the domains: face at rest, facial expression, speech. Comparing NOT-S Total score, it was found that the study group had statistically significantly more frequent abnormalities of at least one function than the control group. Mean scores in the study group were 3.7 points higher than in the control group.

In the third study, "Impact of Cleft Palate Anastomosis in Cleft Lip and Palate Patients with Coexisting Cleft Lip Anastomosis Scar Based on Cephalometric Measurements," cephalometric photographs of patients with unilateral cleft lip and palate (UCLP, n = 30) and patients with unilateral cleft lip (UCL, n = 30) were analyzed. All cephalometric images were electronically stored and analyzed by a single author of this study. Cephalometric analysis was performed using the Webceph. All cephalometric points were manually entered by the authors.

This paper discusses the results of the cephalometric analyses, including the components that affect overbite and overjet. The results were compared between two groups to evaluate the effect of cleft palate fusion surgery on craniofacial morphology with a concomitant cleft lip fusion scar compared to patients with only a cleft lip fusion scar.

The results show a significantly higher degree of jaw prognathism (SNA) occurring in the cleft lip group compared to the cleft lip and palate group. The mean values of the ANB angle, which describes the position of the mandible in relation to the maxilla, were decreased in UCLP and UCL patients. Retroclination of the upper incisors was presented in both groups. An anterior position of the upper lip in relation to the E aesthetic line was observed in patients with cleft lip.

Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation;
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Abstract

Down syndrome (DS) is the most often diagnosed chromosomal disorder in newborns. The incidence is 1:792 live births. The article describes the irregularities and characteristics found in trisomy 21, which greatly affect the functioning of the stomatognathic system. The most significant disorders include the following: false macroglossia, muscular hypotonia and gothic palate. These abnormalities affect articulation, breathing, food intake, and swallowing. We analyzed the morphological characteristics of the craniofacial region in children with DS based on the current literature review. The following databases were used for the analysis: MEDLINE (via PubMed), Scopus, Infona, and Dentistry & Oral Sciences Source. In the course of the study, 199 pieces of literature were analyzed; the analysis also included 18 articles on children and adults with DS. It also took into account the structure of the palate, dental and skeletal defects, size of the tongue, muscular hypotonia, and temporomandibular joint dysfunction. Down syndrome is still a current subject of research. Although macroglossia, hypotonia, malocclusion, and temporomandibular joint abnormalities are not features exclusive to DS, numerous dysfunctions and parafunctions as well as retarded psychomotor development greatly complicate the treatment. Therefore, interdisciplinary treatment of patients with trisomy 21 and early treatment in the first months of life with the use of the Castillo-Morales plate are very important, as they ensure better adaptation to the subsequently used apparatus and reduce the risk of disorders of the stomatognathic system.

Key words: Down syndrome, hypotonia, dental defects, false macroglossia, Castillo-Morales plate

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Down syndrome (DS) was named after John Langdon Down, a British doctor who first described its features in 1866. In 1959, a French doctor Jerome Lejuene identified the cause of this anomaly. The estimated incidence is 1:792 live births.[1] The disorders in persons with DS include mental retardation, unfused lumbar vertebral arches and heart defects, among others.

The facial skeleton and neurocranium include hypoplastic mandible[2] with reduced nasolabial angle, reduced dimensions of the permanent teeth[3] and more frequent occurrence of periodontal diseases as compared to the neurotypical group.[4] Malocclusion resulting from vertical and transverse irregularities of the dental arches is more frequent in patients with trisomy 21.[5] This affects, among others, the demastication and texture of food, swallowing, articulation, and breathing. The abovementioned features are not pathognomonic symptoms.

Orthodontic abnormalities require early treatment of people with trisomy 21. It is mainly conditioned by macroglossia and reduced volume of the palate. These features along with retarded psychosomatic development and muscular hypotonia lead to the occurrence of parafunctions and dysfunctions, which in turn affect the frequency of malocclusions in this group of people. The most clearly marked defect is skeletal class III, which is more severe in older age groups. This affects the lengthening of the lower part of the face and irregularities in the proportions of the facial skeleton.[6]

Muscular hypotonia is characteristic of trisomy 21. Most commonly, it affects the tongue and lips, which is visible on physical examination. Muscles lifting the mandible show different degrees of muscular insufficiency, but in the case of bruxism, severe hypotonia of the masseter muscles can be observed.[7]

The objective of this paper was to analyze the morphological characteristics of persons with DS, i.e., the palate, dental defects, skeletal defects, muscular hypotonia, temporomandibular joint abnormalities, and size of the tongue.

Material and methods

Non-randomized controlled trials (NRCT), systematic reviews (SR) and case series (CS) with sample sizes of 16 or more patients published since 1986, without any restriction in language or publication status, were eligible for inclusion in this review and were considered in our study. Children and adults with DS were matched in terms of age and gender with patients without DS. There was no restriction for the presenting malocclusion, indication for treatment or type of orthodontic treatment undertaken. Studies that investigated malocclusion, temporomandibular joints, measurement macroglossia, hypotonia, and hard palate were reviewed.

Comparison of the outcomes between 2 groups was performed: 1st group – patients with DS; 2nd group – patients without DS. All of the following symptoms were taken into consideration: tongue thrusting, abnormal breathing, eating disorders, lisping, and infantile swallowing.

The following databases were searched from January 24, 2018 to February 12, 2018:
– MEDLINE (via Pubmed),
– Scopus,
– Infona,
– and Dentistry & Oral Sciences Source,
using the following Medical Subject Heading terms:
– Down syndrome,
– dental defects,
– trisomy,
– hypotonia,
– malocclusion,
– macroglossia,
– Castillo-Morales.

The search strategy for PubMed is presented in Table 1. At first, the potentially appropriate studies were identified

Table 1. Search strategy

PubMed/MEDLINE, Scopus, Infona, Dentistry & Oral Sciences Source		
Search No.	Search	
1.	((Down syndrome) AND hypotonia)	185
2.	((Down syndrome) AND macroglossia) AND hypotonia	6
3.	(((trisomy) AND dental defects) OR malocclusion) AND Castillo-Morales	1
4.	((Down syndrome) AND hypotonia) AND malocclusion	1
5.	(Castillo-Morales) AND hypotonia	6

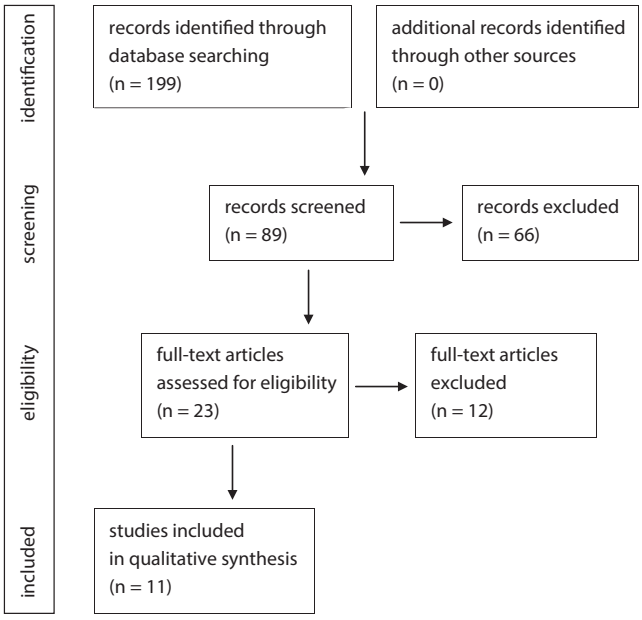

Fig. 1. Flow diagram showing the screening of studies in this systematic review

by title; subsequently, the abstracts were read and the irrelevant studies were rejected. Data was extracted with reference to the participants, age, methods, and outcomes.

Results

The abovementioned irregularities indicate the need for complex therapy in the oral cavity. Castillo-Morales proposed a treatment for people with, i.a., muscular hypotonia and macroglossia.[12] The protocol takes into account the simulating and acrylic plate, i.e., braces with a component aimed at verticalization of the tongue in the back. It is important to start the treatment early (2–3 months of age) as it reduces the negative impact on the psychosomatic development within the oral cavity. The authors refer readers who want to familiarize themselves with the above method of treatment to the article about Castillo-Morales protocol.[12]

Tables 2–5 set forth the results of the analysis of the material contained in the articles selected in accordance with the search strategy described in the Materials and Methods section.

