Formulation of a program for treatment of childhood dysphonia

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Background
Dysphonia is a disorder characterized by change in voice quality, pitch, loudness, or vocal effort that impairs communication or reduces voice-related quality of life. Childhood dysphonia has several adverse educational and psychosocial implications. Dysphonic children are not aware or not bothered by their voice disorder. Although dysphonia might, in some cases, improve by itself in adulthood, it can be of important value to treat the dysphonic voice already during childhood.
Aim
The aim of this study was to adapt and formulate a program of voice intervention for childhood dysphonia and apply it on Egyptian children to explore its effectiveness as a therapeutic tool.
Patients and methods
This study was conducted on 20 children of both sexes attending the Phoniatrics Unit in Alexandria Main University Hospital complaining of dysphonia. The remediation program aims to improve dysphonia in children using a combination of indirect and direct treatment techniques. It is a modification of The Boone Voice Program for Children combined with new technologies such as the voice games by Kay Elementrics. It is designed to provide the clinician with step-by-step procedures and materials to remediate voice disorders in school-aged children. The program was translated to Arabic and a number of modifications were done in order to adapt it to the Egyptian children.
Results
The study showed effectiveness of the remediation program for childhood dysphonia regarding some of the auditory perceptual assessment and acoustic analysis values. Some of the laryngeal examination findings also showed improvement post-therapy. The study showed significant relation between the children's age, sex, diagnosis, and some pretherapy and post-therapy findings.
Conclusion
Data from the current study suggests that voice therapy may prove to be a valid alternative to just planned follow-up.

Keywords:
childhood dysphonia, hoarseness of voice, voice therapy

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Introduction

Dysphonia is defined as a disorder characterized by a change in voice quality, pitch, loudness, or vocal effort that hinders communication or impairs the voice-related quality of life. The prevalence rate of pediatric dysphonia vary considerably, ranging from 4 to 25% [1–4], although researchers found a prevalence rate of 5–7% as realistic in most populations [3,5–7]. The male predominance is about 60% in dysphonia [8–12]; this is less marked before 7 years of age, followed by a male predominance which equalizes by 11 years and then turns into a female predominance by 13 years [11–13]. The etiology of childhood dysphonia may be congenital such as laryngomalacia, laryngeal web, subglottic stenosis, vocal fold paralysis, and subglottic hemangiomas, or acquired including minimal associated pathological lesions (MAPLs), muscle tension dysphonia, vocal fold granuloma, vocal fold paralysis, laryngitits, gastroesophageal reflux disease, papillomatosis, and psychogenic causes. Assessment of the children starts by interviewing the patient and by general presentation; it is also essential to obtain details of the child's personality and environment. The presence of associated laryngeal symptoms is an indicator of a possible serious underlying pathology and must not be missed. A general otolaryngologic examination should be performed. Auditory perceptual assessment of the voice should be thorough and may use a combination of subjective and objective voice analysis measures, including perceptual evaluation of voice, videostroboscopic imaging of vocal cord movement, and acoustic analysis [14]. The effective

treatment for this disorder is still controversial because there are few studies and many children improve or heal spontaneously after puberty [15]. The most common treatment methods are: voice therapy, vocal counseling, surgery, or, taking into consideration the natural history of pathology, no treatment but planned follow-up in the course of time. Therapeutic success is often the result of a combination of different treatments [16].

Aim

The aim of this study was to adapt and formulate a program of voice intervention for childhood dysphonia and apply it on Egyptian children to explore its effectiveness as a therapeutic tool.

Patients and methods

This study was conducted on 20 children of both sexes attending the Phoniatrics Unit in Alexandria Main University Hospital complaining of dysphonia. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Methods

All children were subjected to the following voice protocol of assessment pretherapy and post-therapy starting with elementary diagnostic procedures including patient's interview, auditory perceptual assessment using the GRBAS scale [17,18], ENT examination, and laryngeal examination, followed by clinical diagnostic aids examining the glottis by indirect laryngoscopy or flexible nasofibrolaryngoscopy and continuous lighting or stroboscopic lighting by Kay Pentax^{RLS}9100B Rhino-Laryngeal Stroboscope, USA and voice recording. Then Additional Instrumental Diagnostic Measures and acoustic analysis using the software included in Computerized Speech Lab model 4500–Kay Pentax were done.

