

The Relationship between the Type of Cleft and Nasal Air Emission in Speech of Children with Cleft Palate or Cleft Lip and Palate

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Abstract

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BACKGROUND: Cleft palate, due to damage of the soft palate, leads to dysfunction, i.e., inappropriate closure of the velopharynx during speech production, thus resulting in velopharyngeal insufficiency which characterises with hypernasal speech and nasal air loss/emission during speech production.

AIM: To establish the relationship between the type of cleft according to the Veau classification and the degree of nasal air emission in the speech of patients with cleft using auditory-visual perceptual assessment procedures.

MATERIAL AND METHODS: A group of 40 patients with irregular speech aged 4 to 7, out of which 20 with cleft palate or cleft lip and palate, participated in the research. The Veau classification was used to classify the cleft severity, while an indirect instrumental examination was conducted with the See-Scape instrument to detect nasal air emission during the speech.

RESULTS: The respondents with cleft palate or cleft lip and palate of higher Veau class had a greater degree of nasal air emission during the speech. There is a positive, statistically significant correlation between the results obtained with the Veau classification of cleft lip and palate, and the degree of nasal air emission. The value of Spearman's coefficient of correlation is $R = 0.46$, and the calculated p-value is $p = 0.04$.

CONCLUSION: A more severe cleft type is associated with an increased degree of nasal air emission during the speech, and vice versa.

Introduction

Cleft lip and/or palate, depending on the form in which they appear, generate many problems, such as difficulties while feeding, nursing and swallowing, impaired hearing, orthodontic anomalies, speech disorder, impaired resonance, aesthetic and psychosocial disorders, social and professional isolation and the like [1]. Cleft lip and palate affect all oral functions, and the consequences are especially evident in a speech [2].

Children with cleft lip and palate have pathology in verbal communication, and the reason for that is the incomplete closure of the velopharyngeal sphincter, i.e., the soft palate, lateral walls and posterior wall of the pharynx, which means the oral cavity is not separated from the nasal cavity during

speech and swallowing [3]. In the speech, the closure of the velopharyngeal sphincter separates the oral from the nasal cavity, which prevents nasal air loss in the production of all sounds, except for the nasal consonants /M/, /N/ and /Nj/. The incomplete closure during speech production results with velopharyngeal insufficiency which characterises with hypernasal speech and nasal air emission [4]. If there is no closure of the velopharyngeal sphincter, the child will lack the adequate aerodynamic conditions for the adoption of normal articulation during speech development. Thus, the dysfunctional velopharyngeal sphincter, i.e., cleft palate or cleft lip and palate affect the development of speech and compensatory mechanisms greatly during articulation.

Articulation is not a mechanism the child is born with; it is adopted through the process of learning over time when the speech-language system is

formed. The conditions for the development of regular speech are anatomical, well-functioning speech and hearing organs and a proper speech model. If these conditions do not exist, the resulting adoption of compensatory mechanisms leads to a pathological and completely incomprehensible articulation. The most noticeable articulatory mistakes in the speech of children with cleft palate occur during the production of consonants that require high pressure in the oral cavity [5]. The child's speech can only be understood by his parents, while social contacts are encumbered. The speech disorders impair the individual and disturb their emotions deeply as well. Bearing in mind that speech is an indispensable tool for expressing and conveying thoughts and the most perfect means of communication, it is important that the impairments are resolved from the very beginning, which asks for inclusion of a multidisciplinary specialist team and team approach [6].

The basis of impaired speech lies in hypernasality, i.e. nasal air emission, or directing part of the air through the nose during the speech when the intraoral pressure, which is most important for speech, cannot reach its necessary value. Hypernasality is one of the most typical characteristics of children with cleft [7], [8]. As it is known, nasal air emission often occurs with hypernasality, but it can occur with normal resonance, too [9]. There are four types of nasal air emission [10]: inaudible nasal air emission, audible nasal air emission, nasal rustle (nasal turbulence) and nasal emission typical for phonemes. Apart from the last one, the three other types of nasal air emission are often and commonly accompanied by severe, moderate or mild hypernasality.