Discussion

Macroglossia occurs when a tongue at rest goes beyond the dental arches or alveolar process and the alveolar part of the mandible, as in the case of edentulism. This abnormality occurs, i.a., in hypothyroidism, amyloidosis, Beckwith–Wiedemann syndrome, and DS.[16] There are no clear figures that would indicate macroglossia. The division comprising the true and false form of this abnormality[17] was created with regard to symptomatic treatment. Patients with DS[11] have a smaller tongue (2.432 mm^2) compared to that of the control group (2.767 mm^2). The dimensions of the facial skeleton are also reduced, but the size of the tongue compared to bone parameters remains greater (0.54) than that of the 2nd group (0.46). Therefore, in the case of trisomy 21, false macroglossia occurs.

The potential complications of this anomaly include impaired speech, deformed mandible, malocclusion, or even airway obstruction, which is why it is important to start treatment early. The therapy includes exercise and the use of appliances which expand the dimensions of the oral cavity and (in a modified version) allow the tongue to be kept behind the dental arches. The most aggressive form of treatment is surgical treatment.

Another analyzed feature is the palate.[13] Patients with DS show decreased growth and volume of the palate in the first months of life by approx. 151 days as compared to the neurotypical population, but the analyzed parameters (width and depth) remain unchanged with regard to persons with no genetic predispositions. People aged 10–40 years with DS have narrower palates, but the antero-posterior dimensions and height are similar.[9] Detailed studies[10] analyzed the antero-posterior length, height and volume of the hard palate as well as the size of the dental arches. The results (48 people in the study group and 48 people in the control group at the age of 6–16 years) revealed that the palate was significantly higher in patients with DS, and all other parameters were significantly lower than in the control group. Therefore, it should be concluded that narrowed gothic palate frequently occurring in older children is an acquired feature resulting from other irregularities. One of them is the aforementioned macroglossia. The results of these studies are inconclusive

Table 2. Analysis of the materials contained in the articles

Author (year)	Study	Participants	Methods of outcomes	Results include	Conclusions
Abeleira et al.[8] (2014)	NRCT	SG: 40 patients with DS; age: 10–40 years; sex: 25 M, 15 F CG: age- and sex-matched persons were selected	CBCT images Measurement of: – overall tooth length – crown height – root length – mesiodistal diameter – vestibular-palatine diameter – crown-to-root ratio – cervical circumference	✓ dental defects o hypotonia o malocclusion o palate o tongue ✓ skeletal defects o temporomandibular joints	Microdontia of the permanent teeth and progressive age-related reductions in tooth sizes in persons with DS.
Abeleira et al.[9] (2015)	NRCT	SG: 40 patients with DS, age: 10–40 years; sex: 25 M, 15 F CG: 40 age- and sex-matched persons were selected	CBCT images Measurements of: – anteroposterior length (aAPL) – arch length – anteroposterior length – maximum height – sagittal arch – interdental width – height – skeletal width – coronal arch	o dental defects o hypotonia o malocclusion ✓ palate o tongue ✓ skeletal defects o temporomandibular joints	Interdental and skeletal widths were greater in controls than in DS statistically significant differences between males and females with DS.

SG – study group; CG – control group; F – female; M – male; DS – Down syndrome; CBCT – cone-beam computed tomography; NRCT – non-randomized controlled trial; ✓ – included in research; o – not included in research.

Table 3. Analysis of the materials contained in the articles

Author (year)	Study	Participants	Methods of outcomes	Results include	Conclusions
Allareddy et al.[6] (2016)	CS	27 children and young adults with DS; age: 3–25 years	Analysis of lateral cephalometric radiographs	o dental defects o hypotonia ✓ malocclusion ✓ palate o tongue ✓ skeletal defects o temporomandibular joints	Patients with DS typically show skeletal class III malocclusion.
Bhagyalakshmi et al.[10] (2007)	NRCT	SG: 48 children with DS; sex: 26 M, 22 F CG: 48 children without DS; sex: 26 M, 22 F	Electronic calipers, scale, divider, dental impression material, impression trays, plaster stone, casting tray The parameters measured were: • linear width • curvilinear width • mean height • palatal arch length • anteroposterior length • volume • palatal index	o dental defects o hypotonia o malocclusion ✓ palate o tongue ✓ skeletal defects o temporomandibular joints	The hard palate in children with DS was found to be high-arched and narrow, with acutely aligned palatine plates.
Guimaraes et al.[11] (2008)	NRCT	CG: 16 patients with DS CG: 16 age- and gender-matched controls	On sagittal and axial MR images, parameters for tongue size the bony craniofacial confines of the retroglossal pharynx, the size of the tongue relative to the craniofacial bony parameters.	o dental defects o hypotonia o malocclusion o palate ✓ tongue ✓ skeletal defects o temporomandibular joints	Children with DS do not have true macroglossia but have relatively large tongues compared to the bony confines of the oral cavity.

SG – study group; CG – control group; F – female; M – male; DS – Down syndrome; NRCT – non-randomized controlled trial; CS – case series; SR – systematic review; MR – magnetic resonance; ✓ – included in research; o – not included in research.

Table 4. Analysis of the materials contained in the articles

Author (year)	Study	Participants	Methods of outcomes	Results include	Conclusions
Klimek-Jaworska et al.[12] (2014)	SR	SG(I): 57 children 2 months–3 years of age; SG(II): 50 children 3 months–5 years of age	• Reduction in the severity of the orbicularis oris muscle hypotonia • tongue position, lip closure and facial expression	o dental defects ✓ hypotonia o malocclusion o palate ✓ tongue o skeletal defects o temporomandibular joints	An early implementation of such therapy facilitates the optimal development of motor functions of the orofacial complex.
Klingel et al.[13] (2017)	NRCT	SG: 40 patients with DS; age: 221.3 ±132.4 days; sex: 20 F, 20 M CG: 40 infants; age: 53.9 ±87.2 days; sex: 20 M, 20 F	Width, depth and length of the palate were used as well as the palatal index and 3-dimensional volume.	o dental defects o hypotonia o malocclusion ✓ palate o tongue ✓ skeletal defects o temporomandibular joints	The palate of DS infants in the first 6 to 9 months of life is normally shaped but considerably smaller compared to healthy individuals.
Nęcka et al.[7] (2007)	NRCT	SG: 22 patients with DS CG: 23 persons with hypotonia	Electromyography of mimic and mastication muscles tone	o dental defects ✓ hypotonia o malocclusion o palate o tongue o skeletal defects o temporomandibular joints	No significant differences between the tonus of temporal and masticatory muscles of people suffering from DS; no statistically significant differences were observed during the orbicular muscles examination.

SG – study group; CG – control group; F – female; M – male; DS – Down syndrome; NRCT – non-randomized controlled trial; SR – systematic review; ✓ – included in research; o – not included in research.

as to the reduced parameters of the palate, but all results point to the reduction of its volume. Considering the determinants of development, which include environmental impact, quality of life, lifestyle, and national differences, it should be noted that the narrow gothic palate often found in older children is an acquired feature. This causes disorders, the most serious of which is hypoxia.

People with trisomy 21 often have disorders of the stomatognathic system. These include the following: hypoplasia, diastema, mandibular prognathism, anterior open bite,

Table 5. Analysis of the materials contained in the articles

Author (year)	Study	Participants	Methods of outcomes	Results include	Conclusions
Oliveira et al.[5] (2008)	CS	112 pairs of mothers and their children with DS; age: 3–18 years	Data was collected with a questionnaire given to the mothers and through a clinical examination of the child or adolescent. Univariate, bivariate and multiple logistic regression (backward stepwise) analyses were conducted.	o dental defects o hypotonia ✓ malocclusion o palate o tongue ✓ skeletal defects o temporomandibular joints	Age, nail or finger biting, mouth posture, and upper airway infections were associated with malocclusions in these patients.
Salazar et al.[14] (2016)	CS	40 patients with DS	temporomandibular joint examination	o dental defects o hypotonia o malocclusion o palate o tongue o skeletal defects ✓ temporomandibular joints	The relationship between habits and pain in people with DS.
Tosello et al.[15] (2002)	NRCT	18 children; age: 8–12 years; divided into 3 groups: 1. normal occlusion 2. class II division 1 3. atypical swallowing and/or incompetent lips	electromyographically in resting position and in several movements	o dental defects ✓ hypotonia ✓ malocclusion o palate o tongue ✓ skeletal defects o temporomandibular joints	The 3rd group showed very marked activity of the lower orbicularis oris and mentalis muscles.

