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Article

Bilateral Vocal Nodules Multidimensional Assessment: Pre- and Post- Speech Language Pathology Intervention

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Abstract: (1) Background: Vocal fold nodules are bilateral lesions that can have an important negative impact on a person's job performance, social interaction, and quality of life. This study aims to analyze multidimensional voice evaluation outcomes in a group of patients with bilateral vocal fold nodules who underwent voice therapy. (2) Methods: A retrospective analysis was performed in 42 patients on the following voice evaluations, before and after voice therapy: visual-perceptual (video-laryngostroboscopic evaluation), auditory-perceptual voice analysis based on the GRBAS scale, and aerodynamic voice analysis. Data were collected from January 2001 to December 2019. Data analyses were performed with non-parametric tests (Wilcoxon test) using $\alpha = 0.05$. (3) Results: The patient average age was 33.6.1 $\pm$ 10 years (range 19–60), and 95.2% were female. Voice therapy was delivered by an experienced speech-language pathologist once a week, with an average of 9.8 $\pm$ 3 appointments (range 8–17). Vocal fold lesions disappeared in 40.4% of the patients after voice therapy, especially in participants receiving early voice therapy ($p = 0.035$). When comparing pre- and post-therapy audio-perceptual results, all parameters were improved with statistical significance ($p < 0.05$) except for the asthenic voice scale. Aerodynamic parameters were all improved but without statistical significance ($p > 0.05$); (4) Conclusions: Early timing to initiate voice therapy after the onset of symptoms or diagnosis seems to be an important factor for the success of voice therapy (absence of vocal fold nodules).

Keywords: dysphonia; voice therapy; bilateral vocal fold nodules; speech-language pathology; retrospective; multidimensional assessment

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1. Introduction

Vocal fold nodules (VFN) are whitish or reddish, mainly bilateral benign mass lesions that develop in the middle area of the anterior region of the vocal folds after repetitive glottal trauma (vibration) [1].

Injuries in the vocal fold tissue, and subsequently the development of lesions (nodules), are due to voice overuse, misuse, or abuse and seem to be associated with the type of occupation and sex (female) [2–4].

According to Jones et al. (2002), vocal fold nodules are frequent in vocally and environmentally demanding professions or stressful lifestyles (e.g., aerobics instruction and singers) [5]. Additionally, people involved in teaching activities for large groups and

workplaces with noisy environments (e.g., lecturers, professors) are regarded as being at a higher risk of developing vocal fold nodules [6].

Hoarseness is the symptom that most commonly makes patients seek medical help, especially when it starts interfering with their professional activities, social integration, and consequently their overall quality of life [7].

The available treatment options for managing Vocal Fold Nodules (VFNs) include voice therapy, pharmacotherapy involving corticosteroids, and surgical intervention [8]. Speech therapy is commonly recommended as a preferred treatment approach for VFNs [8]. A recent systematic search and narrative review conducted by Alegria et al. in 2020 investigated the effectiveness of voice therapy in patients with Vocal Fold Nodules (VFNs). However, the review did not provide a definitive conclusion regarding the general effectiveness of voice therapy programs for this condition. Several factors contributed to these inconclusive findings, including the limited number of published studies, the heterogeneity among studies in terms of the specific content of voice therapy, and the lack of standardization in outcome measures [9].

In cases where patients do not show signs of improvement with voice therapy, surgical intervention may be considered [10]. Typically, surgical options involve the excision of the nodules using microsurgical techniques [11].

Established challenges in delivering effective behavioral interventions, such as voice therapy interventions, include high rates of therapy dropouts, patients' resistance to vocal behavioral change, and their lack of motivation [12,13].

Despite several reasons for patients to be non-compliant with therapy, a patient's motivation plays an important role [14,15].

The limited number of studies available on this topic highlights the need for further research to reduce the scientific knowledge gap and enhance our understanding of the effectiveness of speech therapy in managing VFNs.

