

REVIEW ARTICLES

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Review article
Pregledni članci
UDK 616.22-008.5-001-08-053.2
<https://doi.org/10.2298/MPNS2306135P>

SPEECH AND LANGUAGE THERAPY FOR CHILDREN WITH PHONOTRAUMA

LOGOPEDSKI TRETMAN KOD DECE SA FONOTRAUMOM

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Summary

Introduction. Proper voice production requires coordinated, synchronous and efficient functioning of the larynx, respiratory, resonance and articulation mechanisms. Phonotrauma is trauma to the laryngeal mechanism and includes any behavior that results in injury to the vocal folds. The aim of this research was to identify and describe the characteristics of voice disorders in children that occur as a result of phonotrauma, approaches and techniques in speech and language therapy of these speech disorders, and the effects of their application. **The characteristics of phonotrauma in children** reflect the characteristics of hyperfunctional voice disorders, as they usually arise as a result of voice abuse. **Speech and language therapy of children with phonotrauma** includes identification and reduction, i.e. elimination of the vocal behavior that had caused the voice disorder. In addition, treatment focuses on a vocal hygiene program and the use of various direct treatment techniques to achieve appropriate voice production. **Effects of applying direct and indirect treatment techniques** is demonstrated by the reduction of the size of the lesion, the degree of dysphonia and voice disorders, hoarseness, breathiness in the voice, the absence of recurrence, and the achievement of optimal values of the acoustic parameters of the voice. **Conclusion.** In most cases, children can master the correct way of producing speech after a short period of speech and language therapy. However, in order to achieve this goal, it is necessary to actively involve children, their parents, and other people from the immediate and wider social environment.

Key words: Speech Therapy; Language Therapy; Voice Disorders; Voice Training; Child; Dysphonia; Hoarseness

Introduction

Proper voice production is the result of vibration of the vocal cords and other modifications made with the help of the pharynx, lips and the nasal cavity. Thus, voice is produced by the work of the vocal cords, which belong to the phonation organ, with the synchronous action of the respiratory organs

Sažetak

Uvod. Pravilna produkcija glasa zahteva koordinisanu, sinhronu i efikasnu funkciju larinksa, kao i respiratornog, rezonatornog i artikulatornog mehanizma. Fonotrauma predstavlja traumu laringealnog mehanizma i obuhvata svako ponašanje koje dovodi do povrede glasnica. Cilj ovog rada bio je da se sistematskim pregledom dostupne i relevantne literature utvrde i opišu karakteristike poremećaja glasa kod dece koji nastaju kao posledica fonotraume, pristupi i tehnike u logopedskom tretmanu ovih govornih poremećaja, kao i efekti njihove primene. **Karakteristike fonotraume kod dece** odražavaju osobine hiperfunkcionalnih poremećaja glasa s obzirom na to da oni najčešće nastaju kao posledica zloupotrebe glasa. **Logopedski tretman dece sa fonotraumom** obuhvata identifikaciju i smanjenje, odnosno, eliminisanje onog vokalnog ponašanja koje je izazvalo poremećaj glasa. Pored toga, tretman je usmeren na program vokalne higijene i primenu različitih direktnih tehnika tretmana u cilju postizanja adekvatnog generisanja glasa. **Efikasnost primene direktnih i indirektnih tehnika tretmana** ogleda se u smanjenju veličine lezije, stepena disfonije i poremećaja glasa, hrapavosti, šumnosti, izostanku recidiva, kao i u postizanju optimalnih vrednosti akustičkih parametara glasa. **Zaključak.** U većini slučajeva deca nakon kratkog perioda logopedskog tretmana mogu da savladaju pravilan način govorne produkcije. Međutim, za postizanje ovog cilja neophodno je aktivno uključivanje dece, njihovih roditelja, kao i drugih osoba iz neposrednog i šireg socijalnog okruženja.

Glavne reči: terapija glasa; terapija govora; poremećaji glasa; trening glasa; dete; disfonija; promuklost

and resonators [1]. Correct vibration of the vocal cords is an important prerequisite for the production of an adequate voice, and any asymmetry within the larynx can lead to disturbances in the movements of the vocal cords [2].