DS – Down syndrome; NRCT – non-randomized controlled trial; CS – case series; ✓ – included in research, o – not included in research.

lip incompetence, and deepened overbite. Temporomandibular joint dysfunction in patients with DS was found in 77.5% of patients.[14] Malocclusion occurred in 66% of patients,[18] with the dominance of skeletal class III defects. Taking into account the cephalometric analysis,[6] it is dominated by the skeletal class III and increased proportion of the lower part of the face with regard to the overall height, wherein the skeletal class III is more clearly indicated in the older age groups. Analysis of incisors,[8] canines and first molars, i.e., the length of the tooth, crown height and root length, tooth neck perimeter, mesiodistal width, buccolingual dimension, and the ratio between the crown height and root length, with the use of computed tomography, draws attention to the reduction in tooth dimensions while the ratio between the crown height and root length is maintained; no sexual dimorphism was found (only the length of the roots of the incisors remains greater in men). Crown height, mesiodistal diameter and the ratio between the crown and the root gradually decrease with age. This confirms microdontia in patients with trisomy 21.

Muscular hypotonia in persons with DS affects the whole organism. An analysis[7] of temporal muscles (L/R) (L = left, R = right), masseter muscles (L/R) and orbicularis oris muscles with the use of an electromyograph during various physiological functions, i.e., swallowing, chewing, rest position of the mandible, position of the lips as for whistling, maximum intercuspation, indicates significantly higher tension of the orbicularis oris muscle in children with DS compared to the neurotypical group and no statistical differences for the temporal and masseter muscles. At the same time, during the physical examination, insufficiency of the orbicularis oris muscle is clearly expressed, which is contrary to the electromyography (EMG) indication. Careful analysis reveals an increase in the tension of the orbicularis oris muscle when the lips are positioned for whistling, while higher signals on the measuring device result from the conscious tightening of muscles by the patient.

Comparing this data with the results of studies on 3 groups[15]:

1. persons with malocclusions,
2. persons with persistent visceral swallowing,
3. persons with lip incompetence,

who did not undergo orthodontic treatment, in the case of joined lips, the EMG shows higher muscle potential in group 3 and high muscle activity while sucking a lollipop, with no differences between the subgroups while sucking a dummy, a straw or a thumb. This indicates a conscious tightening of fibers, which confirms the abovementioned data.

Conclusions

People with DS have different craniofacial morphology. The treatment plan should take into account the occurrence of false macroglossia, dental irregularities, hypoplasia, and diastema. A well-arched gothic palate is an acquired feature, thus orthodontic activities should prevent the development of this anomaly. Attention should be paid to the reduced tension of the orbicularis oris muscle, which, in conjunction with false macroglossia, affects the incidence of anterior open bite.

Although macroglossia, hypotonia, malocclusion, and temporomandibular joint abnormalities are not features exclusive to DS, numerous dysfunctions and parafunctions as well as retarded psychomotor development greatly complicate the treatment. Therefore, interdisciplinary

treatment of patients with trisomy 21 and early treatment in the first months of life with the use of the Castillo-Morales plate are very important, as they ensure better adaptation to the subsequently used apparatus and reduce the risk of disorders of the stomatognathic system in the future.

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Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: A preliminary report

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Abstract

Background. Cleft lip and palate (CLP) is a genetic and environmental malformation of the face. The resulting interruption of the tissue in the mouth and nasal cavity undoubtedly impairs basic physiological functions, which impacts the quality of life (QoI) of such patients.

Objectives. To assess orofacial dysfunction using the Nordic Orofacial Test-Screening (NOT-S) in a group of Polish children with unilateral CLP (UCLP). The following hypotheses were presented: 1) orofacial dysfunction is more common in children with UCLP and 2) patients with UCLP have a worse QoL than the control group.

Material and methods. Seventy children at the age of 7–13 years took part in the study. The inclusion criterion was a diagnosis of UCLP. The control group (non-UCLP) was matched by gender and age to the cleft group. The research used the NOT-S questionnaire.

Results. In the cleft group, there were statistically significantly more disorders of functions, such as breathing, chewing and swallowing, and drooling; in the NOT-S examination, there were more disorders of the face at rest, facial expression and speech in the cleft group. Comparing the NOT-S total scores, it was found that in the cleft group, there a disorder of at least 1 function was statistically significantly more prevalent than in the control group. Likewise, the median results in the cleft group were 3 points higher than in the control group.

Conclusions. Using the NOT-S survey, it was possible to confirm both hypotheses. Orofacial dysfunction is more common in children with UCLP and this contributes to a worse QoL for them than for children without UCLP.

Key words: quality of life, orthodontics, cleft and lip palate, NOT-S questionnaire

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Introduction

Cleft lip and palate (CLP) is a genetic and environmental face malformation.[1] According to WHO data, it occurs once per approx. 1,100 births around the world.[2] Facial deformities include a disruption of soft and hard tissues, and asymmetry. Scientific studies have shown that asymmetry is present not only in the maxilla, but can also apply to the orbital, zygomatic and frontal bones.[3] Dental anomalies among these patients include hypodontia, supernumerary teeth, microdontia, taurodontism, and transposition of teeth,[4] while occlusal disorders are most often cross-bite and class III malocclusion.[5]

There is no doubt that the abovementioned abnormalities affect speech, articulation, chewing, nose function, and facial appearance.[6] In addition, patients with CLP significantly suffer from otitis media.[7] Speech disorders of people with CLP include delayed speech development, articulation disorders and dysphonia. Moreover, in some cases, fluid and food refluxes often occur and swallowing is difficult.[8] However, it should be noted that the negative impact of CLP mainly concerns psychosocial problems.[9]

The amount of research conducted around the world shows that there is an interest in the quality of life (QoL) of patients with CLP. Researchers from Brazil have proven that the effect of CLP on QoL increases with age.[10] Studies conducted in Iran showed that the biggest difference compared to the control group was in difficulty pronouncing words and that the impact on QoL also concerned the patients' families, emphasizing mainly the financial aspect and parental stress.[11] A survey of CLP patients in the Netherlands, on the other hand, showed that gender does not affect QoL among this group.[12] Furthermore, studies in Switzerland involving patients with unilateral CLP (UCLP) showed a worse sleep pattern than in patients without the disorder; it was emphasized, however, that this is not due to CLP, but to psychosocial loads.[13]

Despite the fact that the QoL of people with cleft lips and palates has been studied for many years, there is no standardized test for its assessment. As a result, researchers evaluate various aspects of life and activities in society and use a variety of questions. One such tool is the Nordic Orofacial Test-Screening (NOT-S) survey.[14] The NOT-S has been used to assess the QoL of people with cleft palates,[15] cerebral palsy[16] or ectodermal dysplasia[17] since 2007.

We conducted a survey among the Polish population to study the QoL of patients with UCLP in comparison with a control group. This is the first study to use the NOT-S questionnaire in Poland.

The following hypotheses were proposed:

1. Orofacial dysfunction is more common in children with UCLP.
2. Patients with UCLP have a worse QoL than the control group.

Material and methods

Material

This study was conducted in full accordance with the World Medical Association Declaration of Helsinki and was approved by the Ethics Committee of the Wroclaw Medical University, Poland.

The cleft group (n = 35) comprised of patients of the Department of Maxillofacial Orthopedics and Orthodontics of the Division of Facial Abnormalities at the Wroclaw Medical University. The inclusion criteria were a diagnosis of UCLP (diagnosis code Q37.1 of the ICD10) and an age of 7–13 years. The exclusion criteria were mental retardation, being under 7 or over 13 years of age, and missing teeth not related to tooth replacement. The age of the cleft group was between 7 and 13 years. Before conducting the study, legal guardians were informed about it and were assured about the confidentiality of the data of the children.