The aim of the present study is to analyze the results achieved with speech therapy over a 19-year period in patients with BVNs by reviewing the voice multidimensional assessment measures administered before and after the speech therapy program.

2. Materials and Methods

A total of 42 patients with bilateral VFNs were involved in this retrospective study. From January 2001 to December 2019, 62 patients diagnosed with bilateral VFNs in the Ear, Nose, and Throat (ENT) outpatient department were referred to the Speech-Language Pathology (SLP) department for voice therapy. The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the CHUP | ICBAS Committee (006-DEFI/067-CE-2019.078) for studies involving humans.

Patients were included in this study if they were: (1) adults, aged 18 or over; (2) diagnosed with bilateral VFNs by an ENT consultant using an indirect video laryngoscopy method; (3) had no infection or inflammation of the upper airway at the time of speech-language therapy evaluation; and (4) had a multidimensional voice assessment. The exclusion criteria comprised participants who had: (1) previous speech therapy; (2) previous professional singing or voice coaching; (3) the presence of severe cardiovascular and respiratory diseases; (4) ongoing psychiatric and neurological disease; and (5) other concomitant vocal cord pathology. Previous speech therapy, previous professional singing, or voice coaching experience were excluded from the selection of participants to ensure a more homogeneous study population.

A speech-language pathologist (SLP) performed a comprehensive initial clinical history and assessment of their voice and speech production. Afterwards, they completed a therapy program that was customized to the participants. Finally, a voice reassessment was performed after the completion of the therapy. Details of the overall procedure are as follows: a phoniatric consultation was conducted by a senior SLP and blinded to this study. The clinical evaluation of the voice included the collection of information through

the following actions: clinical interview, audio-perceptual evaluation, and musculoskeletal and aerodynamic functional examination. A visual-perceptual evaluation was performed by an ear, nose, and throat consultant who was independent and blinded to this study.

Patients were subjected to the following voice evaluations before and after voice therapy: (1) Visual-perceptual: a video-laryngostroboscopic evaluation was conducted by ENT consultants using a rigid or flexible laryngoscope, depending on the patient's degree of comfort and tolerance. ENT consultants did not use any specific protocol to report laryngoscopic findings. A laryngoscopic exam was performed during a sustained vowel /a/ and during respiration; (2) Auditory-perceptual voice analysis: an audio-perceptual evaluation was based on the Grade (G), Roughness (R), Breathiness (B), Asthenia (A), and Strain (S)—(GRBAS) scale [16] and was performed by one senior SLP. The speech samples of sustained vowels, counting, and reading passage were used for the assessment of voice quality with auditory perceptual judgements. All samples were recorded and copied onto a compact disc (CD) (Sony® MDS-JE 500, mini-disk Sony®, and a microphone professional, Le Son®). The senior SLP analyzed the samples that were blinded in terms of timepoint (pre- and post-therapy) and rated each voice sample on a three-point scale, where "0 = normal," "1 = mild disturbance," "2 = moderate disturbance," "3 = severe disturbance," [17,18]. After all the samples were rated, 5 pairs were randomly selected to evaluate intra-rater reliability, which was calculated using the Weighted Kappa; (3) Aerodynamic analysis: a maximum phonation time (MPT) is a frequently used clinical tool for voice evaluation and is also the most common aerodynamic measure for assessing glottal sufficiency [19]. MPT was obtained during a sustained comfortable pitch and loudness, after a profound inspiration. After providing a prior demonstration, three trials were carried out with the longest time selected.

Participants were initially scheduled for a set of 8–10 voice therapy appointments. After the completion of the sessions, participants were reassessed by the ENT doctor, and another set of appointments was recommended if nodules were still present.

The therapy was conducted once a week, and each session lasted around 45 min. Participants were encouraged to exercise at home (indirect voice therapy) for 10 min every day (schematic drawings given by the SLP) with a focus on the techniques taught.