Therefore, establishing a link between hypernasality, i.e., nasal air emission during speech and the type of cleft palate can provide useful information for future diagnostic and therapeutic purposes in the field of speech disorders.

The relationship between the degree of anatomical disruption of the primary and the secondary palates, on which the Veau classification for cleft is based, and nasal air emission in the speech of children with a cleft can be established using perceptual and instrumental (direct and indirect) examinations. Since it is primarily a matter of dealing with a young population from a very early age, it is important to consider non-invasiveness and simplicity during implementation, but fast and precise diagnosis, too. These are just some of the advantages and benefits of perceptual examinations and some other instrumental indirect examinations as well.

Still, the last tool in the chain of procedures for treating speech disorders is not diagnostics. The final correction from an anatomic, morphological and functional aspect is what matters. The success in resolving the existing problem depends on an efficient and appropriate treatment, but palatoplasties as well.

Material and Methods

Material

To meet the established aims, the clinic and paraclinical examinations were conducted in the Center for rehabilitation of hearing, speech and voice – Skopje, during the period from January to December 2016. The patients included in the research were a total of 40, aged 4 to 7, out of which 22 (55%) were females and 18 (45%) males. According to the established diagnosis (congenital anomaly: Palatoschisis or Cheilognatopalatoschisis; irregular speech: Rhinolalia or Dyslalia), the respondents were divided into two groups. The first comprised 20 children with cleft palate or cleft lip and palate and irregular speech Rhinolalia (experimental group). These respondents have already undergone surgery for cleft correction. The second group (control group, comprised 20 children with no cleft, but with irregular speech Dyslalia.

Methods

For this paper, one perceptual and one indirect instrumental examination were conducted. The respondents from the experimental group underwent a clinical, i.e., perceptual examination with the Veau classification for determining the type of cleft [11], which is normally used as an objective measure for determining the severity of the clinical picture of the cleft [12]. Considering the fact that some of the methods for instrumental examination characterize with invasiveness, and having in mind the age group of the patients included in the research (aged 4 to 7), paraclinical examination was chosen (instrumental examination) to carry out the quantitative determination of the degree of nasal air emission by means of the See-Scape instrument [13], [14].

Veau classification of cleft lip and palate

The degree of anatomical disruption of the primary and the secondary palates, on which the Veau classification of cleft lip and palate is based, affects speech greatly. Having that in mind, to determine the type of cleft in our paper the Veau classification was used, which is a widely used system [11]. With the application of extraoral and intraoral examination (Figure 1), it was established whether our respondents had a cleft, and, if so, the same was classified as:

Class I – The cleft only includes the soft palate;

Class II – The cleft includes the hard and soft palate and is limited to the secondary palate;

Class III – The cleft is a completely unilateral cleft lip and palate;

Class IV – The cleft is bilateral cleft lip and palate.



Figure 1: Establishing the existence of cleft lip and palate

Objective assessment of nasal air emission in speech

The See-Scape instrument is used for instrumental examination [15] of nasal air emission in speech. The examination is indirect, non-invasive and simple to conduct. In addition to the clear visual representation, the instrument gives the opportunity to objectively measure the nasal air emission of the patient during the speech. Measuring nasal air emission using the See-Scape instrument (Figure 2) begins by inserting the nasal tip in one of the patient's nostrils.



Figure 2: Measuring nasal air emission using the See-Scape instrument

The nasal tip is connected through a small flexible tube to a rigid plastic vertical tube, graded from 1 to 7, where 1 represents the lowest degree of nasal air emission, while 7 the highest. During the speech, if the patient releases air nasally, the foam piston in the rigid plastic vertical tube reacts instantly and rises.

