The role of the assessment of posture and movement patterns in re-education and improvement of voice in functional voice disorders

Krzysztof Cichocki[1]

[1] Faculty of Health Sciences, Poznan University of Medical Sciences, Poznań, Poland

Correspondence to: Krzysztof Cichocki, email: krzysiekcichocki@gmail.com

DOI: https://doi.org/10.5114/phr.2022.119747

Received: 13.01.2022 **Reviewed:** 06.02.2022 **Accepted:** 08.02.2022

Abstract

Background: Observation of patients with functional voice problems with typical musculoskeletal symptoms revealed the frequent adoption of a characteristic head position in excessive anterior extension, a lack of coordination, and sense of space. So far, there are lack of standards and the difficulty in obtaining objective parameters in the study of both voice and abnormal posture disrupted at a functional level.

Aims: Assessment of the impact of physiotherapeutic methods, associated with improving posture and movement patterns based on existing voice disorders, on enhancing voice emission.

Material and methods: The impact of physiotherapeutic treatment on the voice emission was evaluated. Self-constructed questionnaire and validated scales: Vocal Tract Discomfort (VTD) and Laryngeal Manual Therapy Palpatory Evaluation (LMTPE) were used.

Results: Teachers accounted for 86.4% of the participants in the study. The maximum phonation time has not changed significantly in either of the groups (except for 1 measurement). Therapy resulted in a reduction in the frequency and intensity of symptoms. The head angle in standing position and the chest angle in sitting positions improved significantly in the study group.

Conclusions: Physiotherapy for altering head angle and improving head and neck alignment in a neutral position has an impact on reducing the frequency and intensity of symptoms associated with functional voice problems. Normalizing muscle tone, the larynx alignment and improving the mobility of structures near the vocal tract in patients with excessive head protraction has the effect of improving maximum time results and reducing symptoms.

Key words

cervical spine, physiotherapy, posture, voice disorders, digital photogrammetry, teachers.

Introduction

In-depth observation of patients with functional voice problems with typical musculoskeletal symptoms revealed the frequent adoption of a characteristic head position in excessive anterior extension, a lack of coordination, and sense of space. There is a common view in the literature that a good ergonomic posture is crucial for the quality of the human voice [1-3]. Contrary to widespread knowledge about the effect of correct posture on the voice, few studies are found in the literature. This is due to the lack of standards and the difficulty in obtaining objective parameters in the study of both voice and abnormal posture disrupted at a functional level.

The neutral position is the most favorable from the perspective of the loading force on the structures of the cervical spine region. This is the zone where minimal loading forces act on the skeletal system, intervertebral discs, and other soft tissues. Existing postural abnormalities result from passive suspension on the passive structures of the osteochondral system and lack of active stabilization leading to overload and muscle dysfunction [4]. Bone and muscle changes in the cervical spine, shoulder girdle, and temporomandibular joint (which form a functional unit – **Figure 1**), can lead to functional impairment. Common interactions between the structures of this area will cause various symptoms, such as a change in muscle tone, pain, chewing and swallowing problems, phonation disorders, respiratory problems.

Rental et al. [7] reported that the most common dysfunctional postures while speaking include: non-ergonomic head positioning, a back that is excessively curved in its upper part, and a position with arms raised. The simultaneous adoption of a head positioning posture, together with a hunched upper back, are associated with specific vocal symptoms [6]. Among the undesirable head positions, pushing the head forward is typical, and common, especially among the approximately 75% of teachers with voice disorders. Functionally, the sternocleidomastoid muscles play the most important role in head extension and rotation. Their excessive tension causes misalignment of the head, thus influencing the occurrence of undesirable vocal symptoms [7]. Excessive anterior head position elevates the larynx by shortening the suprahyoid muscles, especially: the stylohyoid muscles and the posterior belly of digastric muscle. These changes affect the nasal resonators and thus reduce the resonance voice properties [8-10].

The above connection forms the hyoid-larynx complex, suspended in the area between the mandible and the manubrium of sternum due to a system of multidirectional connections of external and internal muscles. The tension relations of the external contractile structures, where the external muscles move the entire hyoid-larynx complex, will be important for spatial alignment. Describing the reciprocal relationship of the positioning of the larynx suspended between the working muscles in the central neck, Rubin et al. [10], compare it to a 'constant battlefield' between the deep extensor and flexor muscle groups of the neck and upper back, where the larynx in the case of a muscular imbalance can be seen as a 'casualty in this battle'.