A combined indirect and direct voice therapy approach was used. Even though the voice program was tailored to each participant's needs and progress during the treatment, a general 'structured' program, which focused on meeting key objectives, was followed: Session 1—clinical history taken to identify participant's risk factors and behaviors to develop vocal nodules. Voice assessment is performed, and voice physiology education and voice hygiene are given. Sessions 2 and 3: Exercises to relax shoulder blade muscles. Vocal exercises to reduce laryngeal effort and improve resonance (e.g., nasal sounds). Vocal techniques to redirect airway flow, enhance maximum phonation time, and control (reduce/soften) vocal attacks (inspiratory control without and with sound production during expiration—unvoiced sibilants). Sessions 4 and 5: Expand sessions 2 and 3 vocal techniques, based on reading text, using unvoiced (sibilant) sounds (control of vocal attacks). Techniques to improve normal-tensed coaptation of vocal folds and voice quality (tongue and lips trill); Sessions 6 and 7: Expand sessions 4 and 5 using repetition of most patient-relevant techniques and generalization exercises to reach the level of conversational speech. Additionally, transfer "newly learned" vocal behaviors to "real life" situations outside the therapy setting; Session 8: Voice reassessment and voice outcomes analysis.

Statistical analysis was performed using the software IBM SPSS® Statistics vs.26.0 (IBM Corp. released 2017, Armonk, NY, USA). Descriptive statistical analysis of the quantitative variables included both average and standard deviation and median and interquartile range (IQR: 1st and 3rd quartiles), while the categorical variables were depicted by counts and percentages (n and %). For inferential statistics, the Wilcoxon test compares the pre- and post-therapy results of the quantitative variables. Post-visual-perceptual evaluation distribution results of the outcome groups (no nodules and the nodules reduced groups),

as well as with normal range published values, were compared using the Mann-Whitney test. The level of significance was set at a p value lower than 0.05.

3. Results

Participants' group characteristics according to sex, age, occupation, symptoms, time elapsed to begin voice therapy, and number of sessions are presented in Table 1. The large majority were women (n = 40, 95.2%). The average age of participants was 33.6 ± 10 years (range 19–60 years), revealing great variability. Participants' occupation was categorized according to Koufman and Isaacson's (1991) [20] classification: professional voice users—elite (e.g., singer); professional voice users—non-elite (e.g., educator and teacher); non-professional voice users (e.g., lawyer, dentist, business-person) and other non-professional non-voice users (e.g., student, agriculture/farmer, unemployed). The average time elapsed from the onset of bilateral VFN symptoms to the beginning of voice therapy was 0.48 ± 0.32 months, ranging from 7 days to 1 month. Patients were enrolled initially with a first set of therapy sessions, which ranged between 8 and 10 sessions. Those patients who did not improve after this first set of sessions were subjected to additional therapy. Patients, on average, had 9.8 ± 3.0 sessions, ranging from 8 to 17 sessions in total.

Table 1. Study group characteristics.

Variable	Group	Statistics
Sex	F, n (%)	40 (95.2%)
	M, n (%)	2 (4.8%)
Age (years)	Average (sd)	33.6 (10)
	min–max	19–60
Occupation Category	Professional voice users—elite, n (%)	0 (0)
	Professional voice users—non-elite, n (%)	20 (47.6%)
	Non-professional voice users, n (%)	6 (14.3%)
	Non-professional non-voice users, n (%)	16 (38.1%)
Symptoms	Dysphonia, n (%)	37 (88.0%)
	Dyspnea, n (%)	1 (0.02%)
	Phonoastenia, n (%)	1 (0.02%)
	Aphonia, n (%)	3 (0.71%)
Time elapsed to begin voice therapy (months)	Average (sd)	0.48 (0.32)
	min-max	0.25–1
	Time = 1 week (0.25 months)	22 (52.38%)
	Time > 1 month	20 (47.61%)
Number of sessions	Average (sd)	9.8 (3)
	Me (P25–P75)	8 (7–11.3)
	min–max	8–17

sd, standard deviation.