The control group, without a diagnosis of CLP (n = 35) and matched in terms of sex and age to the cleft group, were patients of the Division of Maxillofacial Orthopedics and Orthodontics at the Wroclaw Medical University.

Methods

The study used the NOT-S survey after it was translated into Polish by the researchers. The children were examined by the same trained examiner according to the same protocol. Each survey contained data on age, gender, diagnostic code (ICD-10), examination position, and position of the head when seated. The interview reflected 6 domains: I) sensory function, II) breathing, III) habits, IV) chewing and swallowing, V) drooling, and VI) dryness of the mouth. The examination contains sections: 1) the face at rest and tasks regarding 2) nose breathing, 3) facial expression, 4) masticatory muscle and jaw function, 5) oral motor function, and 6) speech. Each of these domains contains from 1 to 5 components for which the patients' responses or examination results were recorded: X = yes, 0 = no, or (–) = not assessed. If there was 1 or more X answers in a section, the researchers placed a score of 1 in the domain. The results were recorded at the time the survey was conducted on pre-printed NOT-S forms. The total possible NOT-S score ranges from 0 to 12 points. The higher the score, the more severe the orofacial dysfunction and the worse the QoL.

Statistical analysis

Statistical analysis was performed using STATISTICA v. 13 (StatSoft Inc., Tulsa, USA). For measurable variables, the mean, median (Me), upper and lower quartile, and range of variability (extreme values – minimum (Min) and maximum (Max)) were calculated. The frequency

of occurrence (percent) was calculated for qualitative variables. All quantitative variables were checked with the Shapiro–Wilk test to determine the type of distribution. The qualitative variables between groups (cleft compared to the control) were compared using the two-tailed Fisher's exact test. The quantitative variables between groups were compared using the Mann–Whitney U test. The level of $\alpha = 0.05$ was used for all comparisons.

Results

Table 1 presents a comparison of the frequency of a particular function based on the NOT-S between the cleft group (n = 35) and the control group (n = 35). The 1st part presents the results from the 6 sections assessed with NOT-S interviews: sensory functions, breathing, habits, chewing and swallowing, drooling, and dryness of the mouth. The 2nd part contains the results from the 6 NOT-S examination sections: face at rest, nose breathing, facial expression, masticatory muscle and jaw function, oral motor function, and speech. The 3rd part is the summary of the entire test (NOT-S total score).

In the NOT-S interview, it was observed that disorders of functions such as breathing, drooling, chewing, and swallowing were statistically significantly more prevalent in the cleft group. In the cleft group, breathing disorders were found in almost 46% (n = 16) of the study participants, while in the control group, this figure was 11.4 (n = 4; p = 0.003). Disorders of the next 2 functions were also more common in the cleft group: disorders of chewing and swallowing function were noted in 51.4% of patients (n = 18 compared to the control group: 8.6%; n = 3; p < 0.001), and drooling in 25.7% (n = 9 compared to the control group: 2.9%; n = 1; p = 0.013). In addition, the summaries of the interview part were compared. The number

Table 1. Comparison of the frequency of selected function disorders based on NOT-S between the cleft group and the control group

Nordic Orofacial Test		Cleft group (n = 35)		Control group (n = 35)		p-value*
		n	%	n	%	
I. NOT-S interview						
Sensory function	0 1	32 3	91.4 8.6	35 –	100 –	0.23
Breathing	0 1	19 16	54.3 45.7	31 4	88.6 11.4	0.003
Habits	0 1	17 18	48.6 51.4	25 10	71.4 28.6	0.087
Chewing and swallowing	0 1	17 18	48.6 51.4	32 3	91.4 8.6	<0.001
Drooling	0 1	26 9	74.3 25.7	34 1	97.1 2.9	0.013
Dryness of the mouth	0 1	25 10	71.4 28.6	32 3	91.4 8.6	0.062
NOT-S interview – total score	0 ≥1	2 33	5.7 94.3	16 19	45.7 54.3	<0.001
II. NOT-S examination						
Face at rest	0 1	12 23	34.3 65.7	31 4	88.6 11.4	<0.001
Nose breathing	0 1	32 3	91.4 8.6	35 –	100 –	0.24
Facial expression	0 1	5 30	14.3 85.7	34 1	97.1 2.9	<0.001
Masticatory muscle and jaw function	0 1	33 2	94.3 5.7	35 –	100 –	0.49
Oral motor function	0 1	33 2	94.3 5.7	35 –	100 –	0.49
Speech	0 1	10 25	28.6 71.4	32 3	91.4 8.6	<0.001
NOT-S examination – total score	0 ≥1	0 35	0 100	27 8	77.1 22.9	<0.001
III. NOT-S – Total score						
Total score	0 ≥1	0 35	0 100	11 24	31.4 68.6	<0.001

NOT-S – Nordic Orofacial Test-Screening; 0 – non-affected; 1 – affected; n – number of participants; *two-tailed Fisher's exact test.

Table 2. Comparison of the total results of NOT-S between the cleft group and the control group

Nordic Orofacial Test	Cleft group (n = 35)					Control group (n = 35)					p-value*
	Me	Q1	Q3	Min	Max	Me	Q1	Q3	Min	Max	
NOT-S interview – total score	2	1	3	0	5	1	0	1	0	2	<0.001
NOT-S examination – total score	2	2	3	1	4	0	0	0	0	1	<0.001
NOT-S – Total score	4	4	5	2	8	1	0	1	0	2	<0.001

NOT-S – Nordic Orofacial Test-Screening; Me – median; Q1 – lower quartile; Q3 – upper quartile; Min – minimum value; Max – maximum value; *Mann–Whitney U test.

of participants with a disorder of at least 1 function was also listed. There was a disorder of at least 1 function statistically significantly more often in the cleft group than in the control group (94.3% compared to 54.3%; $p < 0.001$).

In the NOT-S examination, it was observed that in the cleft group, there were statistically significantly more disorders of functions such as face at rest, facial expression and speech. In the cleft group, facial disorders at rest were found in almost 66% (n = 23) of the study participants, while in the control group, it was 11.4% (n = 4; $p < 0.001$). Disorders of the 2 other functions were also more common in participants from the cleft group. In the cleft group, facial expression disorders occurred in 85.7% (n = 30 compared to the control group: 2.9%; n = 1; $p < 0.001$) and speech disorders in 71.4% (n = 25 compared to the control group: 8.6%; n = 3; $p < 0.001$). In addition, the summary results of the NOT-S examination were also compared. In the cleft group, there were statistically significantly more disorders of at least 1 function than in the control group (100% compared to 22.9%; $p < 0.001$).Comparing the total score, it was also found that in the cleft group there were statistically significantly more disorders of at least 1 function than in the control group (100% compared to 68.6%; $p < 0.001$).

A comparison of the results of the NOT-S between the cleft group (n = 35) and the control group (n = 35) is presented in Table 2. The summary of the NOT-S interview results, the NOT-S examination and the NOT-S total score showed statistically significantly higher values in the cleft group than in the control group. In the cleft group, the Me of the NOT-S interview scores was 2 points, the Min was 0 points and the Max was 5 points (compared to the control group: Me = 1 point, Min = 0, Max = 2; $p < 0.001$). The Me in the NOT-S examination total score was 2 points, (Min = 1, Max = 4; compared to the control group: Me = 0; $p < 0.001$). Comparing the NOT-S total score, it was also found that Me values in the cleft group were 3 points higher than in the control group ($p < 0.001$).

Discussion

This is the first study among the Polish population to use the NOT-S questionnaire. The questionnaire was conducted to assess orofacial dysfunction in children with UCLP in comparison with the control group. Both hypotheses have been confirmed.

