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Acoustic analysis and speech therapy intervention in spoken and sung voice with the Lax Vox technique: on the subject of a case

Tatiana Romero-Arias[1,5*], Fernando García-Escudero[2], Francisco Redondo-Ventura[3], Moisés Betancort-Montesinos[4]

[1]Departamento de Psicología Cognitiva, Social y Organizacional, Universidad de La Laguna, Tenerife, (Spain).
[2]Centro VocalCoach2.0. Madrid, (Spain).
[3]Servicio de Otorrinolaringología. Complejo Hospital Universitario de Canarias (CHUC). Tenerife. La Laguna. (Spain).
[4]Departamento de Psicología Clínica, Psicobiología y Metodología, Universidad de La Laguna, Tenerife, (Spain).
[5]Instituto Universitario de Neurociencia (IUNE). Universidad de La Laguna, Tenerife, (Spain).

*Correspondencia: Tatiana Romero-Arias tromeroa@ull.edu.es

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Resumen

Análisis acústicos e intervención logopédica en voz hablada y cantada con la técnica Lax Vox: a propósito de un caso.

El Lax Vox es una técnica que se utiliza para el tratamiento de la voz; tanto para voces sanas como para voces patológicas (nódulos, pólipos, edemas, fatiga vocal…). El Lax Vox se encuentra dentro de las técnicas de fonación con tubos y su finalidad es el alargar el tracto vocal de forma artificial y generar un cambio positivo en las cuerdas vocales.

En el presente trabajo estudiamos el caso clínico de un paciente con patología vocal que ha sido derivado del servicio de otorrinolaringología a la unidad de logopedia con la finalidad de instaurar un plan de evaluación y un tratamiento logopédico ajustado a las características del paciente con el fin de mejorar la calidad de su voz.

Palabras clave: patología de la voz, lax vox, rehabilitación logopédica, disfonía.

Summary

Acoustic analysis and speech therapy intervention in spoken and sung voice with the Lax Vox technique: on the subjetct of a case.

The Vox Lax is a technique that is used for the treatment of the voice; both for healthy voices and for pathological voices (nodules, polyps, edemas, vocal fatigue ...). The Vox Lax is within the techniques of phonation with tubes and its purpose is to lengthen the vocal tract artificially and generate a positive change in the vocal cords.

In the present work we study the clinical case of a patient with vocal pathology that has been derived from the otorhinolaryngology service to the speech therapy unit with the purpose of establishing an evaluation plan and a logopedic treatment adjusted to the characteristics of the patient in order to improve the quality of his voice.

Keywords: speech pathology, lax vox, speech therapy rehabilitation, dysphonia.

Introduction

The speech therapy rehabilitation of patients with vocal pathology through the use of techniques and exercises of semi-occluded vocal tract has hardly been studied. Most physiological rehabilitation programs are based on exercises with semi-occluded vocal tract (TVSO). This type of exercises refers to a series of postures whose purpose is to lengthen and / or partially occlude the vocal tract [12], causing a change in the vibratory pattern of the vocal folds. The TVSO has a long history in its use by voice therapists, voice teachers and other voice professionals, however, there is little research to explain the physical principles [3]. The exercises that are included under the denomination of semi-occluded vocal tract are: lip vibration, tongue vibration, humming, bilabial fricatives and phonation with tubes of different diameters

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[3,5]. The resonance tubes can be used in two ways: leaving the distal end of the tube free in the air and the other way is immersing the distal end in water: in both cases the tube is kept straight in the mouth of the participant, acting as an artificial extension of the vocal tract [7].