In the area of voice improvement and rehabilitation, a physiotherapist's tasks will include prevention of compensations and overload from the musculoskeletal system and direct work on the tissues around the vocal tract. The aforementioned anterior head postures described in the literature and co-occurring during speaking, affect the voice. Therefore, it is important to assess the posture adopted for correct work and voice ergonomics in patients with functional dysphonia.

Aims

This study aimed to assess the extent to which physiotherapy methods related to improving posture and movement patterns can have an impact on improving voice emission.

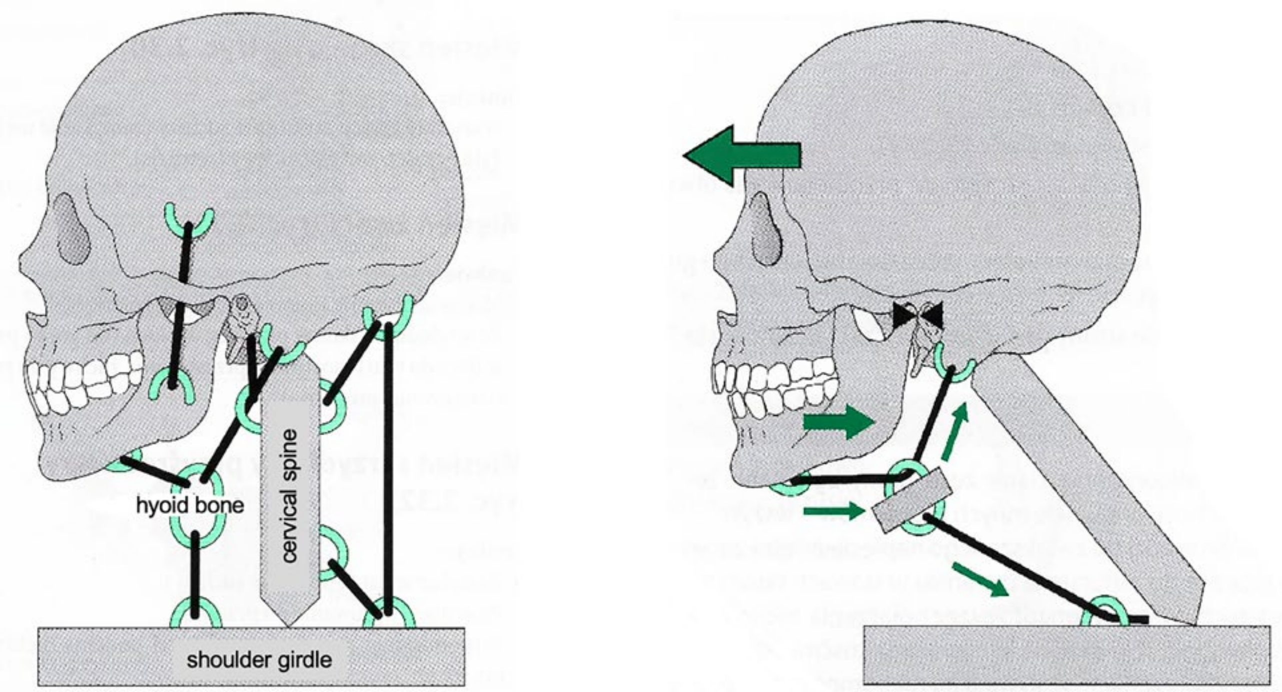

Figure 1. Functional unit: mandible / hyoideo-laryngeus complex / cervical spine [5].

Material and methods

Participants

Sample of 22 patients staying at the Railway Spa Hospital in Ciechocinek, for 24 days on a rehabilitation stay, participated in the study. They were referred by ZUS units for rehabilitation therapy as part of disability prevention for people with voice disorders. Respondents were divided into two groups. The study group consisted of 12 people (54.5%) who were diagnosed with functional disorders of the vocal tract structures and had an abnormal posture. The control group consisted of 10 people (45.5%) who were also diagnosed with voice problems resulting from functional disorders of the vocal tract structures and representing normal posture.

Selection

Inclusion criteria for the study were: diagnosed functional voice dysphonia, no musculoskeletal and/or surgical trauma to the tissues of the vocal tract in the last six months, no temporomandibular joint, neurological or ophthalmic conditions as well as poor posture characterized by a deepened head protraction. The scope of the study included: the first day prior to the therapeutic process, the collection of information as part of the subject interview and the completion of the Vocal Tract Discomfort (VTD) questionnaire, and a physical examination, which included: measurement of maximum phonation time (MPT), angle measurements, laryngeal palpation according to the Laryngeal Manual Therapy Palpatory Evaluation (LMTPE) scale. On the following 16 days, the subjects participated in therapeutic activities: patients in the control group underwent manual voice therapy, which mainly consisted of soft tissue therapy of the vocal tract area. Patients in the study group also participated in manual voice therapy and exercises to correct abnormal posture. The final day was dedicated to information gathering and all the tests from the first day were carried out again with the exception of the anamnestic interview.