Phonotrauma, which is also referred to as voice abuse, is any behavior or phenomenon that results in strain and/or damage to the vocal cords [3]. It is

trauma to the laryngeal mechanism, i.e., the vocal cords, resulting from various vocal behaviors that include inappropriate use of vocal pitch and volume, and activities such as yelling, screaming, cheering, and throat clearing. These vocalizations are often accompanied by an elevated tone and hyperactivity of the larynx [4]. In addition, phonotrauma can be caused by improper hydration, improper breathing patterns, excessive stress or tension, inadequate coping mechanisms in dealing with negative emotions, and insufficient recovery time of the vocal cords [5].

Some authors believe that the term phonotrauma is more appropriate than the term voice abuse because the former does not contain negative connotations. Parents may equate the term abuse with the act of bullying, insulting, or harming the child and, consequently, adopt a hostile attitude toward the speech therapist. They also often confuse the terms “verbal abuse” and “name-calling”. In addition, the term “abuse” suggests that the behavior is intentional and that the child has “violent personality”.

The characteristics of vocal habits present in childhood help to find and analyze possible causes and factors that contribute to the development of vocal changes [6]. The habit of “shouting” and speaking loudly during and outside of play is common in childhood and may be the cause of chronic hoarseness resulting from impaired muscle coordination necessary for proper phonation [7]. As many children participate in activities in which voice is abused, it is very important to understand the effects of such behaviors on the development of dysphonia and other anatomical and functional changes in the phonation organ [8].

The aim of this research was to identify and describe the characteristics of voice disorders in children that occur as a result of phonotrauma, approaches and techniques in the speech and language therapy of such speech disorders, and the impact of their application through a systematic review of the available and relevant literature.

Characteristics of phonotrauma in children

Early recognition of behaviors that are considered misuse of voice is very important, because voice is not only a sound produced by the vibration of the vocal cords, but also affects the communication competence of the speaker. This competence depends on the modulation of the sound, the adjustment of the intensity, the resonance, and the type of voice that conveys the appropriate emotional aspects and allows the characterization of the child's personality [6]. It is considered that disorders resulting from voice misuse are the most widespread and common voice disorders [3]. The three most common diagnoses associated with voice disorders in children younger than three years of age are subglottic stenosis, laryngomalacia, and vocal fold nodules, while vocal fold nodules, subglottic stenosis, and papillomas are most common between the age of 4 and 11 [9]. Vocal fold nodules and papillomas, as benign

lesions of the vocal cords, are the main causes of voice disorders in children with phonotrauma [10].

Functional injuries of the larynx occur as a result of voice misuse. Voice functional disorders are caused by inadequate use of the phonatory apparatus [1]. Phonotrauma leads to increased effort and tension of the throat muscles, which is a risk factor for the development of hyperkinetic dysphonia and vocal nodules [11]. Most voice disorders in children belong to the group of hyperfunctional voice disorders, which are mainly manifested by poor breath control, tension in the neck and root of the tongue, typical contractions and tension in voice, and hoarseness [4]. The majority of chronic hoarseness is due to structural changes resulting from phonotrauma and includes numerous changes in voice quality [12]. The most common conditions resulting from voice abuse are laryngitis, vocal fold nodules, polyps, cysts, thickening of the vocal cords, and contact ulcers [3, 13, 14].

When considering the consequences of phonotrauma, it is important to give equal attention to the negative psychological and/or behavioral effects. These consequences may be related to bad habits that lead to excessive effort or tension during vocalization, resulting in misdirected and ineffective communication, as well as negative reactions from communication partners and the appearance of negative stereotypes [15]. Aggressiveness and disturbed relationships with peers may occur in these children. All of these factors can lead to difficulties in participating in social interactions, as well as the development of shyness, fear, and social anxiety in children with phonotrauma [6, 15].

Speech and language therapy of children with phonotrauma

Rehabilitation of children with phonotrauma involves much more than just eliminating behaviors associated with voice abuse. As most disorders caused by voice abuse are considered reversible, the treatment approach should include careful identification and gradual elimination of voice behavior causing the voice disorder [3]. Identification and reduction, i.e., elimination of voice abuse, are the primary goals of speech and language therapy for hyperfunctional disorders with or without anatomic changes, such as vocal nodules, polyps, or contact ulcers [16]. In assessing and determining the treatment program, it is important for the speech-language pathologist to inform the child and parents about how to limit or reduce the vocal behavior that reflects the phonotrauma. In many cases, a short course of speech therapy may be sufficient for the child to master the appropriate vocal techniques and the correct way to produce speech. For this reason, the treatment of voice disorders lends itself to the application of primary and secondary prevention models [17]. Primary prevention involves eliminating or preventing the onset and development of voice and communication disorders. Primary prevention programs in functional voice disorders aim to reduce excessive use of voice in preschool- and school-age

children, which is achieved through educational programs for asymptomatic children at this age. Secondary prevention involves early detection and treatment to prevent worsening of the condition and includes mass screening and early intervention [18].