3.1. Visual-Perceptual

Documentation of the laryngostroboscopic examination findings by the ENT consultants was very scarce and mostly limited to the presence or absence of vocal fold nodules.

The study involved comparing pre- and post-therapy visual examinations of vocal folds. Table 2 demonstrates a summary of the visual-perceptual results (pre- and post-therapy) related to participants' professional category and their vocal symptoms, as well as post-therapy evaluation comparisons for the different outcome groups. A statistical comparison of results regarding sex (Table 2) was not possible as male participants are

scarce, therefore preventing testing. The results showed that among the participants, 40.4% experienced the complete disappearance of vocal fold nodules after undergoing voice therapy sessions. In an additional 40.4% of the participants, the nodules were found to be reduced. However, in 8% of the participants, no noticeable changes were observed in the nodules after the therapy sessions. Voice therapy demonstrated a statistically significant outcome when considering any observed changes in vocal nodules, including their absence or reduced size ($p = 0.029$). Among the participants who experienced a complete disappearance of vocal nodules, receiving early voice therapy was identified as a statistically significant factor ($p = 0.035$), while reduced (0.581) or no change ($p \approx 1.00$) outcomes did not show differences regarding early voice therapy.

Table 2. Visual-perceptual evaluation.

		Pre-Therapy	Post-Therapy		
			No Nodules	Nodules Reduced	No Change
All		42 (100%)	17 (40.4%)	17 (40.4%)	8 (19%)
Sex	F, n (%)	40 (95.2%)	15 (40.4%)	17 (40.4%)	8 (19%)
	M, n (%)	2 (4.8%)	2 (100%)	0 (0)	0 (0)
Professional category	Professional voice users—elite, n (%)	0 (0)	0 (0)	0 (0)	0 (0)
	Professional voice users—non-elite, n (%)	20 (47.6%)	3 ^{b} (17.6%)	10 ^{b} (58.8%)	7 ^{a} (87.5)
	Non-professional voice users, n (%)	6 (14.3%)	4 (23.5%)	1 (5.9%)	1 (12.5)
	Non-professional non-voice users, n (%)	16 (38.1%)	10 ^{a} (58.8%.)	6 ^{a} (58.8%)	0 ^{b} (0)
	p	0.029			
Time elapsed to begin voice therapy (months)	Time $\leq$ 1 week (0.25 months), n (%)	23 (54.8%)	12 ^{A} (80%)	8 (61.5%)	3 (60%)
	Time $\geq$ 1 month, n (%)	10 (30.3%)	3 ^{B} (20%)	5 (38.5%)	2 (40%)
		p *	0.035	0.581	≈1.000

F, female, M, male; sd, standard deviation; *p*-value comparing median values of quantitative variables for the post Visual-perceptual. ^{a,b} different letters indicate significant differences regarding the post-therapy output using the McNemar test. ^{A,B} different letters indicate significant differences regarding effect of the therapy onset on the post-therapy output, using the * Binomial test.

3.2. Auditory-Perceptual Ratings

There was a statistically significant improvement in all GRBAS scale parameters after voice-after-voice therapy except in the asthenic voice scale ($p = 0.127$). A summary of the audio-perceptual results is presented in Table 3. The intra-rater reliability score for the SLP rater was 0.88 (Weighted Kappa, $p < 0.001$), indicating strong reliability for the rater.

3.3. Aerodynamic Analysis

Table 4 presents the results of the average and median values of the aerodynamic assessment before and after speech therapy. Twenty-eight patients had the MPT reported. The median MPT /a/was 7.93 (Q1–Q3: 6.13–9.77) before therapy and increased to 8.65 (Q1–Q3: 6.9–10.55), not showing statistically significant improvements.

Table 3. Auditory-perceptual evaluation.