Measurements

For the medical interview that preceded the physical examination, the proprietary Subject Research Questionnaire (SRQ), the VTD questionnaire, the LMTPE questionnaire, a stopwatch and a digital camera built into a smartphone (Samsung Galaxy A50 with Android 10 operating system), Scodiac v2.6 software installed on a desktop computer (x64-based PC with Microsoft Windows 10 Home operating system) were used.

The MPT was a measurement taken before and after therapy, during which the subject was asked to phonate the vowel 'a' during one full exhalation after inhaling. The test result was the average of the phonation time calculated from three consecutive trials. For comparison, the results of the aerodynamic parameter MPT from the medical examination preceding the physiotherapist's assessment were extended. A time of >20 seconds has been accepted as the norm; measurement values below 20 seconds are indicative of reduced phonation time and lower phonatory capacity [11].

The VTD Scale involved asking each patient both before and after therapy to subjectively assess the occurrence of sensations or discomforts experienced during speech or associated by the patient with the phonation process and to complete a questionnaire. The VTD scale relates to eight symptoms from the vocal tract (burning, tightness, dryness, pain, scratching, tenderness, irritation, feeling of noodle-like object in the throat), assessed in subscales of frequency and severity. The total score can range from 0 points (8 questions with answers of 0 points each) to 48 points (8 questions with answers of 6 points each) [11-13].

The digital photogrammetry examination was carried out using the digital camera photography built into a smartphone on a stable tripod. The participants were photographed in their undergarments with their body exposed as much as possible. The examiner marked the following landmarks on the subject's body: the C7 spinous process, a point located in the central region of the jugular notch, the point of transition of the manubrium into the sternal body, the central point of the right and left acromion process, a point/line projected from the center of the clavicle onto the pectoral girdle. The subject then was positioned for a photographic examination on marked, intersecting lines in a pre-prepared area. The examinee faced a digital camera located 100 cm from the ground and 250 cm away from the subject. Prior to therapy, participants were photographed in habitual (spontaneous, relaxed) postures while standing and sitting, to obtain data from which the control and study groups were created. The control group consisted of individuals for whom spontaneous standing and sitting were characterized by correct posture. When selecting for the study group, particular attention was paid to excessive forward head posture, which was the main criterion for inclusion. The projection of the vertical line from the edge of the chin not extending beyond the contour of the manubrium of sternum (approximately 1/3 of the length of the sternum) was accepted as the norm. Extension of the chin beyond this boundary was indicative of impaired posture and deepened head protraction. In addition, attention was paid to whether the auricular lobule seen in the sagittal plane protruded beyond the contour of the anterior edge of the clavicle. Patients in the study group were photographed in actively corrected posture after therapy, where active posture correction involved the patient performing movements aimed at improving posture. Once in the correct position, the first photograph was taken capturing the posture from the front in a standing position. This was followed by photos taken respectively with the left side facing the camera, the back facing the camera, the right side facing the camera and a sitting position with the right side facing the camera. A further step was to obtain data using a semi-automated computer program to calculate quantitative postural parameters. For this purpose, the Scodiac software was used, which allowed the digital photograph to be analyzed through the captured snapshot during the examination and the subsequent editing and analysis of the current screen display with the view of the taken photograph and, finally, to obtain parameters from the photograph in the sagittal plane: sacral angle, lumbar lordosis angle, thoracic kyphosis angle, thoracic tilt angle, head angle. The data was obtained through previously marked points on the patient's body and characteristic anatomical contours of the body, with the values calculated automatically. For the final analysis, the two most relevant parameters for the study of patients with functional dysphonia were used: chest incline angle (CI) – the angle between the horizontal line and the line connecting the C7 spinous process to a point in the central region of the jugular notch, and head-posture angle (HP) – the angle between the horizontal line and the line connecting the C7 spinous process to the external auditory canal (**Figure 2**).