Within the phonation with tubes of different diameters, is the Vox Lax. The Vox Lax is a technique that is used for the treatment of the voice with which it is intended to elongate the vocal tract artificially semiocluding and thus generate attenuation in the glottal impedance and increase of the impedance of said vocal tract, creating a TV in the form of an inverted megaphone [8]. In this way, a positive change in the vibration of the vocal cords is generated. This technique is used during the treatment of voice pathologies with vocal fatigue, tension in the laryngeal muscles, nodules, polyps, edema and also in normal voices for training and warming up the voice (actors, singers, teachers ...). Singers who have used this technique have managed to make their voices clearer, brighter and more resonant [10]. In the therapeutic field, resonance tubes have been applied in different cases of vocal pathology, including functional dysphonia and patients with nodules [18,19]. Other phonation investigations with tubes found an increase in the input impedance in the fundamental frequency range due to the decrease in the frequency of the first formant [20]. Sampaio, Oliveria and Behlau in 2008 [16], studied the immediate effects of TVSO exercises (finger kazoo and phonation with tubes) and found positive results in vocal self-assessment and acoustic evaluation, in which there was a decrease in F0, both with kazoo finger and with tube phonation exercises. They also found positive results in perceptual-auditory assessment only in phonation with tubes [16]. From the acoustic point of view one of the benefits of phonation with tubes and partial occlusions of the vocal tract is the descent of the first formant (F1), therefore, the F0 (fundamental frequency) can be produced near F1; which would allow to experience effects of a low threshold of phonation pressure, a decrease in transglottic air flow and voice rich in harmonics [7]. As we have seen, there are few speech therapy interventions with TVSO exercises, but all find positive changes in the quality of the participants' voice. That is why our research has focused on the use of this technique to carry out the rehabilitation of a patient or vocal pathology, and at the same time contrast with the results obtained in other cases where this therapy has been used.

Clinical Case

We present the case of a 36-year-old male patient with a diagnosis of fibrous nodules faced with pronator abuse, referred by the otorhinolaryngologist to the Speech Therapy Service for the assessment and rehabilitation of his voice to avoid surgery. The patient presents in the Right Vocal Cord (RVC) a large fibrous nodule that contacts a micronodule on the Left Vocal Cord (LVC) with an edematous base due to probable contact injury. Initial stroboscopic: mucosal wave presents bilateral with slight asymmetry due to increased thickness of the Left Vocal Cord. (Hiatus in hourglass).

The objectives of this study were to achieve the reabsorption of the patient's injury to avoid surgery, reposition the right arytenoid cartilage and reeducate vocal hygiene guidelines and break the circle of vocal overexertion.

Method

Speech therapy pre-rehabilitation instruments

To evaluate the patient, the following instruments were used in the Otorhinolaryngology Service and the Speech Therapy Service: -a Stroboscope-b Nasofibroscope- c Glatzel mirror- d Radiography- e Questionnaire on adaptation and validation of the vocal disability index (VHI) - 30) [13]. and its abbreviated version (VHI-10).

In order to know the anatomophysiological status of the larynx of the patient before starting the speech therapy rehabilitation, the speech therapist asks the otolaryngology service for a laryngeal examination using stroboscope. In this examination, the otolaryngologist confirmed that the patient had a large, fibrous nodule in the RVC that contacted a micronodule in the edematous-based LVC with slight asymmetry due to an increase in the thickness of the LCV, a hiatus in an hourglass. A dislocation of the right arytenoid cartilage was also observed, which prevented a symmetrical closure of the vocal cords, causing an air leak that was reflected in the blown voice presented by the patient. Figure 1 shows a recording of the patient emitting the sound / e /. This recording is prior to speech therapy rehabilitation; where we can see a dull fragment (air escape) in the patient's voice.

The Glatzel Mirror test was performed to measure the degree of nasal permeability of the patient and rule out the presence of respiratory obstructions. The results of this test showed that the patient has a slight respiratory obstruction in the right nostril. Even so, he was able to expel a large amount of air through both nostrils, with the left nostril predominating.

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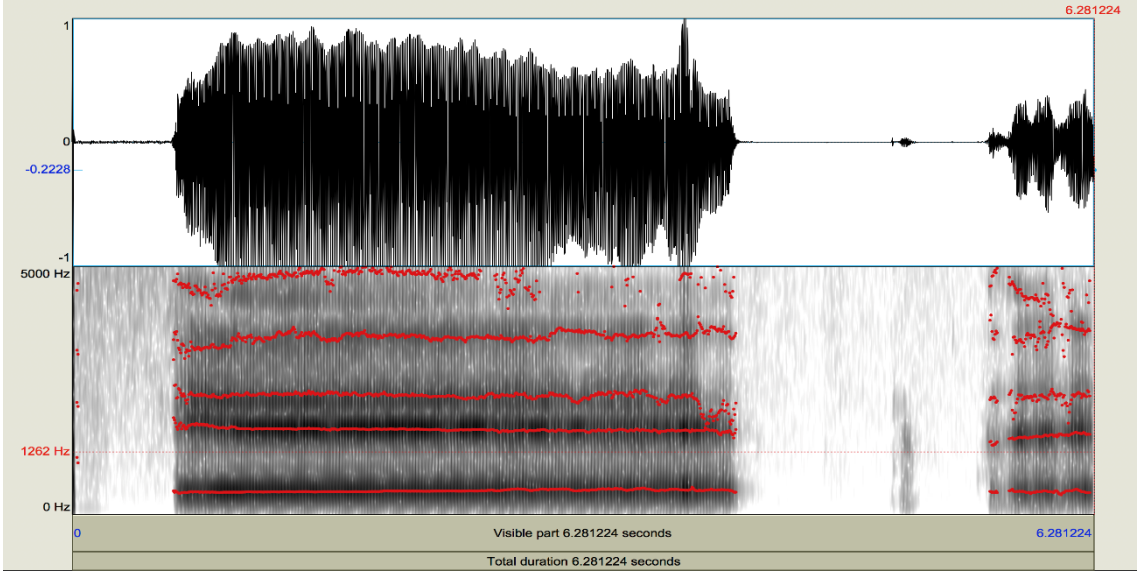