		Pre	Post	*p*
Grade, All (n = 27)	Average (sd)	1.28 (0.68)	0.91 (0.56)	
	Me (Q1–Q3)	1 (1–2)	1 (0.5–1.5)	0.022
Professional voice users—non-elite (n = 16)	Average (sd)	1.31 (0.81)	0.81 (0.6)	
	Me (Q1–Q3)	1.25 (1–2)	1 (0.125–1)	0.047
Non-professional voice users, (n = 4)	Average (sd)	1.25 (0.50)	0.88 (0.63)	
	Me (Q1–Q3)	1 (1–1.75)	1 (0.25–1.38)	0.276
Non-professional non-voice users, (n = 7)	Average (sd)	1.21 (0.49)	1.14 (0.38)	
	Me (Q1–Q3)	1 (1–1.5)	1 (1–1.5)	0.725
Roughness, All (n = 27)	Average (sd)	1.37 (0.86)	0.96 (0.59)	
	Me (Q1–Q3)	1.5 (1–2)	1 (0.5–1.5)	0.029
Professional voice users—non-elite (n = 16)	Average (sd)	1.38 (0.83)	0.94 (0.68)	
	Me (Q1–Q3)	1.5 (1–2)	1 (0.125–1.5)	0.030
Non-professional voice users, (n = 4)	Average (sd)	1.38 (1.11)	1.00 (0.41)	
	Me (Q1–Q3)	1.5 (0.25–2.375)	1 (0.625–1.375)	0.450
Non-professional non-voice users, (n = 7)	Average (sd)	1.36 (0.94)	1.00 (0.50)	
	Me (Q1–Q3)	2 (0–2)	1 (1–1.5)	0.493
Breathness, All (n = 27)	Average (sd)	0.83 (0.77)	0.44 (0.54)	
	Me (Q1–Q3)	1 (0–1.5)	0 (0–1)	0.005
Professional voice users—non-elite (n = 16)	Average (sd)	0.84 (0.83)	0.50 (0.61)	
	Me (Q1–Q3)	1 (0–1.5)	0.25 (0–1)	0.062
Non-professional voice users, (n = 4)	Average (sd)	0.63 (0.48)	0.13 (0.25)	
	Me (Q1–Q3)	0.75 (0.125–1)	0 (0–0.375)	0.157
Non-professional non-voice users, (n = 7)	Average (sd)	0.93 (0.84)	0.50 (0.50)	
	Me (Q1–Q3)	1 (0–2)	0.5 (0–1)	0.063
Ashtenic, All (n = 17)	Average (sd)	1.02 (0.89)	0.83 (0.73)	
	Me (Q1–Q3)	1.5 (0–2)	1 (0–1.5)	0.127
Professional voice users—non-elite (n = 16)	Average (sd)	1.09 (0.92)	0.91 (0.80)	
	Me (Q1–Q3)	1.5 (0–2)	1 (0–1.5)	0.244
Non-professional voice users, (n = 4)	Average (sd)	0.88 (1.03)	0.88 (0.63)	
	Me (Q1–Q3)	0.75 (0–1.875)	1 (0.25–1.375)	≈1.000
Non-professional non-voice users, (n = 7)	Average (sd)	0.93 (0.89)	0.64 (0.69)	
	Me (Q1–Q3)	1.5 (0–1.5)	0.5 (0–1.5)	0.102
Strain, All (n = 17)	Average (sd)	0.85 (0.68)	0.59 (0.56)	
	Me (Q1–Q3)	1 (0–1)	0.5 (0–1)	0.018
Professional voice users—non-elite (n = 16)	Average (sd)	0.91 (0.74)	0.69 (0.60)	
	Me (Q1–Q3)	1 (0–1.375)	0.75 (0–1)	0.144
Non-professional voice users, (n = 4)	Average (sd)	1.00 (0.82)	0.63 (0.48)	
	Me (Q1–Q3)	1 (0.25–1.75)	0.75 (0.125–1)	0.180
Non-professional non-voice users, (n = 7)	Average (sd)	0.64 (0.48)	0.36 (0.48)	
	Me (Q1–Q3)	1 (0–1)	0 (0–1)	0.102

Table 4. Aerodynamic evaluation.