Disorders in the cleft group mainly concerned breathing, chewing and swallowing, drooling, face at rest, facial expression, and speech. These results are consistent with data published by Hairfield et al.,[18] who showed that people with UCLP statistically more often have respiratory problems. This may be directly due to the narrowing of the upper respiratory tract within the nasal cavity among patients with UCLP.[19] However, it is worth emphasizing that the paranasal sinuses remain well-developed.[20] Respiratory plethysmography in combination with an integrated pneumotachograph, to measure the percentage of nasal breathing, and a flow pressure test showed that most people had less than 0.4 cm^2 of airway, which is less than normal.[21]

Chewing and swallowing disorders affect 51.4% of the cleft group (n = 18; compared to the control group: 8.6%; n = 3; $p < 0.001$). Using a chewable test material, the particle size of the crushed food was determined in patients with UCLP; it was found to be larger in the cleft group than the control group. Likewise, the number of chewing cycles needed to crush the material was greater.[22] It is worth emphasizing that the orbicularis oris muscle tension measured with an electromyograph[23] was higher in the group of patients with UCLP than in the control group while swallowing and at rest.

On the other hand, the results regarding dryness of the mouth show that in the group with UCLP the problem was not statistically significantly more frequent. This confirms a study published in 2008,[24] in which sialometers and sialochemistry were used to assess these patients. There were no differences in the abovementioned parameters between patients with UCLP and those in the control group. Interestingly, cortisol[25] concentration in the saliva of UCLP patients was also checked as an expression of stress response to determine health-related quality of life (HRQoL). There was no difference in salivary cortisol levels between the patient and control groups. No correlation between cortisol concentration and HRQoL was confirmed.

In the NOT-S examination, facial disorders at rest affected 66% (n = 23) of patients, while in the control group, this figure was 11.4% (n = 4; $p < 0.001$). It has been shown that the face of patients with CLP is perceived more

negatively than that of people without the disorder. Moreover, observation of the nose and mouth area in these people lasts longer. It has also been shown that patients with CLP looking at other people with CLP spend more time looking at the nose and less time looking at the eyes than people without CLP.[26] It should also be emphasized that the intensity of asymmetry increases with a maximum smile.[27] Based on scientific reports, presurgical nasal molding improves the esthetics of the nose in patients with unilateral clefts of the lip, alveolus and palate, and distinctly flattens nasal wings.[28]

Patients with CLP undergo surgery due to the lack of tissue continuity. However, despite a significant improvement in facial symmetry after surgery, 4 years after surgery the remaining asymmetry is more visible: the philtrum of the upper lip is deviated toward the scar tissue on the cleft side, and the asymmetry of the nose is significantly worse.[29] The effects of secondary osteotomy were also compared. No significant influence was demonstrated on craniofacial growth in children with UCLP.[30]

Considering the aspects discussed above, it is understandable that they affect the QoL of patients with UCLP, which was confirmed in our study.

Conclusions

The NOT-S survey is an effective tool for assessing disorders in patients with UCLP. It has been shown that patients with UCLP have more orofacial dysfunctions and worse QoL compared to the control group. Orofacial function areas and treatment outcomes need to be continually evaluated and monitored.

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Impact of Cleft Palate Anastomosis in Cleft Lip and Palate Patients with Coexisting Cleft Lip Anastomosis Scar Based on Cephalometric Measurements

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Featured Application: This paper aims to indicate which cephalometric parameters should be specifically analyzed in patients with cleft lip and palate and with cleft lip and which ones should be targeted by orthodontic treatment.

Abstract: (1) Background: This article focuses on examining components affecting the overbite, overjet, and the effect of palate surgery on craniofacial morphology with a concomitant cleft lip fusion scar, and a comparison of patients who had only a cleft lip fusion scar. Patients with unilateral cleft lip (UCL) and patients with unilateral cleft lip and palate (UCLP) were included in the study. We aimed to find if cephalometric parameters were significantly different in these groups. (2) Material and methods: The study group consisted of a lateral cranial radiograph of patients with UCLP (n = 30) and UCL (n = 30). Cephalometric radiographs were saved electronically, and cephalometric analysis was performed using a computer program. (3) Results: We observed that a statistically significant higher degree of maxillary prognathism occurred in the UCL than in the UCLP. We observed the anterior position of the upper lip in relation to E-line in patients with cleft lip. (4) Conclusions: The results present the effect of cleft palate surgery on further forward growth of the maxilla. There was a decreased ANB angle present in the skeletal class II in patients with UCL and UCLP. The SNB angle was not increased, and the reverse overjet was due to the rectroclination of the upper incisors and protruded lower incisors.

Keywords: cleft lip; cleft lip and palate; cephalometric measurements; orthodontics

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1. Introduction

Orofacial clefts are the most common head and neck congenital malformation [1] and are the second most common congenital abnormality in children, after heart defects [2,3]. Unilateral cleft lip and palate (UCLP) accounts for 45% of all clefts; the second most frequent is unilateral cleft lip (UCL), which involves 25% of patients [4]. Both groups of patients require complex multidisciplinary care [5].

Lack of soft and hard tissue continuity contributes to craniofacial deformities. These include skeletal abnormalities, such as abnormal development of the maxillary bones, frontal, zygomatic, and orbital bones, as reported in a study conducted in Taiwan [6]. However, it is noteworthy that there was no statistical difference in the ossification time of the Spheno-Occipital Synchondrosis in patients with UCLP compared to patients without cleft [7].

Researchers from Japan have reported the occurrence of maxillary retrusion and a steeper mandible in patients with unoperated UCLP [8]. Moreover, the occurrence of hypodontia, hyperdontia, and disturbances in the size, shapes and position of the teeth have been confirmed within the dentition. The absence of permanent tooth buds concerns 24% of patients with clefts in the craniofacial area. Almost every patient in this cleft lip and palate group has a delayed eruption of permanent teeth, as described in the study by Polish

researchers [9]. Authors from Sweden point out the occurrence of dental abnormalities, including infraocclusion of primary molars and transposition in patients with UCLP [10]. Another study, conducted in Italy, concerns the three-dimensional assessment of the jaw and palate of patients with UCLP. Attention is drawn to the reduced surface area and volume of the palate, the reduced intercanine width, and the insignificantly reduced intermolar dimension in the superior arch. Moreover, according to studies carried out in Finland, hypodontia of the lateral incisor in patients with UCLP delays the dental age [11].

The authors decided to conduct this study because of the discrepancy in previous results from other researchers.

It is widely believed that surgical treatment of cleft palate is the main cause of tissue scarring and the reason for reduced i.a. forward maxilla dimension [12]. This is also supported by studies conducted on patients of Caucasian origin with UCLP [13] and studies by Bin Ye and coauthors [14]. This is contradicted by the results of other authors who did not present reduced maxilla growth in patients with only cleft palate fusion [15]. Moreover, patients with unoperated cleft palate demonstrate reduced maxillary length and retruded maxillary position relative to the cranial base [16,17].

Further conflicting reports concern the substrate of the reverse overbite in operated UCLP patients. Some studies report anterior growth of the mandible as the cause of reverse overjet [18], while other authors report that individuals with cleft lip and palate had a significantly shorter maxillary length [19].

We aimed to perform a cephalometric analysis in patients with cleft lip and with cleft lip and palate. The article focuses mainly on examining components affecting the overbite, overjet, and the effect of palate surgery on craniofacial morphology with a concomitant cleft lip fusion scar and a comparison for patients who had only a cleft lip fusion scar. Patients with UCL and patients with UCLP were included in the study. Both groups were patients treated with surgery, which included cleft lip repair and cleft lip and palate repair, respectively.

The following statements were made as the research hypothesis:

(1) SNA angle is smaller in UCLP patients than in UCL patients.
(2) SNB angle reaches a similar value in patients with UCLP and UCL.
(3) U1 to NA (mm) is smaller in UCLP patients than UCL patients.
(4) Eversion of the upper lip is observed in UCL patients.

2. Materials and Methods

2.1. Materials

Sample size analysis was performed in Statistica 13 (TIBCO Software Inc.). Based on the available results, differences between the two groups (groups: UCL vs. UCLP) were evaluated. The mean and standard deviation of SNA scores in both groups were used in the sample size estimation analysis. The estimated sample size was calculated based on the *t*-test for means of two samples (*t*-test for independent samples). Parameters: the mean in the PW group was 79.45 (SD = 4.19); the mean in the W group was 83.62 (SD = 5.60); and the alpha level was set at 0.05 and the power of the test was set at 0.8. It was also assumed that there was no correlation of the variables evaluated and the two-sided null hypothesis was accepted. Based on the parameters, an estimated sample size of 30 patients in each group was obtained.