Figure 1. Sound recording / e / with a duration of 6.28 seconds with the Praat software

To rule out that the voice pathology was due to cervicalgia and / or laryngeal muscle tension, the patient underwent two radiographs.
In the radiographic study (figure 2 and figure 3), the patient presents a rectification of the cervical lordosis, a mandibular deviation to the left (therefore, the deviated chin) and the upper right clavicle higher (due to scoliosis).

Fig.2 anteroposterior Rx

At the level of C3, the smallest joint space can be seen, which can be due to a crushing of the disc, a facet problem in the left articular facets.

In order to complete the initial interview, the questionnaire of adaptation and validation of the vocal disability index (VHI-30) in its abbreviated version (VHI-10) was passed on to the patient [13].

Fig.3 lateral Rx

The abbreviated version of this questionnaire has three blocks of questions. The first block refers to the functional part, where the patient obtains a score of 3, which indicates that the problems of his voice do not affect him in his personal life or in his work life. The second part of the questionnaire evaluates the physical aspects,

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where the patient obtains a score of 11; which means that the patient perceives his normal voice, like a voice without pathology. With this score, we can see that the patient is not aware of his voice pathology. The third and final block of this questionnaire is the emotional block, where the patient obtains a score of 0. The patient, not being aware of his pathology, is not affected in his social relations and does not get to feel ashamed for his problem of voice.

Instruments of speech therapy intervention

During the speech therapy intervention, the following instruments were used: the neuromuscular bandage, the piano and the lax vox.

The neuromuscular bandage (kinesio taping) was used to work the patient's body posture since this technique improves the circulatory action, the proprioceptive action since it is a sensitive stimulus, the analgesic action, the neuroreflex action and the mechanical action [14]. The use of kinesio taping in the field of speech therapy is a novel technique that has hardly been investigated.

Lax Vox 25 cm long silicone tube. With an external diameter of 12 mm and an internal diameter of 8mm. A bottle with 3-4 cm of water. We work with the use of the Lax Vox with technical exercises and the support of the piano as an acoustic reference or imitative pattern in order to achieve with the patient a correct phono respiratory coordination and the creation of a good air column from the leveling of the sub-supralaryngeal pressures.

Results

After the collection and analysis of patient data, the speech therapist prepared a rehabilitation plan for 14 sessions spread over a period of 7 weeks. The rehabilitation plan includes re-educating the patient regarding vocal hygiene guidelines, with the aim of maintaining vocal health potentiate positive habits and trying to avoid those that are unfavorable [17].

We started from the base step, which is the phono-respiratory coordination, to establish abdominal diaphragmatic breathing to achieve a constant murmur with uniform, effective and prolonged pressure and a good abdominal support [1]. In the first rehabilitation sessions, different inverse phonation exercises were used to replace the right arytenoid cartilage before it could become ankylosed.

In figure 4 we see a nasofibroscopy image made during speech therapy rehabilitation. Where we observed that the right arytenoid cartilage continues without being in correct position. This is reflected in the patient's voice, presenting a broken and dry voice and having the need to tighten the throat to produce a voice.

Fig. 4 Nasofibroscopy image during speech therapy intervention. Where we observed that the right arytenoid cartilage continues without being in correct position

Fig. 5 Nasofibroscopy image during speech therapy intervention. Where we see a complete clousure of the vocal cords.