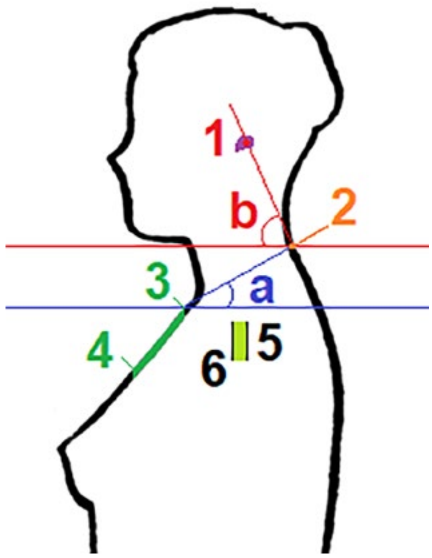

Figure 2. Method of determining the line with marking the points forming the photographic angles: a – chest angle, b – head angle; 1 – central point of the external auditory canal, 2 – spinous process of the C7, 3 – point of the central region of the jugular notch, 4 – transition of the sternal manubrium into the sternal body, 5 – line in the middle of the acromion process dividing it into anterior and posterior parts, 6 – line projected from the posterior surface of the middle of the clavicle onto the shoulder.

Conditions

The adopted research methodology was carried out according to a concept and accepted standardization of the study introduced by Stolinski et al. [14] with the exception of the height and distance of the digital camera positioning in relation to the subject. Due to the measurements being taken in adults and the available floor space of the room, the settings of the recording equipment had to be adapted by the author to the conditions of the study, for the images to be legible. Manual examination was done by palpation assessment and was performed both before and after therapy. For both groups, palpation of the larynx and soft tissues of the vocal tract area was assessed using the LMTPE scale created by Mathieson et al. [11]. The LMTPE scale, translated into Polish, was used for the clinical examination of the individual items in the above assessment [15].

Statistical analysis

Statistical analysis was performed using Statistica 13.1. by StatSoft. The collected data was organized and presented graphically using Microsoft Excel. The choice of the parametric test was conditioned by the fulfilment of its basic assumptions, i.e., the conformity of the distribution of the measured variables with the normal distribution, which was verified by the Shapiro-Wilk test. Descriptive statistics were calculated for each variable: mean, median, and standard deviation. The Independent Sample T-test or alternatively the non-parametric Mann-Whitney U test were used to assess differences in the two groups. The Dependent Sample T-test or alternatively the non-parametric Wilcoxon signed-rank test was used to assess within-group variability in the two groups. The level of statistical significance was assumed at $p<0.05$.

Results

MPT measurements in the study group did not significantly differ: before and after therapy for the first and second out of the three measurements taken by the physiotherapist, as well as for the mean of the three measurements taken by the physiotherapist and for the measurements taken by the doctor ($p>0.05$). However, the third measurement, taken by the physiotherapist, was statistically significant ($p=0.018$). The mean phonation time in each measurement increased, and in this particular case, it was a significant change, from 11.12 sec. ± 5.55 sec. before therapy to 16.42 sec. ± 6.34 sec. after therapy. The maximum phonation time in the treatment and control groups before therapy was compared. Initially, significant differences were found in the third measurement taken by the physiotherapist, and also for the mean score of the physiotherapist from the three measurements ($p=0.011$ and $p=0.039$, respectively). The mean score for control subjects was significantly higher (17.78 sec ± 6.48 sec) than the mean score for subjects in the treatment group (11.8 sec ± 5.81 sec). Overall, the baseline phonation times of those in the study group were longer than of those in the control group.

The frequency of symptoms before and after therapy was significantly different between the study group in terms of experiencing tension ($p=0.004$), dryness ($p=0.007$), pain ($p=0.008$), scratching ($p=0.037$) and irritation ($p=0.049$). The results obtained in the post-therapy measure were significantly lower in terms of the listed symptoms when compared to the results obtained before therapy. The values obtained for the assessment of other symptoms, i.e., burning, tenderness and a feeling of noodle-like object in the throat, were also lower in the post-therapy measurement than in the pre-therapy one, but these were not statistically different ($p>0.05$). Symptom severity was assessed in a similar way to the symptom frequency assessment, in pre- and post-therapy measurements in the study and control groups. In the treatment group, statistically significant changes in symptom severity were observed in tension ($p=0.011$), dryness ($p=0.011$), pain ($p=0.011$), and scratching ($p=0.012$). Each time after treatment, these symptoms were significantly less severe.

In the photographic baseline measurement, the pre-therapy head angle score was significantly different between the study and control groups in both the standing ($p=0.002$) and sitting ($p=0.014$) positions. In each of these two measurements, those in the control group obtained higher angle values. There were no differences in the size of the chest angles, either while standing or sitting ($p>0.05$) (**Table 1**, **Figure 3**).