The study group consisted of a lateral cranial radiograph of patients with unilateral cleft lip and palate (n = 30) and patients with unilateral cleft lip (n = 30). All of them were patients of the Department of Maxillofacial Orthopaedics and Orthodontics, Division of Facial Abnormalities, Wroclaw Medical University in Poland. The inclusion criterion was the diagnosis of unilateral cleft hard palate with cleft lip (diagnosis code Q37.1 according to ICD10) who underwent anastomosis cleft lip and palate surgery in childhood. The second group comprised children with a diagnosis of unilateral cleft lip (diagnosis code Q36.9 according to ICD10) who underwent cleft lip anastomosis surgery. All patients were operated on in the same hospital. The cleft lip anastomosis procedure in UCL and UCLP

patients was performed using the same method. Patients included in the study were between age 8 years 10 months to 10 years 7 months. The exclusion criteria were prior orthodontic intervention and non-operative UCL/UCLP patients. All patients with UCL and UCLP had upper lateral incisors.

The retrospective study included lateral cranial radiographs taken as standard for orthodontic diagnosis between 2016 and 2021.

2.2. Methods

All lateral cranial radiographs were analyzed by a single author of this study. The cephalometric radiographs were saved electronically, and cephalometric analysis of each radiograph performed using a Webceph software. All cephalometric points were applied manually. During the measurements, 33 measurement points were marked. The results of 10 angles, 3 reference lines, and 2 segments were included in the study. Example measurements are shown in Figure 1.

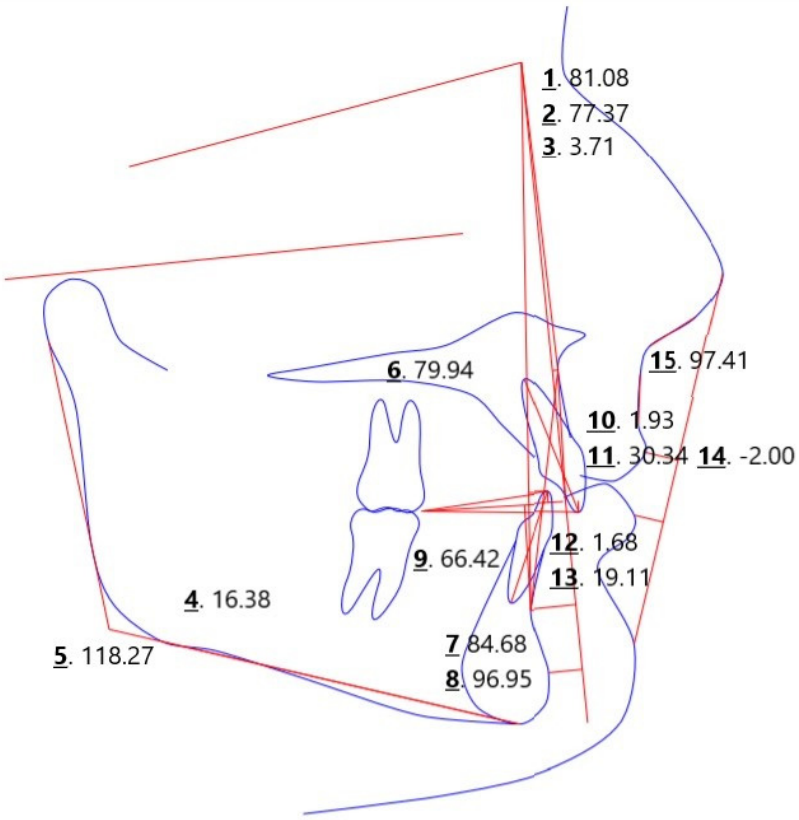

Figure 1. Example measurements included in the study. 1. SNA; 2. SNB; 3. ANB; 4. FMA; 5. Gonial Angle; 6. APDI; 7. ODI; 8. IMPA; 9. L1 to LOP; 10. U1 to NA (mm); 11. U1 to Na (deg); 12. L1 to NB (mm); 13. L1 to NB (deg); 14. Upper lip to E-plane;.15. Nosolabial angle.

The analysis considered the following parameters: SNA describes the anterior–posterior position of point A (the point lying deepest on the anterior outline of the alveolar process) in relation to the anterior cranial fossa, SNB describes the anterior–posterior position of point B (the point lying deepest on the anterior outline of the alveolar portion of the mandible) in relation to the anterior cranial fossa, ANB describes the position of mandible in relation to maxilla, FMA included between lines FH (corresponds to Frankfurt horizontal plane—passes through points orbitale and tragion) and GoGn (line of mandibular body defined by points Gonion and Gnathion), Gonial angle, ODI stands for overbite depth indicator, APDI stands for anteroposterior dysplasia indicator, IMPA located between long axis of lower incisor tooth and GoGn line, U1 to NA (mm), and U1 to NA (deg) determines anteroposterior

position of upper incisor teeth in relation to maxillary base, L1 to NB (mm) and L1 to NB (deg) are the anteroposterior positions of the lower incisors in relation to the base of the mandible, and L1 to LOP is the anteroposterior positions of the lower incisors in relation to the lower occlusal plane, the upper lip to E-plane is the location of the upper lip in relation to the aesthetic line that passes through the tip of the nose and chin (upper lip should be 3 mm apart), and the Nasolabial angle.

2.3. Statistical Analysis

Statistical analysis was performed using Statistica 13 software (TIBCO, 3307 Hillview Avenue Palo Alto, CA 94304, USA). Arithmetic means, medians, standard deviations, quartiles, and range of variability (extreme values) were calculated for measurable variables. All study variables of quantitative type were checked by Shapiro–Wilk test to determine the type of distribution. Comparison of results between the "cleft lip and palate" group and the "cleft lip" group was assessed using the *t*-test for independent samples or U-Mann–Whitney depending on the assumptions met. In addition, Spearman rank correlation analysis or Pearson correlation analysis was performed depending on the assumptions met. An $\alpha = 0.05$ level was used for all comparisons.

3. Results

A comparison of the results obtained in the cleft lip and palate group and the cleft lip group for SNA, SNB, and ANB parameters is presented in Table 1. It was observed that a statistically significant higher degree of maxillary prognathism (SNA) occurred in the cleft lip group ($\bar{x}$ = 82.9 degrees; SD = 4.0 degrees) than in the cleft lip and palate group ($\bar{x}$ = 79.1 degrees; SD = 4.0 degrees) ($p < 0.001$). In addition, there were statistically significant differences in mandibular versus maxillary (ANB) position between the study groups ($p = 0.008$). The mean ANB score for the lip and palate group was 2.13 degrees (SD = 2.7 degrees) and for the lip group was 4.03 degrees (SD = 2.7 degrees) (Table 1).

Table 1. Comparison of SNA, SNB, and ANB scores between cleft lip and palate and cleft lip groups.

	Group														
	Cleft Lip and Palate (n = 30)							**Cleft Lip (n = 30)**							***p*-Value**
	$\bar{x}$	**Me**	**Min**	**Max**	**Q1**	**Q3**	**SD**	$\bar{x}$	**Me**	**Min**	**Max**	**Q1**	**Q3**	**SD**	
SNA	79.1	79.0	69.7	86.4	75.9	81.5	4.0	82.9	82.8	71.1	92.7	81.0	84.9	4.0	**<0.001** *
SNB	76.9	76.7	69.5	86.8	74.6	79.2	4.3	78.9	78.8	74.1	86.3	76.7	81.0	3.1	0.053 **
ANB	2.13	2.56	−2.33	7.41	−0.11	4.07	2.7	4.03	4.30	−3.01	9.91	2.53	5.67	2.7	**0.008** **

n—number of persons; $\bar{x}$—mean; Me—median; Min—minimum value; Max—maximum value; Q1—lower quartile; Q3—upper quartile; SD—standard deviation; * U-Mann–Whitney test; ** independent samples *t*-test.

Table 2 presents the comparison of FMA, Gonial angle, APDI, and ODI scores between the study groups. Statistically significant differences were observed for the ODI parameter ($p = 0.046$), with the cleft lip and palate group having a mean score of 74.0 points (SD = 8.8 points) and the cleft lip group having a mean score of 78.2 points (SD = 7.0 points) (Table 2). Otherwise, no statistically significant differences were observed.