In figure 5 we see a nasofibroscopy image made during logopedic rehabilitation, where we see a complete closure of the vocal cords. Before the rehabilitation, the patient presented a hiatus in an hourglass. During the rehabilitation, the complete closure was achieved.

During the rehabilitation process, recordings were repeated with the Praat software, where we see that the patient manages to increase the phonation time, without having deaf fragments.

In figure 6 we see the Hz scores of the formants of the patient's voice before and during the speech therapy rehabilitation. We found an increase in the formants incluiding the fundamental tone F0. This increase in the frequency of the first formant decreases the input impedance in the range of the fundamental frequency by increasing the frequency of the first formant

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	F0	F1	F2	F3	F4
Pre-rehab	108.55	476.47	1721.17	2408.91	3611.70
During-rehab	118.54	497.22	1870.66	2453.88	3415.17

Figure 6. Table with the scores in Hz of the formants of the patient's voice before the rehabilitation and during the rehabilitation

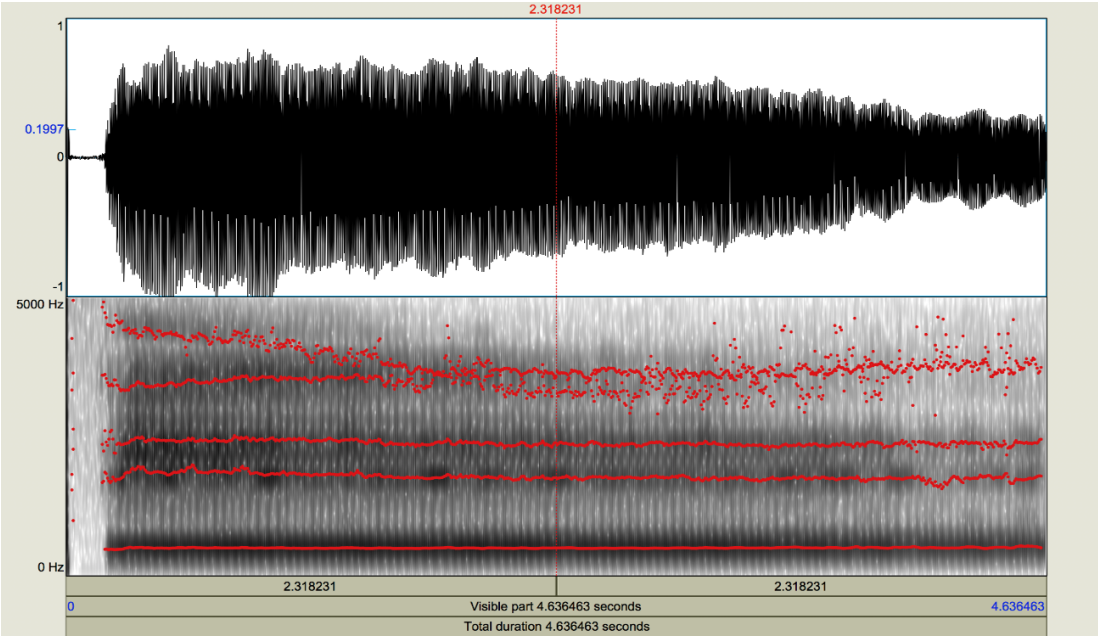

Figure 7. Sound recording / e / with a duration of 4.63 seconds with the Praat software during rehabilitation

In figure 6 we see the Hz scores of the formantes of the patient's voice before and during the speech therapy rehabilitation. We found an increase in the formants including the fundamental tone F0. This increase in the frequency of the first formant decreases the input impedance in the range of the fundamental frequency by increasing the frequency of the first formant.

Figure 7 presents a recording of the sound / e / during rehabilitation, where the patient is capable of continuos phoning, that is, without sound fragments, although we can appreciate the loss of the formants F3 and F4 over time.

We did an analysis of the FFT, Fast Fourier Transform- Fast Fourier Transform before and during the speech therapy rehabilitation. Figure 8 shows the FFT of the patient before speech therapy rehabilitation; while in Figure 9 the patient's FFT is presented during speech therapy rehabilitation. The FFT is the representation of the frequency (horizontal axis) and the amplitude (vertical axis) of the harmonics at an instant of the speech signal. The spectrum (FFT) and the waveform (oscillogram of the vowel /e/ is presented.) Figure 8 shows the FTT before the speech therapy rehabilitation, in blue the F0, in red F1, F2, F3, F4. 8 presents the FFT during speech therapy rehabilitation, in blue the F0, in red F1, F2, F3, F4.