In the treatment group, there was a statistically significant change in the post-therapy measurement relative to the pre-therapy measurement of head angle value in the standing position ($p<0.001$) from 55.16° ± 4.62° to 59.97° ± 4.59° and in the chest angle in the sitting position ($p=0.002$) from 33.14° ± 4.59° to 28.45° ± 3.79°. The values of the remaining measurements – head angle in the sitting position and chest angle in the standing position - were not significantly different in the two measurements ($p>0.05$) (**Table 2**, **Figure 4**).

Table 1. Angular measurements in the study and control group before therapy – baseline assessment of patients.

Angular measurements before therapy [°]	Study group			Control group			t	p
	x̄	Me	SD	x̄	Me	SD		
HPp-S	55.16	56.05	4.62	60.59	60.75	1.63	**-3.53**	**0.002**
Cip-S	25.22	25.50	3.96	25.24	23.40	6.62	-0.01	0.992
HPp-SI	52.10	51.45	7.72	59.12	58.55	3.09	**-2.69**	**0.014**
Cip-SI	33.14	32.50	4.59	28.44	30.00	6.13	2.06	0.053

Abbreviations: x̄ – arithmetic mean, Me – median, SD – standard deviation, t – Student's t-test value for independent variables, p – test probability value, HPp-S – head angle in standing position, Cip-S – chest angle in standing position, HPp-SI – head angle in sitting position, Cip-SI – chest angle in sitting position.

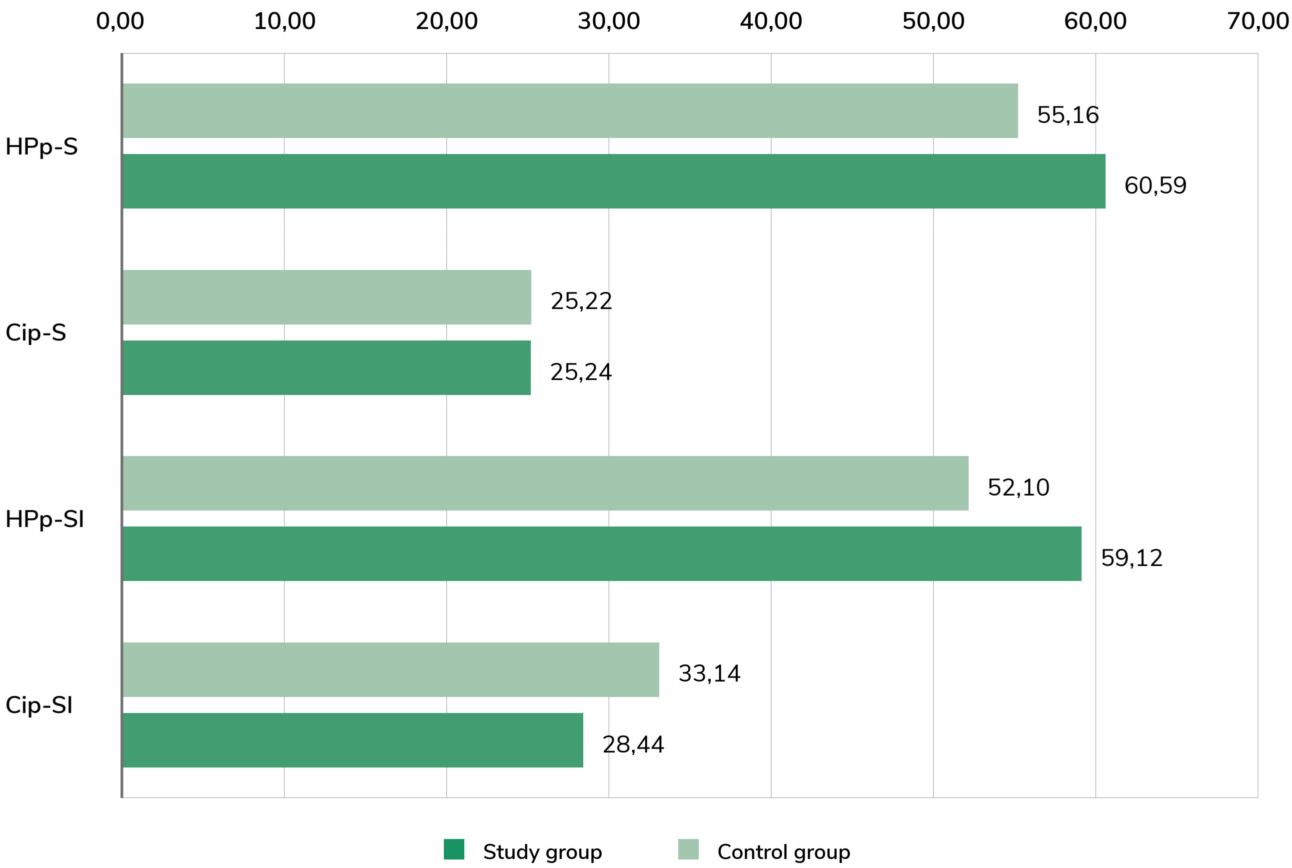

Figure 3. Angular measurements in the study and control group before therapy – baseline assessment of patients.