		Pre	Post	*p*
MPT /a/, All (n = 28)	Average (sd)	8.83 (4.76)	8.74 (2.05)	
	Me (Q1–Q3)	7.93 (6.13–9.77)	8.65 (6.9–10.55)	0.407
Professional voice users—non-elite (n = 16)	Average (sd)	9.02 (5.76)	8.56 (2.23)	
	Me (Q1–Q3)	7.69 (5.84–9.77)	8.65 (6.52–10.55)	0.485
Non-professional voice users, (n = 4)	Average (sd)	10.93 (4.85)	10.36 (1.69)	
	Me (Q1–Q3)	12.29 (5.9–14.61)	10.65 (8.61–11.82)	0.715
Non-professional non-voice users, (n = 8)	Average (sd)	7.41 (1.08)	8.29 (1.56)	
	Me (Q1–Q3)	7.84 (6.69–8.14)	8.12 (6.89–9.34)	0.128

4. Discussion

Vocal demand from everyone is associated with an increased risk of developing vocal problems [21,22]. Although vocal professional use usually occurs in about 1/3 of the working population, phonatory requirements vary according to the occupation [22]. Several studies found in the literature describe that the most frequent complaint of teachers is vocal fatigue and that at least 80% of these teachers presented vocal complaints in a determined period of their career [21,22]. In our study sample, most of the participants (47.6%) (n = 20) were classified as belonging to the group of professional voice users—non-elite, which included six schoolteachers and two kindergarten teachers. In addition, 14.3% (n = 6) were classified as belonging to the group of non-professional voice users, and 38.1% (n = 16) belonging to the group of non-professional non-voice users. There is an accumulation of factors that help the appearance of vocal alterations, and dysphonia cannot be explained by a single cause [23]. In the study by Spina (2009), this author applied a protocol of quality of life and voice with the degree of dysphonia to 101 users with vocal complaints in an outpatient department of otorhinolaryngology. The sample consisted of 46 male and 55 female individuals and only 37 of the 101 participants were voice professionals [24].

Mara Behlau and colleagues (2018) [23] argues that the appearance of vocal fold changes and dysphonia cannot be explained only by the degree of voice use, misuse, or abuse but rather by the accumulation of a variety of factors. In our study sample, four of the six participants were classified as non-professional voice users and ten out of the sixteen participants belonging to the non-professional non-voice users, had their vocal nodules disappear after voice therapy (Table 2). These positive results after therapy in the groups of patients at less risk of developing vocal nodules are in accordance with the results observed in the study by Spina (2009), where many of the participants were non-voice professionals [24].

In this study, the sample shows female dominance, constituting 95.2% of the participants. The literature is unanimous in mentioning a higher incidence of vocal disorders in women [25]. Smith et al. (1996) at the University of Iowa and Utah showed a 2/1 woman-to-man ratio in vocal disorder treatments [26].

Even though the voice multidimensional outcome measures were generally positive in this group, the rate of dropouts (32%) from therapy was still considered moderate, despite being below some rates reported in the literature. In the Portone–Maira et al. (2011) study, 120 out of 197 patients (60%) with dysphonia who were referred for voice therapy by an ENT dropped out of treatment [13]. In comparison, in a meta-analysis review of 110 studies of adults requiring psychotherapy (behavioral change therapy), the average rate was 35.2%. In this study, three participants (12%) dropped out of therapy because they found it difficult to change their vocal habits and voice behavior and were not motivated for therapy.