Discussion

When comparing, the results obtained in the recordings with the praat software and comparing them with the previous studies, we find that our results are not convergent with those found so far, since we found an increase in the Hz of the formants when comparing the pre-recorded recordings speech therapy intervention Vs during- speech therapy rehabilitation [7].

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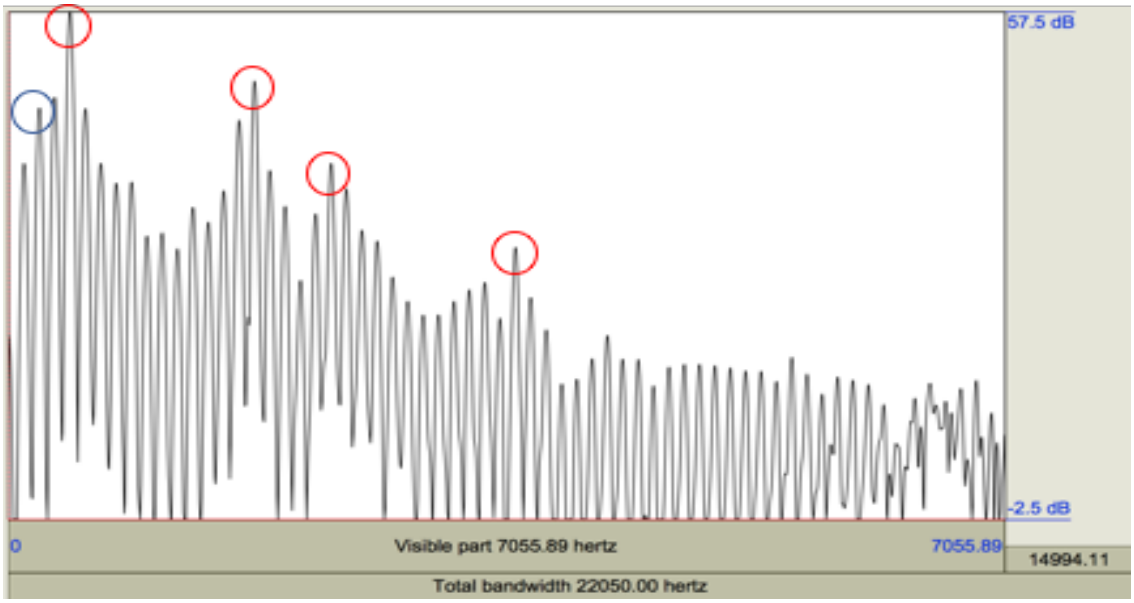

Figure 8. FFT, Fast Fourier Transform - before speech therapy rehabilitation.