Table 2. Angular measurements in the study group before and after therapy.

Angular measurements before therapy [°]	Before therapy			After therapy			t	p
	$\bar{x}$	Me	SD	$\bar{x}$	Me	SD		
HPp-S	55.16	56.05	4.62	59.97	59.85	4.59	**-5.29**	**<0.001**
Cip-S	25.22	25.50	3.96	26.17	25.65	5.04	-0.89	0.392
HPp-SI	52.10	51.45	7.72	55.30	54.45	4.40	-1.94	0.078
Cip-SI	33.14	32.50	4.59	28.45	28.80	3.79	**4.19**	**0.002**

Abbreviations: $\bar{x}$ – arithmetic mean, Me – median, SD – standard deviation, t – Student's t-test value for independent variables, p – test probability value, HPp-S – head angle in standing position, Cip-S – chest angle in standing position, HPp-SI – head angle in sitting position, Cip-SI – chest angle in sitting position.

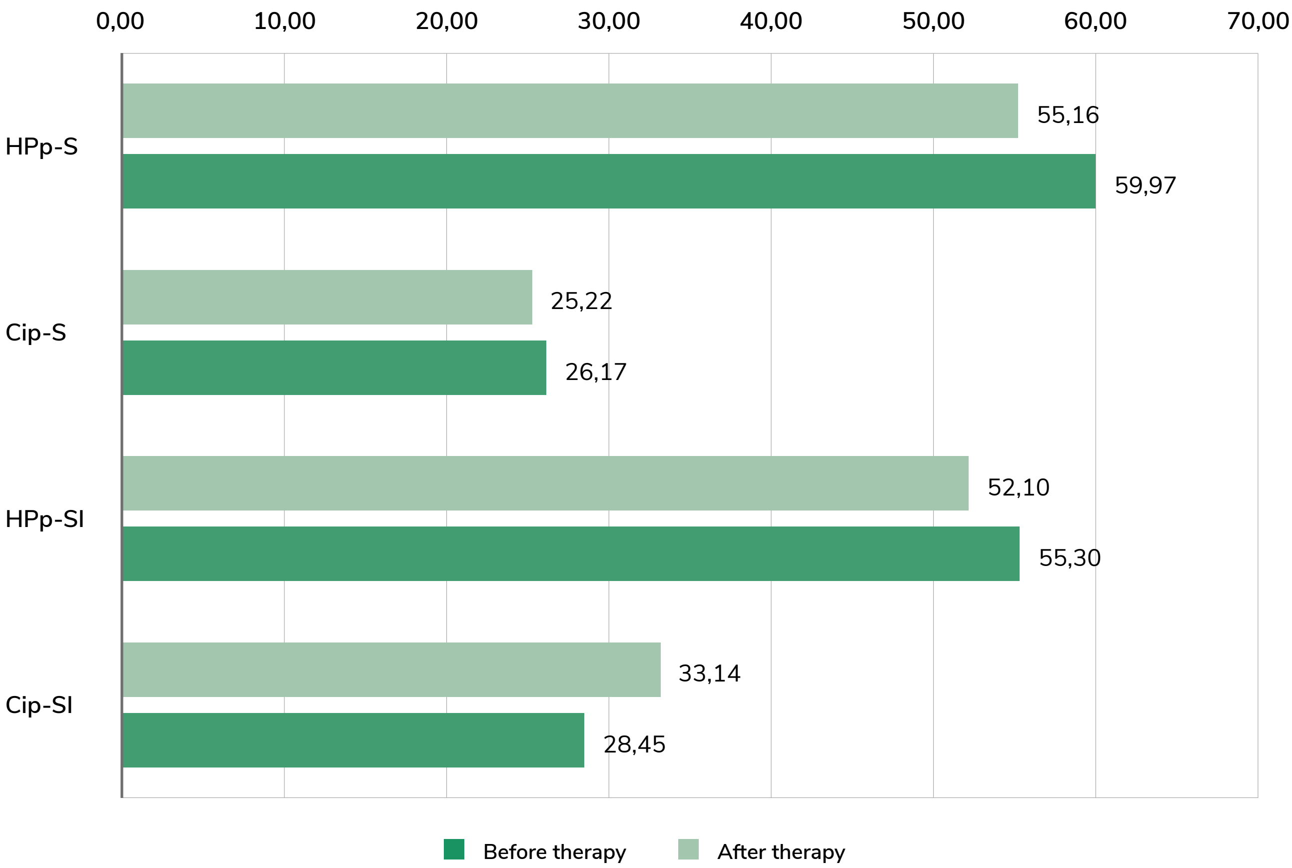

Figure 4. Angular measurements in the study group before and after therapy.

The LMPTE scale indicated presence of statistically significant differences in pre- and post-therapy measurements for the study group for each of the analyzed parameters. Resistance for the sternocleidomastoid muscle decreased significantly from a median value of 2.0 points to a median value of 0 points for both the right (p=0.002) and left (p=0.003) side. The same changes were observed for supraglottic resistance assessment values (p=0.002) and for lateral resistance (p=0.002). The position of the larynx also significantly changed (p=0.018), from a median score of 1.0 points to a median score of 2.0 points (defining baseline position). The outcomes obtained from the LMPTE scale were compared between the two groups. There were no differences between the variations observed between the pre- and post-therapy measurements in the study and control groups in sternocleidomastoid muscle resistance (right and left) and in the assessment of supraglottic tension and lateral resistance (p>0.05). However, the treatment effect obtained in the two groups regarding the larynx positioning was significantly different (p=0.024). A greater positive change was observed in the study group (mean 0.58 points and median 1.0 points) than in the control group (mean 0.1 points and median 0.0 points).

Discussion

In Poland, teachers are by far the largest group out of all professions affected by increased voice strain. Individuals affected by voice disorders in our own research were primarily teachers. Occupational disorders of the vocal tract have for many years been ranked first in terms of the frequency of diagnosis. Between 2007 and 2009, they even accounted for around 25% of all occupational disorders. Chronic voice strain can result from the adverse effects of a variety of factors, both external and internal. Determining the level of functional voice activity is of great importance for the quality and effectiveness of interpersonal communication in everyday situations, as well as for the verbal interaction of people who work in professions where voice and speech are essential working tools (voice and speech professions) [16, 17].