The examination with See-Scape includes procedures at phoneme, word and sentence level. At the phoneme level, the respondent repeats isolated phonemes in words previously tested and established that they are nasalised (e.g. raka-maka, Viki-Miki). At word level, respondent repeats words that do not contain nasal sounds /M/, /N/ and /Nj/ (e.g. zhaba-kapa), while at sentence level, the respondent repeats short sentences not containing /M/, /N/ and /Nj/ (e.g.

Kate kupi kaput; Tode vide dete). All these procedures indicate which phonemes, words and sentences raise the foam piston in the rigid plastic vertical tube, respectively. The highest degree obtained through the examination is considered as a final degree of nasal air emission.

Statistical analysis

The statistical analysis of the data obtained from the research was done in the statistical programs Statistica for Windows 7.0 and SPSS 17.0. The obtained data is represented in tables and figures. The categorical (attributive) variables are represented with absolute and relative numbers. For comparing the analysed variables between the experimental and control group, a non-parametric test (Fischer exact test) was used. The correlation between the results within the experimental group was analysed with the Spearman's Rank-Order Correlation coefficient. The statistical significance was defined at level $p < 0.05$.

Results

Results of the total sample

Twenty (50%) of the respondents with a cleft palate of different type had their cleft classified. According to the Veau classification, the largest number and percentage of those respondents belonged to Class III (Table 1), i.e., they had a complete unilateral cleft lip and palate – 9 (45%), followed by respondents of Class I, whose cleft only included the soft palate – 7 (35%), then 3 (15%) respondents of Class II, where cleft included the hard and soft palate and was limited to the secondary palate, and only one respondent belonging to Class IV, which included bilateral cleft lip and palate.

Table 1: Number of respondents according to the type of cleft

Veau classification of cleft lip and palate	n (%)
Class I. The cleft includes only the soft palate	7 (35)
Class II. The cleft includes the hard and soft palate and is limited to the secondary palate	3 (15)
Class III. The cleft is a completely unilateral cleft lip and palate	9 (45)
Class IV. The cleft is bilateral cleft lip and palate	1 (5)

The results from the experimental examination with the See-Scape instrument (Table 2) revealed that 16 (40%) of the respondents had no nasal air emission. In the group of respondents where the instrument registered nasal air emission, the most common level was 7, which is equivalent to the highest degree of nasal air emission, and this was the case with 10 (25%) of the respondents. Among the 24 respondents where nasal air emission was registered hypernasality was also noticed.

Table 2: Number of respondents according to the degree of nasal air emission

See-Scape The degree of nasal air emission		n (%)
No nasal air emission	0	16 (40)
Degree of nasal air emission	1	5 (12.5)
	2	3 (7.5)
	3	2 (5)
	4	1 (2.5)
	5	1 (2.5)
	6	2 (5)
	7	10 (25)

Comparative analysis of results from the experimental and control group

The results from the experimental examination with the See-Scape instrument (Table 3) revealed that all 16 respondents with no nasal air emission belonged to the control group. On the other hand, the presence of nasal air emission was established in 20 (100%) of the respondents from the experimental group and only 4 (20%) from the control group. Also, the statistical difference in the presence of nasal air emission between both of the examined groups was confirmed as significant for $p = 0.0000002$. In the experimental group, the most commonly measured degree of nasal air emission was 7 i.e. 10 (50%) respondents, while among 4 of the respondents with nasal air emission from the control group, 3 were with degree 1, while 1 respondent was with degree 2.

Table 3: Number of respondents according to the degree of nasal air emission

See-Scape The degree of nasal air emission	Group		p-value
	Experimental n (%)	Control n (%)	
No nasal air emission	0	16 (80)	no/has $p = 0.0000002^{**}$
Presence of nasal air emission	20 (100)	4 (20)	
The degree of nasal air emission			
1	2 (10)	3 (15)	
2	2 (10)	1 (5)	
3	2 (10)	0	
4	1 (5)	0	
5	1 (5)	0	
6	2 (10)	0	
7	10 (50)	0	

p (Fisher exact test); $^{**}p < 0.01$.