A comparison of IMPA, U1 to NA (mm), U1 to NA (deg), L1 to NB (mm), and L1 to NB (deg) scores relative to the study groups is presented in Table 3. Statistically significant differences were observed for the IMPA parameter ($p = 0.001$), the mean score for the cleft lip and palate group was 88.2 points (SD = 7.9 points), and for the cleft lip group the mean score was 94.7 points (SD = 6.8 points). Additionally, statistically significant differences were observed for the parameter L1 to LOP ($p = 0.004$), the mean score in this case for the cleft lip and palate group was 72.8 points (SD = 7.8 points) and for the cleft lip group the mean was 67.3 points (SD = 6.3 points). The results were statistically significantly different for the parameter L1 to NB (deg) ($p = 0.004$), the mean score for the cleft lip and palate group was 18.1 deg (SD = 6.6 deg) and for the cleft lip group the mean score was

23.1 deg (SD = 6.5 deg). Otherwise, no statistically significant differences ($p > 0.05$) were observed (Table 3).

Table 2. Comparison of FMA, Gonial angle, APDI, and ODI scores between the lip and palate group and the lip group.

	Group														*p*-Value *
	Cleft Lip and Palate (n = 30)							Cleft Lip (n = 30)							
	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	
FMA	25.4	26.1	16.8	36.3	20.3	28.9	5.4	22.9	23.1	9.9	34.8	20.4	26.8	6.3	0.116
Gonial angle	124.2	124.1	111.1	135.8	118.9	129.7	7.0	121.0	121.3	109.5	134.4	116.4	125.3	6.5	0.069
APDI	82.0	82.0	71.9	92.2	77.0	86.7	5.9	79.7	79.8	68.0	93.0	75.6	83.3	5.5	0.121
ODI	74.0	74.5	57.8	98.0	69.4	79.7	8.8	78.2	78.5	65.7	95.8	73.0	82.1	7.0	**0.046**

n—number of persons; $\bar{x}$—mean; Me—median; Min—minimum value; Max—maximum value; Q1—lower quartile; Q3—upper quartile; SD—standard deviation; * U-Mann–Whitney test.

Table 3. Comparison of IMPA, L1 to LOP, U1 to NA (mm), U1 to NA (deg), L1 to NB (mm), and L1 to NB (deg) scores between the cleft lip and palate group and the cleft lip group.

	Group														*p*-Value
	Cleft Lip and Palate (n = 30)							Cleft Lip (n = 30)							
	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	
IMPA	88.2	87.3	74.2	107.3	83.6	91.9	7.9	94.7	95.1	78.7	109.1	90.5	100.5	6.8	**0.001** **
L1 to LOP	72.8	72.7	56.0	89.6	68.3	77.0	7.8	67.3	66.9	55.1	79.9	62.2	69.7	6.3	**0.004** **
U1 to NA (mm)	1.49	1.26	0.04	5.33	0.61	2.06	1.2	1.69	1.55	0.05	4.23	0.92	2.59	1.0	0.274 *
U1 to NA (deg)	19.6	21.3	2.4	37.5	13.4	25.0	8.6	20.4	21.8	−2.4	33.5	15.5	29.8	10.1	0.530 *
L1 to NB (mm)	1.57	1.63	0.07	4.58	0.58	2.15	1.1	2.18	2.34	0.08	5.51	1.11	3.02	1.4	0.059 **
L1 to NB (deg)	18.1	17.2	8.3	31.9	13.1	22.5	6.6	23.1	24.0	8.9	33.1	17.7	27.8	6.5	**0.004** **

n—number of persons; $\bar{x}$—mean; Me—median; Min—minimum value; Max—maximum value; Q1—lower quartile; Q3—upper quartile; SD—standard deviation; * U-Mann–Whitney test; ** independent samples *t*-test.

Table 4 presents the comparison of the results obtained for Lip to E-plane and Nasolabial angle against the study groups. Statistically significant results were presented for Upper lip to E-plane ($p = 0.002$), where the mean score for the cleft lip and palate group was −2.32 points (SD = 1.5 points) and for the cleft lip group the mean score was −1.17 points (SD = 1.3 points). Otherwise, no statistically significant differences ($p > 0.05$) were observed (Table 4).

Table 4. Comparison of upper lip to E-plane and nasolabial angle scores between the cleft lip and palate group and the cleft lip group.

	Group														*p*-Value *
	Cleft Lip and Palate (n = 30)							Cleft Lip (n = 30)							
	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	
Upper lip to E-plane	−2.32	−2.28	−5.25	0.47	−3.17	−1.37	1.5	−1.17	−1.07	−3.88	0.98	−1.95	−0.14	1.3	**0.002**
Nasolabial angle	95.2	94.4	55.3	ca8.7	88.0	103.9	17.1	101.7	102.4	84.1	127.1	91.5	108.7	12.0	0.095

n—number of persons; $\bar{x}$—mean; Me—median; Min—minimum value; Max—maximum value; Q1—lower quartile; Q3—upper quartile; SD—standard deviation; * U-Mann–Whitney test.

Table 5 presents the correlations between SNA, SNB and ANB parameters in the cleft lip and palate group. A statistically significant positive correlation was observed between SNA and SNB scores. This indicates that subjects who have a greater degree of maxillary prognathism (SNA) also have a greater degree of mandibular prognathism (SNB). (Table 5).

Table 5. Summary of correlations between SNA, SNB, and ANB scores in the cleft lip and palate group.

	SNA		SNB		ANB	
	r	***p*-Value**	**r**	***p*-Value**	**r**	***p*-Value**
SNA	-	-	**0.721 ****	**<0.001**	0.249 **	0.184
SNB	**0.721 ****	**<0.001**	-	-	**−0.430 ***	**0.018**
ANB	0.249 **	0.184	**−0.430 ***	**0.018**	-	-

r—correlation coefficient; * Pearson's correlation coefficient; ** Spearman's Rank correlation coefficient.

Table 6 presents the correlations between SNA, SNB and ANB parameters in the cleft lip group. A statistically significant positive correlation was observed between SNA and SNB scores. This indicates that subjects who have a greater degree of maxillary prognathism (SNA) also have a greater degree of mandibular prognathism (SNB) (Table 6).

Table 6. Summary of correlations between SNA, SNB, and ANB scores in the cleft lip group.

	SNA		SNB		ANB	
	r	***p*-Value**	**r**	***p*-Value**	**r**	***p*-Value**
SNA	-	-	**0.736 ****	**<0.001**	**0.444 ****	**0.014**
SNB	**0.736 ****	**<0.001**	-	-	−0.035 *	0.855
ANB	**0.444 ****	**0.014**	−0.035 *	0.855	-	-

r—correlation coefficient; * Pearson's correlation coefficient; ** Spearman's Rank correlation coefficient.

4. Discussion

Based on the above results, all the research hypotheses were confirmed.

The SNA angle is considered correct between 79–85 degrees [20]. Patients with UCLP after lip and palate fusion surgery had a mean score 79.1 degrees. This indicates a tendency towards a retrognathic maxilla. This was also confirmed by the results obtained by Corbo and coauthors [21]. Searching for the cause of reduced maxillary anterior growth in scientific reports, two positions are apparent. Some scientists describe the effect of cleft palate fusion surgery on reduced maxillary anterior growth [22,23]. Others indicate [24] that retrognathic upper jaw also occurs in patients with UCL, suggesting a primary disturbance of growth factors regardless of the surgery performed. Comparing the results obtained by the authors, in which the group of patients with UCL obtained a mean SNA angle value 3 degrees higher than a mean SNA volue in UCLP group, the authors tend to favor the first of these explanations. Moreover, the authors do not confirm the results of Alam [24] and coauthors regarding reduced maxillary anterior growth in UCL patients.

The SNB angle is considered correct in the range of 77–83 degrees [20]. The results present a tendency towards a retrognathic mandible in patients with UCL and UCLP. This is also confirmed by the results of Da Silva Filho and coauthors [25].