One of the programs for prevention of voice change in school-age children [18] involves training children and teachers in two half-hour sessions per week for two weeks. The speech production methods and the vocal apparatus anatomy are explained in the first lesson. Terms such as vocal cords, voice quality, and hoarseness are explained to the participants. In addition, voice recordings are presented to the children followed by a discussion about the voice quality of the participants in the recording. The second lesson includes a discussion of adequate and inadequate voice quality. The participants will be asked about various childhood activities and behaviors associated with specific vocal behaviors and possible vocal abuse. Children are then introduced to the characteristics of impaired vocal qualities and a discussion begins about situations associated with voice abuse. The speech therapist lists possible situations while the children list additional activities that may cause phonotrauma and hoarseness. In addition, the children are presented with a list of nonviolent vocal behaviors, and they contribute in the same way. Afterwards, short stories can be read to the participants that feature characters who abuse their voices and use them correctly to encourage them to identify different vocal behaviors on their own.

Early intervention is considered critical for children who have developed a voice disorder and for children who are assessed to be susceptible to the development of such disorders.

In addition to applying these models, the treatment of voice disorders resulting from phonotrauma includes the application of direct and indirect techniques [11]. The aim of using direct techniques is to change incorrect phonatory patterns, voice production methods, and breathing mechanisms, while indirect techniques target the psychological and social aspects of vocal emission [11].

Direct and indirect treatment techniques

Direct treatment techniques focus on the part of the vocal system where anatomical changes and pathology are present, and on modifying vocal behavior to achieve appropriate voice production [19]. This goal is achieved by modifying neuromotor planning and requires the child's active participation in the exercises [20]. Direct treatment techniques include voice function exercises, resonance therapy, and the use of a semi-occluded vocal tract [19].

Exercises to improve vocal function involve direct manipulation of parts of the effector communication system to achieve physiological balance between them [21]. In addition, the exercises aim to strengthen the muscles of the larynx and improve adduction of the vocal cords. This treatment approach involves the use of a series of four systematically organized exercises [22]. The first exercise

is a warm-up exercise for the voice. The second exercise allows the vocal cords to stretch by gradually changing the pitch range from low to high notes. The third exercise serves to contract the vocal cords where the child needs to change the pitch range from higher to lower notes in this case. The last exercise is a 'strength exercise' aimed at achieving full adduction of the vocal cords.

Exercises for achieving the optimal vocal resonance aim to create a feeling of vibration on the lips and face and to achieve adequate vibration of the vocal cords without straining the muscles of the larynx [23]. This mainly includes different singing techniques and their variations [22]. Right at the beginning, the child is asked to purr their lips as if asking their communication partner for additional clarification ('mmm?'). After that, singing, chanting or reciting words and non-words containing the sounds 'm' and 'v' is used to detect the feeling of vibration or 'tickling' on the lips [23]. Singing is eliminated over time when the child reaches the appropriate resonance in natural speech.

The goal of using a semi-occluded vocal tract is to alter the vibration pattern of the vocal cords [24]. Increased subglottic and decreased glottic pressure allow adequate adduction and abduction of the vocal cords without the need to use excessive muscle force [25]. The term semi-occluded vocal tract implies various maneuvers that increase the interaction between the airflow directed by the vibration of the vocal cords and the resonance properties of the vocal tract [22]. In the treatment, the mouth is opened in a reduced manner during phonation with the help of a tube or straw [26]. Making bubbles in water with the help of a straw, gargling, and prolonged phonation of the vowel 'u' are the main components of this approach [23]. As with the previously described exercises, these activities gradually progress to the production of syllables, words, and sentences.

As mentioned earlier, indirect treatment techniques target cognitive, psychological, and physiological aspects, as well as changes in the child's behavior and physical environment. They are divided into external, which are performed by a speech therapist, and internal, which are applied independently by the child [27]. To change behavior, the child, parents, and people in the immediate and wider social environment must be educated on how to recognize and eliminate inappropriate vocal behavior.