Correlation between results within the experimental group

Table 4 shows the distribution of respondents from the experimental group with Class I, Class II, Class III and Class IV type of cleft established with the Veau classification, and concerning the degree of nasal air emission measured instrumentally with the See-Scape instrument. The highest degree of nasal air emission was measured in 2 of the 7 respondents with cleft only of the soft palate (Class I), 4 of the 9 respondents with cleft lip and palate (Class II), all 3 of the respondents with a completely unilateral cleft lip and palate (Class III), and the respondent with bilateral cleft lip and palate (Class IV).

Table 4: Distribution of respondents according to the type of cleft and degree of nasal air emission

See-Scape The degree of nasal air emission	Veau classification of cleft lip and palate			
	Class I n (%)	Class II n (%)	Class III n (%)	Class IV n (%)
1	1 (14.29)	1 (11.11)	0	0
2	1 (14.29)	1 (11.11)	0	0
3	1 (14.29)	1 (11.11)	0	0
4	1 (14.29)	0	0	0
5	1 (14.29)	0	0	0
6	0	2 (22.22)	0	0
7	2 (28.57)	4 (44.44)	3 (100)	1 (100)

Positive, statistically significant correlation was established between the results obtained with the Veau classification of cleft lip and palate and the degree of nasal air emission ($R = 0.46$; $p = 0.04$) (Figure 3), which points to the conclusion that the degree of nasal air emission rises with the increase of the severity of cleft, and vice versa.

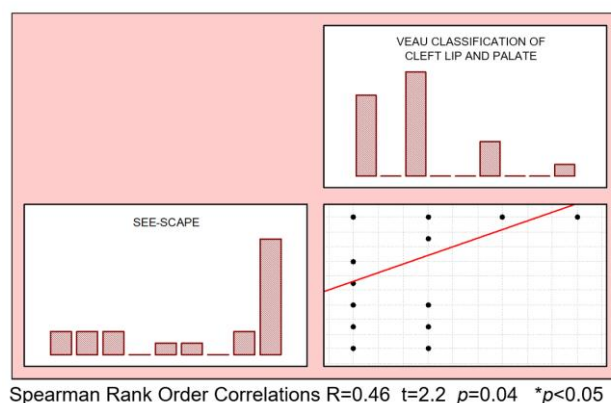


Figure 3: Correlation between the type of cleft and the degree of nasal air emission

Discussion

An anatomical and physiologically functional vocal apparatus plays an important role in correct articulation and speech. The relation of cleft palate or cleft lip and palate – nasal air emission – regular speech requires a separate analysis of each of them because, in such a way, unique information will be obtained about their condition and role in the speech of children with cleft palate or cleft lip and palate. Since it is primarily a matter of dealing with a population of the youngest age, it was important to consider the non-invasiveness and simplicity of the examinations, as well as a fast and precise diagnosis during implementation. These advantages and benefits were gained with the application of the perceptual examination method which determined the grade of severity of cleft palate, but also with the application of an instrumental non-invasive indirect method for determining of the nasal air emission in the speech of children with cleft palate or cleft lip and palate.

The results obtained from the examined variables in this research for the respondents with cleft palate or cleft lip and palate and irregular speech (experimental group) differed from those of the respondents with only irregular speech (control group), i.e., the values obtained for nasal air emission during speech are much higher for the experimental group. Specifically, our research results revealed statistically significant more common presence of nasal air emission in the respondents with cleft palate or cleft lip and palate (experimental group) than those with no cleft (control group).

Within the experimental group, our research results revealed that in the speech of respondents with cleft palate or cleft lip and palate the degree of nasal air emission rises with the increase of the severity of cleft and vice versa.