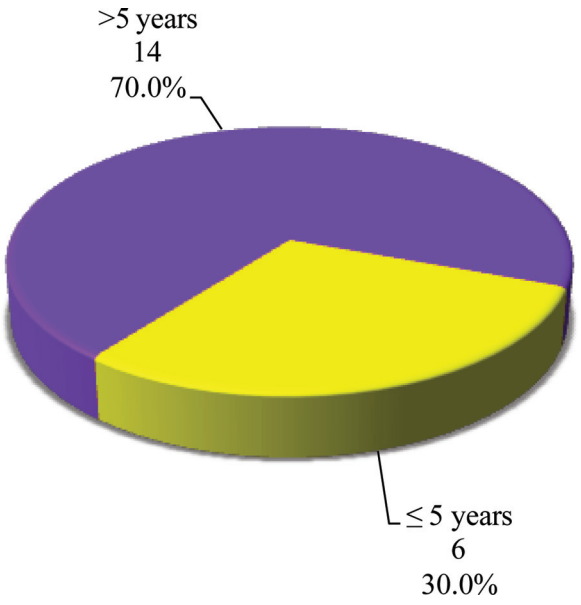
Intervention

The program was applied to all patients through one to two sessions per week for a duration from 1 to 2 months. Each approach was introduced through one to two sessions till the child habituates the best voice. The child is sitting in front of the phoniatrician. Each step is explained to the child through cards and pictures trying to clarify the target goal. The remediation program for the children is designed to provide the voice clinician with step-by-step procedures and materials to remediate voice disorders in school-aged children. Vocal Abuse Reduction Program is introduced to the child by explaining how lesions occur using the story. A systematic reduction of the child abuse through documenting the child abuses on daily numbered cards, then monitoring the responses on a chart in order to make the child aware of and able to reduce or eliminate the vocal abuse and then presenting it on the balloon chart. This program is based on the therapeutic philosophy and procedures described in The Voice and Voice Therapy (Boone and McFarlane, [19]). The program is composed of 12 facilitating approaches combined with new technologies such as the voice games by Kay Elemetrics which offers a cognitive way to give children insight into why they may have voice problems related to voice abuse.

Results

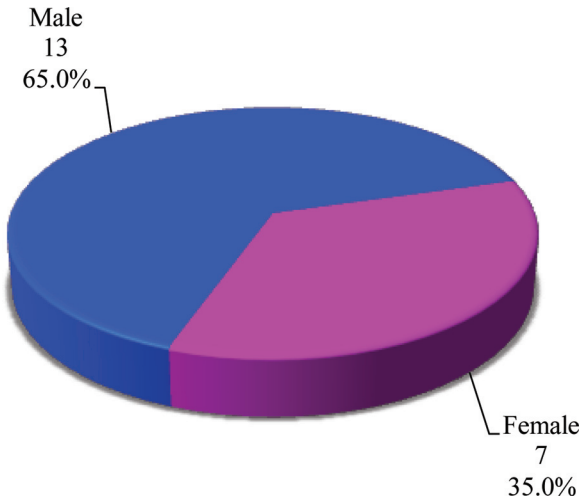
The ages of the children ranged from 4 to 10 years. The male to female ratio among the children was nearly 2 : 1, 13 (65%) men to seven (35%) women. The majority of the studied children were from moderate socioeconomic level constituting 65%, and 35% were from low socioeconomic level. All the children were complaining mainly of change of voice and only 50% were complaining also of phonasthenia (Figs 1 and 2). As regards the etiology, it was high vocal demand in all patients, with 75% exposed to noise as an environmental factor, 35% exposed to smoking

Figure 1



Distribution of studied sample according to age.

Figure 2



Distribution of studied sample according to sex.