After the speech-language pathologist identifies the situations in which vocal inflexion occurs, s/he should work with the child and the parents to determine how many times a day the child participates in such activities. If it is an older child, s/he can independently make a graph of the frequency of such situations, which is a kind of 'visual reminder' [16]. This chart raises the person's awareness of what activities they participate in throughout the day, which gradually leads to a reduction in those behaviors that can lead to voice abuse. Depending on the child's age, siblings, peers, and teachers may also be involved in this process. Any reduction in inappropriate vocal behavior should be

highlighted and praised, as positive reinforcement is considered more effective than criticism [5]. The effectiveness of this and similar approaches depends largely on the speech therapist's ability to motivate the child to stop inappropriate behavior [1]. Speech and language therapy can only lead to a positive outcome when the frequency of behaviors that lead to voice abuse is significantly reduced.

In addition to behavior, modification of vocal physiology is another indirect treatment technique. This includes the use of vocal hygiene, which is often the first step in beginning speech and language therapy. Structured vocal hygiene programs reduce or eliminate the risk of vocal trauma and promote appropriate vocal behavior [28]. The main goal of the program is to identify, modify and eliminate the factor that caused the disorder [1]. Vocal hygiene refers to the correct use of voice to eliminate hyperactivity or excessive contraction of the laryngeal mechanism [29]. It is considered the basis for the treatment of voice disorders because it helps the child develop awareness of their problem and voice disorder [30]. The vocal hygiene program for children with vocal cord trauma caused by vocal fracture includes auditory skill development, reduction of total time of speech production during the day, vocal intensity and frequency, vocal rest periods after vocal stress, adequate hydration, and patterns of proper diaphragmatic breathing for better support during phonation and reduction of laryngeal hyperactivity during speech [31].

Effects of applying direct and indirect treatment techniques

The effectiveness of speech and language therapy requires the obtained results to indicate a clinically significant change that is generalized and persists during long-term follow-up, and that the estimated voice parameters reach threshold values [32]. The results of a study on the voice quality change after the application of exercises to achieve optimal voice resonance in children with vocal nodules [33] showed that there was a change in fundamental frequency, and in parameters related to frequency variability and voice intensity. These parameters change due to the presence of vocal nodules, and their inadequate function can significantly affect the voice quality. In addition, positive changes were noted in hoarseness, roughness and breathiness in voice. The six-week speech and language therapy included exercises for relaxation of the throat, lips, tongue, and pharynx muscles, and the establishment of proper breathing. Subsequently, the subjects repeated the sequence 'mama' to feel the vibration in the nasal cavity, sinuses and face area. Words, phrases, and texts beginning with the sound 'm' were used as the treatment progressed. Reduction of roughness, hoarseness, and breathiness in voice was reported as a positive result of treatment of children aged five to ten with cysts and nodules on the vocal cords, using semi-closed vocal tract exercises [25]. The treatment involved blowing air through a straw placed between the teeth

and lips, producing sounds. A decrease in hoarseness and breathiness in voice was noted after three minutes of such phonation, while a lesser degree of dysphonia and hoarseness in the voice was noted after five minutes. The improvement in voice quality was determined by assessing acoustic and auditory-perceptual parameters. A significant reduction in the degree of dysphonia, the presence of vocal nodules, and a change in the level of fundamental frequency were reported as positive results of the eight-week vocal hygiene program [34]. However, no positive changes were observed in the values of fundamental frequency or in the parameters related to the variability of vocal intensity in this study. A combination of direct and indirect treatment techniques is thought to provide optimal results, as they include both neurophysiological and behavioral changes in children with voice disorders [20].

Positive results of simultaneous application of direct and indirect treatment techniques were shown in a study of children under the age of 18 with dysphonia caused by benign changes in the vocal cords [35]. Vocal hygiene, semi-occluded vocal tract exercises, and exercises to achieve optimal vocal resonance were used in the treatment. Auditory-perceptual and acoustic measurements showed improvement in the subjects' voice quality in terms of fundamental frequency, effort in speaking, pitch and intensity of voice, hoarseness, loudness, and degree of voice disturbance. Significant changes in the values of these parameters indicate a functional improvement in voice quality.

The results of a study on the use of vocal hygiene and exercises to achieve optimal vocal resonance in children with vocal nodules showed a significant improvement in the severity of dysphonia as well as in the Voice Impairment Index as a parameter of auditory-perceptual voice analysis [36]. The treatment consisted of six consecutive one-hour exercises performed once a week. Positive results were observed in terms of voice quality, psychosocial functioning, and communication, although no changes were observed in the values of acoustic parameters, i.e., fundamental frequency, and parameters related to variability of frequency and intensity of voice.