Some authors worldwide have conducted different research in this field, but each of them analyses and presents, with their approach and from their perspective, the importance of the type of cleft and nasal air emission in the speech of children with cleft palate or cleft lip and palate. Taking into consideration all the research that has been done so far, there is no study, or studies, in the international scientific literature identical to this research where the same methods and number of respondents are used so that a complete comparison of the results obtained could be made. Still, there was an opportunity to make limited comparisons and correlations with similar research by other authors, but only about certain defined variables. It has been proven that the results obtained in our research are, to a certain level, compatible with the results obtained in other research, but also different at times.

Kaewkumsan et al., [16], who examined the degree of hypernasality and formation of an oronasal fistula in 40 patients, aged between 5 and 6,9 years, with non-syndromic cleft palate with or without cleft lip, established that the patients with cleft Class IV and Class III (according to the Veau classification) had a higher total score for hypernasality than patients with Class I. Garcia-Vaquero et al., [17] conducted research about the hearing and speech of 121 patients aged above 6 who had already undergone intervention of the cleft palate. Among other things they also examined the relation between Veau classification and hypernasality. They established a direct association between hypernasality and the Veau grade of cleft palate ($p = 0.053$).

In our paper, the increasing severity of cleft is related to a higher degree of nasal air emission; while it must also be pointed out that hypernasality was noticed in all respondents where nasal air emission was registered. The See-Scape instrument used in our examination indicates nasal air emission during speech rather than nasality, but in that way, it also indicates towards lack of velopharyngeal competence, which is perceived as hypernasality [14]. Also, when it

comes to nasal air emission and hypernasality during the speech, Dotevall et al., [18] have established a strong link between the results of velopharyngeal function and hypernasality and nasal air emission. They examined the correlation between perceptual assessment of speech variables related to velopharyngeal function and the behaviour of nasal air emission in the phase of velopharyngeal closure in the speech of children with or without cleft palate. According to them, the results for nasal air emission related to velopharyngeal closure during the speech were closely related to the perceptual results for velopharyngeal function and hypernasality.

Marrinan et al., [19] had researched 228 patients with cleft palate to determine the relative importance of the surgical technique, the year when it was conducted and the type of cleft on velopharyngeal function. According to them, it was commonly believed that the more severe the cleft was (according to the Veau classification), the weaker the speech results would be. However, according to Marrinan et al., [19] the patients with Veau Class II and IV had weaker speech results than those with Class I and III. They suggest that the predicted gradation of the severity of the cleft described with the Veau classification may not be clinically progressive, at least in respect to the speech results. Similar is the attitude of Timmons et al., [20], who studied a speech of patients after correction of the isolated cleft palate or cleft lip and palate. They point out to the existence of many studies in which focus is to make a correlation between speech results and the degree of anatomical disruption of the primary and the secondary palates (Veau classification). According to their study, some authors found that there was no correlation between the type of cleft and degree of speech disorders, while others that severe cleft entailed worse speech. Still, the results of Timmons et al. did not reveal a simple correlation between the Veau classification and speech. Lam et al., [4] imply that among the studies that examined speech results upon palate correction, certain researchers noticed negative or non-linear association with the severity of the cleft as defined by the Veau classification.

In their experiment, Coston et al., [21] assessed the surgical intervention of m.levator veli palatini based on the velopharyngeal competence acquired as a result of the intervention. An important finding which the results of Coston et al., the show is that the more severe the cleft is, the less likely the surgical intervention is to produce favourable results, i.e., have normal nasality and no nasal air emission [21].

Our study contains certain limitations that should be pointed out. First, future research should include a greater number of respondents so that the obtained results have greater relevance. The second limitation is that this research only established the existence and classification of cleft (cleft palate or cleft lip and palate) using the Veau classification, but no a

measurement of its width. Considering that the types of cleft from the same Veau class can have different width [22] which can affect the degree of nasal air emission during the speech, future research should explore this aspect as well.

Given that certain speech aspects are directly related to the condition of cleft palate or cleft lip and palate and nasal air emission establishing unique information about their condition and status is of great importance for correct diagnosis and rehabilitation of speech disorders in children with cleft palate or cleft lip and palate.

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