With respect to the visual-perceptual evaluation, 40.4% of the participants had no vocal fold nodules at the end of the first set of voice therapy sessions. This result suggests that the voice therapy delivered was effective for some participants. When taking into

consideration the time elapsed since the participants experienced vocal symptoms, it seems that delivering early therapy (<1 week) was a significant factor in a good response to the treatment. For all participants who had a shorter period of symptoms, the vocal nodules disappeared. In contrast, three of the participants who had vocal symptoms for a longer period and presented with severe symptoms (aphonia) required a second set of voice therapy sessions. Despite this, the vocal nodules only reduced in size or were unchanged at the end of treatment. One of the reasons that could have explained the lower effectiveness of speech therapy was the participants' constant vocal use on their jobs, not allowing vocal rest (an integral part of the therapy). All three participants belong to the professional voice user's non-elite group. Another aspect that could have helped in the interpretation of this result was knowing the degree of keratosis of the vocal nodules and the vocal hyperfunction before starting therapy; however, this information was not documented in the patient's clinical process by the ENT doctor. More fibrotic vocal nodules are less likely to disappear after therapy [27].

Regarding audio-perceptual evaluation, the pre-therapy results in this study were in accordance with findings in other studies [28,29]. Furthermore, all parameters were improved but with no statistical significance after voice therapy, except for the asthenic voice scale result (Table 3). These outcome measure results are comparable with the Alegria et al. (2019) systematic review study on the effectiveness of voice therapy in patients with vocal fold nodules, where a significant improvement of the overall audio-perceptual parameters was observed [9].

With respect to the aerodynamic evaluation of the voice, the measurement of MPT is one of the procedures used frequently in the vocal evaluation. The presence of a nodule on the vocal fold edge creates an air leak during phonation [6,30,31]. In the present study, the participants' MPT /a/ were increased at the end of therapy, which is in line with the literature. In a survey carried out by Kurtz et al. (2010), the authors stated that the MPT was reduced in all 38 female participants with vocal nodules [32]. In another study by Cielo et al. (2015), a total of 54 subjects, predominantly women (n = 46, 85%) with a diagnosis of vocal fold nodules, had their MPT /a/ values increased after voice therapy [30].

Despite the evidence of the overall benefits of voice therapy care, caution should be given when reading the results as the cohort sample was small; therefore, more studies or studies with larger sample sizes are required to avoid the risk of overestimating the outcome effect and limit the generalization of the findings. Another limitation of the results is the considerable risk of measurement bias, as there were no procedures to reduce measurement errors, in all the different assessment methods used.

In this study, the therapeutic strategy aimed for a holistic approach to the vocal problem, combining a direct and indirect therapy approach. Although there was a similar "structured" treatment plan for each participant, the intensity and duration of each exercise and technique were adapted to the individual, depending on their evolution during therapy sessions and comfort. Further studies are needed to better understand which components of the intervention were responsible for the clinical improvement.

It would have also been interesting to give continuity to this study by following-up on these patients to confirm the functional stability of the results 6 or 12 months after completing voice therapy.

It is important to state that this is related to the number of ratters in the perceptual evaluation of the voice (one evaluator in the present study), increasing the risk of bias in the results and decreasing its robustness. Nevertheless, in this study, the intra-rater assessment for the audio-perceptual measurement was good (0.88), which demonstrates high reliability and consistency of assessments by the examiner.

The lack of other objective voice measurements, such as acoustic, in association with the absence of subjective self-assessment of voice quality by the participants limits the validity and quality of the voice therapy results (therapeutic effect). Another important factor is that data analysis is limited to the quality and accuracy of documentation in the participants' clinical notes, and therefore, the data needs to be analyzed with prudence.

Given the limitations mentioned and the areas for further research, it is crucial to approach the study's findings with caution.

5. Conclusions

The results of the study revealed that voice therapy showed a statistically significant impact when evaluating any observed changes in vocal nodules, encompassing both their absence and reduction in size. Furthermore, among the participants who achieved complete disappearance of vocal nodules, the administration of early voice therapy was identified as a statistically significant contributing factor. These findings suggest that early initiation of voice therapy is associated with a higher likelihood of complete resolution of vocal nodules.

By incorporating larger sample sizes, acoustic outcome measures, and assessments of vocal hyperfunction, future research can provide a more comprehensive and robust evaluation of the effectiveness of speech therapy programs for vocal nodules. These additional measures would contribute to a deeper understanding of treatment outcomes and inform evidence-based practices for managing vocal nodules.

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