The maximum phonation time of the examined patients did not change significantly as a result of rehabilitation, but the study demonstrated a significant change in phonation time in the treatment group in one out of 3 measurements. The prevalence of symptoms was improved for five symptoms: tightness, dryness, pain, scratching and irritation, a similar improvement was also observed in the study group. The average severity of presenting symptoms also decreased in both groups. Improvements in the frequency and severity of symptoms have also been reported in other findings in the literature. In the research conducted by Sznurowska-Przygocka and Sliwinska-Kowalska [17], an improvement in the form of complete resolution of hoarseness was achieved in 24% of the rehabilitated patients in the study group. In some patients, hoarseness has gone from constant to intermittent, which should also be considered a positive outcome of the therapy. The incidence of hoarseness in teachers in the non-rehabilitated group remained at the level of the preliminary investigation and was at approximately 80%. Sliwinska-Kowalska et al. [18], in the post-rehabilitation group found an improvement in the incidence of permanent and intermittent hoarseness of 26% and 25%, respectively. Fiszer [19] noted the frequency of improvements for permanent hoarseness after speech rehabilitation was around 21%. In contrast to the rehabilitation group, no spontaneous improvement was observed in the control group. In these studies, up to 33% of teachers reported a cessation of mucosal dryness after speech rehabilitation.

Our own research provided evidence of the effectiveness of rehabilitation with regard to the head angle in the standing position and the chest angle in the sitting position. Other aspects (head angle in sitting position and chest angle in standing position) did not change significantly, nor did the parameters tested in the control group. The occurrence, as a result of therapy, of a statistically significant improvement in parameters such as resistance of the sternocleidomastoid muscle on both sides, or laryngeal resistance, lateral, and larynx positioning was also confirmed in our study. The improvement for the latter parameter was statistically greater in the study group than in the control group. Individuals who use their voice professionally are particularly susceptible to functional voice disorders due to inappropriate or excessive vocal strain. In case of recurrent microtrauma to the vocal tract muscles of the larynx and mucous membrane, educating patients on voice hygiene is recommended and should include: anatomy and physiology of the vocal tract. By discussing incorrect posture, vocal abuse and its consequences, together with instruction on correct vocal technique and posture, overload of the vocal tract can be eliminated.