The effectiveness of treatment can be further improved by active parental involvement. The results of studies on the effects of involving mothers in the treatment of voice disorders show that the use of voice function and vocal hygiene exercises with the active participation of parents can increase the child's motivation and the fulfillment of treatment goals [37]. During the first week of treatment, the children were introduced to the vocal hygiene program and ways to reduce vocal fracture. They were given instructions on how to improve vocal hygiene, which included avoiding speaking in a noisy environment, during play and physical activity, consuming fluids, ensuring adequate humidity in the environment, and observing periods without speech production during the day. During the following week, they were trained to perform vocal exercises, such as relaxation, warm-up and stretching exercises, mouth and tongue

fluttering, and proper breathing. They also practiced producing the “molm” sequence, changing the pitch range. The mothers were present during the treatment and were involved in performing the exercises and vocal hygiene programs. In this study, an increase in the value of fundamental frequency, maximum phonation time, a decrease in the variation of fundamental frequency and intensity, and the score in the voice impairment assessment instrument were recorded.

The studies investigating the effects of using different speech and language therapy techniques mainly involved children with vocal nodules, cysts, and papillomas, which are the main causes of voice disorders in children with phonotrauma. The study results indicate statistically significant changes in the children’s voice characteristics after treatment. They refer to the reduction of the size of the lesion, the degree of dysphonia and voice disorders, hoarseness, breathiness in the voice, the absence of recurrence, and the achievement of optimal values of the acoustic parameters of the voice. In addition, no deterioration was observed after the speech and language therapy, and no side effects of the application occurred. Because different direct and indirect treatment techniques and their combinations were used, no explicit or specific treatment protocol was followed because of the different needs of the subjects. When it comes to comparing different treatment techniques, it is too early to determine which technique is more effective in practice. This is due to a variety of variables, such as the characteristics of the children, the type of treatment technique, the appropriateness of the diagnosis, and the instruments used in the assessment. In addition, a greater number of studies in this area are needed to better define the meaning of the term “effectiveness of speech and language therapy” and to determine the specific components of treatment that affect its outcome. The most common limitations of the studies were related to insufficient sample size and the lack of control groups to be included to exclude the placebo effect. In addition, the effects of different treatment durations and exercise intensities during this period need to be compared.

Application of computer technology in the treatment of children with phonotrauma

In the early 21st century, various computer hardware and software began to be used in speech and

language therapy of voice disorders, mostly in the form of “therapeutic games” for children. Computerized treatment approaches offer the possibility of automatically recording, analyzing, and providing feedback on certain speech parameters, as well as storing the resulting data. In this way, more accurate, easier and faster diagnosis and rehabilitation of voice disorders is ensured [38]. These systems can be focused on the end product or the process itself. Various computer programs provide important visual feedback about the quality of the voice, such as the correct pitch or intensity. When the child speaks into the microphone, the computer program detects the pitch and volume of the voice and displays it on the screen. This provides feedback on whether the specified goal has been achieved [39]. The integration of auditory and visual information about the nature of speech production leads to improvement in speech perception [40]. In addition to visual feedback, other programs, such as a computerized voice laboratory, provide acoustic or aerodynamic information that has a positive effect on the success of the treatment and is a great help for both the child and the speech therapist [41]. This type of treatment can provide the necessary motivation for modulating the child’s vocal behavior as well as for the process of generalizing what has been learned.

Conclusion

Voice disorders resulting from abuse are a very common disorder in preschool and school-aged children that can have significant social and educational implications. Because voice disorders are also communication disorders, the literature emphasizes the importance of prevention programs and the role of speech-language pathologists in their implementation. In addition, voice treatment includes the use of direct and indirect treatment techniques, as well as computer technology, the application of which has a positive impact on the success of treatment.

The efficacy and long-term effects of various specific treatment techniques are actively studied in the literature. It is believed that treatment planned based on the child’s age, needs, abilities, developmental level, and learning style can lead to positive outcomes. Active participation of parents as well as other people from the social environment is also necessary to reduce and eliminate voice abuse.

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Rad je primljen 28. VI 2023.

Recenziran 13. X 2023.

Prihvaćen za štampu 13. X 2023.

BIBLID.0025-8105:(2023):LXXVI:5-6:135-140.