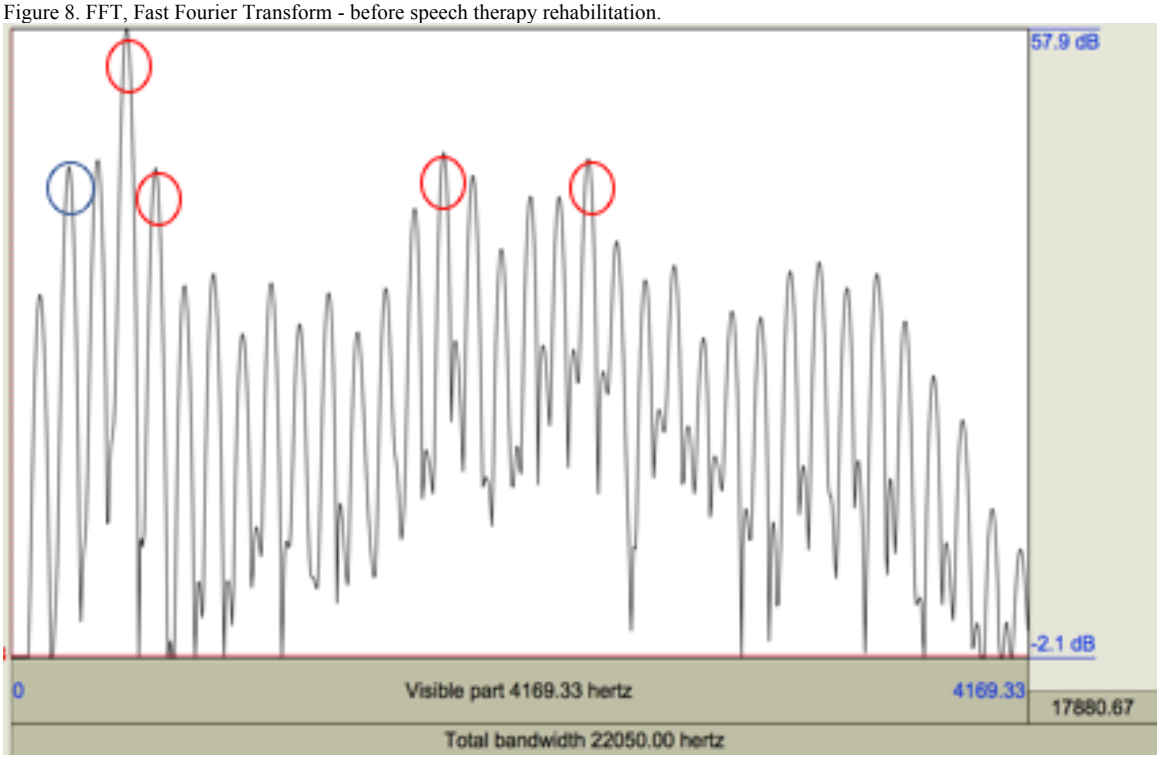

Figure 9. FFT, Fast Fourier Transform during speech therapy rehabilitation.

Laukkanen [10] in his study found that using phonation with tubes, a drop in the F0 value in men was observed. As seen in Figure 6, we find the opposite. Before speech therapy intervention, the patient obtained 108,558 Hz and during rehabilitation he obtained 118,543 Hz; 10 Hz difference.

Guzmán [7] from the acoustic point of view, in his study found that F1 also decreased after tube training. In figure 6 we see how the patient scores before the speech therapy 476.47 Hz rehabilitation and during the speech therapy rehabilitation scores 497.22 Hz. These results are not convergent with the previous studies.

In contrast to our acoustic results of the patient's voice and at the physiological level, we found in the nasofibroscopy images an improvement in the patient's injury. Prior to speech therapy

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rehabilitation, the patient underwent a stroboscope where the otorhinolaryngologist diagnosed the patient with a large, fibrous nodule in the RVC that contacted a micronodule in the edematous-based LVC; adding a slight asymmetry and a hiatus closure in an hourglass. In the nasofibroscopy images made during the speech therapy intervention, we found that the large nodule of the RVC had decreased significantly. While in the LVC the micronodule had disappeared leaving only a slight edematous base. During speech therapy sessions, the patient's voice improved a lot, losing that rough characteristic that it brought to the beginning and the voice began to clear up. In figure 5 we see how the symmetrical closing of the strings is achieved.

The neuromuscular bandage has become a novel therapeutic alternative considering its physiological acting principles that have not yet been scientifically established [2]. This technique has been constituted as a complementary tool in the therapeutic intervention of different disciplines where the results that have been found expose a decrease in pain and an increase in the mobility arcs of the structures that have been treated [2]; but in the field of speech therapy it is still in development. Physiotherapy and medicine studies [4,6,9] have demonstrated the effectiveness of this technique, obtaining improvements in the musculature of their patients.

We apply the neuromuscular bandage with the intention of relaxing the patient's musculature and improving posture in order to make a good placement of the air column. With the application of the neuromuscular bandage it was possible to improve tense muscular posture that the patient presented from the beginning at the cervical, shoulders and lumbar level.

The work carried out in the speech therapy sessions included reeducation and establishment of vocal hygiene guidelines, where we must point out the patient's lack of readiness for this new learning. According to Levack et al., [11] and Romero et al., [15] the attitude and awareness of the importance in the implication of their rehabilitation are key guidelines for a speedy recovery. In this clinical case, the patient, despite not getting involved in his rehabilitation, generally achieves good results; avoids the surgery of his vocal pathology and improves the quality of his voice. we suppose that the improvement of voice quality will last a short time because during the rehabilitation process, the patient did not manage to establish the necessary guidelines for the health and / or quality of his voice. That is why we think it will be a patient who relapses.

Conclusion

The joint work of speech therapist-otorhinolaryngologist is of vital importance for a good treatment of any vocal pathology. It is a reciprocal learning between professionals not only at the clinical level but at the research level. This clinical case allows us to reflect on the importance of the involvement of professionals and especially the involvement of the patient in their rehabilitation.

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