Conclusions

Normalizing muscle tone, larynx alignment and improving mobility of structures around the vocal tract in patients with excessive head protraction improves the results of maximum phonation time and reduces the experienced symptoms. Improved control of excessive forward head posture carried out as part of physiotherapy in patients with functional voice problems has little effect on increasing phonation time. Physiotherapy associated with changing the angle of the head and improving the alignment of the head and neck in a neutral position reduces the frequency and severity of symptoms associated with functional voice problems.

References

1. Rubin JS, Mathieson L, Blake A. Posture and voice. J Singing. 2004; 60: 271-275.
2. Behrman A. Common practices of voice therapists in the evaluation of patients. J Voice. 2005; 19: 454-469.
3. Herman-Ackah YD. Physiology of voice production: considerations for the vocal performer. J Singing 2005; 62: 173-176.
4. Czaprowski D, Stoliński Ł, Tyrakowski M, Kozinoga M, Kotwicki T. Non-structural misalignments of body posture in the sagittal plane. Scoliosis Spinal Disord. 2018; 13: 6.
5. Hochschild J. Anatomia funkcjonalna dla fizjoterapeutów. MedPharm Polska, Wrocław 2018.
6. Rantala L, Sala E, Kankare E. Teachers' Working Postures and Their Effects on the Voice. Folia Phoniatr Logop. 2018; 70: 24-36.
7. Kooijman PG, de Jong FI, Oudes MJ, Huinck W, van Acht H, Graamans K. Muscular tension and body posture in relation to voice handicap and voice quality in teachers with persistent voice complaints. Folia Phoniatr Logop. 2005; 57 (3): 134-147.
8. Heman-Ackah YD. Care of the professional voice: physiology of voice production: consideration for the vocal performer. J Sing. 2005; 62: 173-176.
9. Rubin JS, Blake E, Mathieson L. Musculoskeletal patterns in patients with voice disorders. J Voice. 2007; 21: 477-484.
10. Rubin JS, Mathieson L, Blake E. Care of the professional voice: posture and voice. J Sing. 2004; 60: 271-275.
11. Pruszewicz A, Obrębowski A. (Eds.): Zarys foniatrii klinicznej. Wydawnictwo Naukowe Uniwersytetu Medycznego w Poznaniu, Poznań 2019.
12. Mathieson L, Hirani SP, Epstein R, Baken RJ, Wood G, Rubin JS. Laryngeal manual therapy: a preliminary study to examine its treatment effects in the management of muscle tension dysphonia. J Voice. 2009; 23 (3): 353-366.
13. Woźnicka E, Niebudek-Bogusz E, Kwiecień J, Wiktorowicz J, Sliwińska-Kowalska M. Applicability of the vocal tract discomfort (VTD) scale in evaluating the effects of voice therapy of occupational voice disorders. Med Pr. 2012; 63 (2): 141-152.

14. Stolinski L, Kozinoga M, Czaprowski D, Tyrakowski M, Cerny P, Suzuki N, et al. Two-dimensional digital photography for child body posture evaluation: standardized technique, reliable parameters and normative data for age 7-10 years. Scoliosis Spinal Disord. 2017; 12: 38.
15. Woźnicka E, Niebudek-Bogusz E, Morawska J, Wiktorowicz J, Śliwińska-Kowalska M. Laryngeal manual therapy palpatory evaluation scale: A preliminary study to examine its usefulness in diagnosis of occupational dysphonia. Med Pr. 2017; 68 (2): 179-188.
16. Kaźmierczak M. The influence of voice disorders on the quality of communicative interaction in the assessment of philological students. Otorynolaryngol. 2018; 17 (1): 29-35.
17. Sznurowska-Przygocka B, Śliwińska-Kowalska M. Effectiveness of phoniatric voice rehabilitation in teachers with chronic dysphonia. Otorynolaryngol. 2012; 11 (2): 60-70.
18. Śliwińska-Kowalska M, Fiszer M, Niebudek-Bogusz E, Ziatkowska E, Kotyło P, Domańska M. The effectiveness of voice therapy for teachers with voice disorders. Occup Med. 2003; 54 (4): 319-325.
19. Fiszer M. Zawodowe choroby narządu głosu u nauczycieli: występowanie, czynnik ryzyka, skuteczność terapii logopedycznej i psychologicznej. Rozprawa doktorska. Instytut Medycyny Pracy im. prof. dr. med. Jerzego Nofera, Łódź 2007.