In patients with UCLP and UCL, the mean values of the ANB angle indicate the presence of a class II malocclusion. The same findings about patients with unilateral cleft lip and palate were obtained by Romanini and coauthors [26]. The group of patients without cleft—skeletal class II is also the most diagnosed malocclusion in the Polish population [27]. The causes of this abnormality are found, among others, in genetic factors, habits, but also in sagittal and vertical malocclusion disorders, which leads to skeletal compensation in the anterior–posterior plane [28]. With regard to the sagittal plane, crossbite is diagnosed in patients with UCL and UCLP [29,30]. In the vertical plane, the results obtained by the authors confirm the tendency of mandibular downward rotation in patients with UCLP [25]. In unoperated patients with unilateral cleft lip and palate the gonial angle presented a vertical growth pattern [31]. There were no differences regarding overjet between the UCL and UCLP groups. ADPI values were less than normal in both groups. Negative overjet was also described by Tindlund and coauthors [32] among UCLP patients before orthodontic

treatment. The results obtained demonstrate the effect of cleft palate anastomosis in patients with UCLP on overbite, and the dental parameters are described below.

The mean value of the distance of U1 from the NA line was significantly reduced, similarly the angle contained between the NA line and U1 in both groups. Rectroclination of upper incisors in UCLP patients was also described by Burak [33]. The lower incisors were significantly more protruded in patients with cleft lip and palate. The parameters described above are an attempt of the dental compensation that often occurs in skeletal class II. Among patients without cleft, the position of the lower incisors and the inclination of the occlusal plane have been presented to be the most significant in relation to skeletal class II dental compensation [34]. It is also worth mentioning that the researcher cited above, Burak, in his study describes the occurrence of skeletal class III, which is contradicted by the results obtained by the authors.

The analysis of the position of the upper and lower lip in relation to the aesthetic E-line indicates a significant anterior position of the upper lip in patients with cleft lip compared to patients with cleft lip and palate. The E-line was also used in another study to assess the facial attractiveness of individuals with UCLP [35]. It was presented that laypeople, non-orthodontists, rated the face as less attractive if the position of the upper or lower lip was moved away from the E-line. Interestingly, these patients' perceptions were not influenced by the parameters SNA, SNB, ANB, GoGn-SN, and nasolabial angle, which were analyzed by one researcher. Among orthodontists and surgeons-beyond the E-line described-the significance of SNA and GoGn-SN angle on facial perception were confirmed.

5. Conclusions

The results present the effect of cleft palate surgery on further forward growth of the maxilla. Decreased ANB angle was present in skeletal class II in patients with UCL and UCLP. The SNB angle was not increased, and the reverse overjet was due to the rectroclination of the upper incisors and protruded lower incisors. Cleft palate surgery affects overbite. Due to the distance of the upper lip from the E-line in UCL patients, they may be perceived as less attractive compared to the patients with cleft lip and palate.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki. Ethical review and approval were waived for this study, due to the nature of the study being a retrospective study basing on already available data.

Informed Consent Statement: Patient consent was waived due to the nature of the study being a retrospective study basing on already available data.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to a Non-Disclosure Agreement.

Conflicts of Interest: The authors declare no conflict of interest.

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Wnioski

1. Makroglosja, hipotonia, wady zgryzu, zaburzenia w obrębie stawów skroniowo-żuchwowych przyczyniają się do występowania dysfunkcji i parafunkcji oraz opóźnienia rozwoju psychoruchowego u pacjentów z Zespołem Downa.
2. Leczenie pacjentów z trisomią chromosomu 21 należy rozpocząć w pierwszych miesiącach życia. Zapewnia to lepszą adaptację do stosowanych następnie aparatów ortodontycznych.
3. Niezbędne jest interdyscyplinarne leczenie pacjentów, które zmniejsza ryzyko występowania zaburzeń w obrębie układu stomatognatycznego.
4. U pacjentów z rozszczepem wargi i podniebienia (UCLP) stwierdzono gorszą jakość życia w porównaniu do grupy kontrolnej.
5. W oparciu o kwestionariusz NOT-S dysfunkcje twarzoczaszki występują częściej u pacjentów z UCLP.
6. Wykazano wpływ operacji zespolenia rozszczepu podniebienia na dalszy wzrost szczęki u pacjentów z UCLP.
7. U pacjentów z rozszczepem wargi oraz rozszczepem wargi i podniebienia stwierdzono II klasę szkieletową.
8. Odwrotny nagryz poziomy jest efektem przechylenia górnych siekaczy i wychylenia dolnych siekaczy u pacjentów z UCLP.

Conclusions

1. Macroglossia, hypotonia, malocclusion, temporomandibular joint abnormalities contribute to dysfunctions and parafunctions and psychomotor developmental delay in patients with Down syndrome.
2. Treatment of patients with chromosome 21 trisomy should begin in the first months of life. This ensures better adaptation to orthodontic appliances used later.
3. Interdisciplinary treatment of patients with DS is necessary to reduce the risk of stomatognathic disorders
4. Patients with cleft lip and palate (UCLP) have a worse quality of life compared to the control group.
5. Based on the NOT-S questionnaire, craniofacial dysfunctions are more common in patients with UCLP.
6. The effect of cleft palate fusion surgery on subsequent jaw growth in patients with UCLP was demonstrated.
7. Skeletal class II has been demonstrated in patients with cleft lip and cleft lip and palate.
8. Reverse overjet is a result of upper incisor inclination and lower incisor inclination in patients with UCLP.

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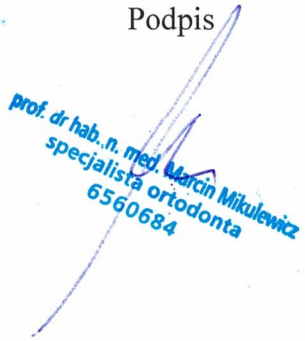
OŚWIADCZENIE

Oświadczam, że w pracy:

Kaczorowska N, Kaczorowski K, Laskowska J, Mikulewicz M. Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review. Adv.Clin.Exp.Med. 2019 Vol.28 no.11. DOI: 10.17219/acem/111410

Mój wkład polegał na współudziale w koncepcji i projekcie badawczym, krytycznej recenzji i ostatecznym zatwierdzeniu artykułu.

Podpis



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OŚWIADCZENIE

Oświadczam, że w pracy:

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Mój wkład polegał na współudziale w analizie i interpretacji otrzymanych wyników i poprawkach manuskryptu.

Joanna Laskowska

Podpis

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OŚWIADCZENIE

Oświadczam, że w pracy:

Kaczorowska N, Kaczorowski K, Laskowska J, Mikulewicz M. Down syndrome as a cause of abnormalities in the craniofacial region: A systematic literature review. Adv.Clin.Exp.Med. 2019 Vol.28 no.11. DOI: 10.17219/acem/111410

Mój wkład polegał na współudziale w krytycznej recenzji i ostatecznym zatwierdzeniu artykułu.

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OŚWIADCZENIE

Oświadczam, że w pracy:

Kaczorowska N, Markulak P, Mikulewicz M. Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: a preliminary report. Adv.Clin.Exp.Med. 2020 Vol.29 no.11. DOI: 10.17219/acem/128187

Mój wkład polegał na współudziale w poprawkach manuskryptu oraz ostatecznym zatwierdzeniu artykułu.

Podpis

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OŚWIADCZENIE

Oświadczam, że w pracy:

Kaczorowska N, Markulak P, Mikulewicz M. Assessment of orofacial dysfunction in a group of Polish children with unilateral cleft lip and palate: a preliminary report. Adv.Clin.Exp.Med. 2020 Vol.29 no.11. DOI: 10.17219/acem/128187

Mój wkład polegał na współudziale w gromadzeniu i opracowaniu danych oraz poprawkach manuskryptu.

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OŚWIADCZENIE

Oświadczam, że w pracy:

Kaczorowska N, Mikulewicz M. Impact of Cleft Palate Anastomosis in Cleft Lip and Palate Patients with Coexisting Cleft Lip Anastomosis Scar Based on Cephalometric Measurements. Applied Sciences. 2022; 12(3):1104. https://doi.org/10.3390/app12031104

Mój wkład polegał na współudziale w krytycznej recenzji i poprawkach manuskryptu, walidacji oraz nadzorze nad badaniami.

Podpis