Table 1 Distribution of the studied sample according to diagnosis (*N*=20)

	n (%)
Diagnosis	
Bilateral vocal fold nodules	14 (70.0)
Hyperfunctional dysphonia	6 (30.0)

(passive smoker), and 85% with tense temperament. According to the diagnosis, 14 children were diagnosed as bilateral vocal fold nodules and six were diagnosed as hyperfunctional dysphonia (Table 1). By auditory perceptual assessment roughness, asthenia, and strained voice quality between the children pretherapy and post-therapy showed statistically significant results with a *P* value of 0.007, 0.001, and 0.001, respectively. But as regards the breathiness of voice pretherapy and post-therapy it showed insignificant statistical results with a *P* value of 0.102 (Table 2): 65% had register break pretherapy and 10% had register break post-therapy. The effect of the therapy on the register break showed statistically significant results with a *P* value of 0.001. Pretherapy all the children had decreased voice pitch but post-therapy 30% had decreased voice pitch and 70% had average pitched voice. The children's voice pitch pretherapy and post-therapy showed statistically significant results with a *P* value less than 0.001 using marginal homogeneity test. All the children used excessively loud voice pretherapy and 65% of the children were using hard glottal attack. All of them shifted to using average loudness post-therapy and only 5% of them used hard glottal attack. During vocal fold examination by continuous light, 15 children had increased girth of both vocal folds pretherapy, but post-therapy only two had increased girth of both vocal folds. The vocal folds girth pretherapy and post-

Table 2 Comparison between the studied groups according to GRBAS scale

	Pretherapy (*N*=20) [*n* (%)]	Post-therapy (*N*=20) [*n* (%)]	*Z*	*P*
Grade				
0	0 (0.0)	3 (15.0)	3.573*	<0.001*
1	6 (30.0)	15 (75.0)		
2	9 (45.0)	2 (10.0)		
3	5 (25.0)	0 (0.0)		
Roughness				
0	3 (15.0)	4 (20.0)	2.676*	0.007*
1	6 (30.0)	14 (70.0)		
2	9 (45.0)	2 (10.0)		
3	2 (10.0)	0 (0.0)		
Breathiness				
0	16 (80.0)	19 (95.0)	1.633	0.102
1	1 (5.0)	1 (5.0)		
2	2 (10.0)	0 (0.0)		
3	1 (5.0)	0 (0.0)		
Asthenia				
0	6 (30.0)	15 (75.0)	3.418*	0.001*
1	8 (40.0)	5 (25.0)		
2	5 (25.0)	0 (0.0)		
3	1 (5.0)	0 (0.0)		
Strain				
0	4 (20.0)	13 (65.0)	3.474*	0.001*
1	7 (35.0)	7 (35.0)		
2	5 (25.0)	0 (0.0)		
3	4 (20.0)	0 (0.0)		

Z for Wilcoxon's signed ranks test for comparing between preoperative and postoperative. *Statistically significant at *P* value less than or equal to 0.05.

therapy showed statistically significant results with a *P* value less than 0.001 using the McNemar test. As regards the presence of swellings on the vocal folds, 14 children had at the free edge bilateral rounded vocal fold nodules and six had no swellings pretherapy. Post-therapy 12 still had nodules on the vocal folds. Pretherapy most of the children had small and moderate-sized nodules, but post-therapy all the children who still had nodules were small sized. Stroboscopic examination showed that pretherapy 90% of the children had incomplete glottic closure during phonation, post-therapy 75% had incomplete glottic closure, which showed statistically insignificant results. Pretherapy 10% of the children during phonation had no glottic gap, and most of them had glottic gaps 1 and 2 mm with a mean of 1.55±0.83 mm. Post-therapy 20% had no glottic gap and 75% had a glottic gap of 1 mm with a mean of 0.85±0.49 mm, which showed statistically significant results with a *P* value of 0.004. As regards acoustic analysis, the perturbation measures the jitter of the children's voices pretherapy which ranged from 0.40 to 6.40 and the shimmer ranged from 1.90 to 18.0, but post-therapy the jitter ranged from 0.30 to 4.50 and the shimmer ranged from 2.70 to 9.0. The jitter of the children's

Table 3 Comparison between the studied groups according to acoustic analysis

	Pretherapy (*N*=20)	Post-therapy (*N*=20)	Test of significance	*P*
Jitter				
Minimum–maximum	0.40–6.40	0.30–4.50	*t*=1.841	0.081
Mean±SD	3.58±1.75	2.73±1.18		
Median	3.40	3.0		
Shimmer				
Minimum–maximum	1.90–18.0	2.70–9.0	*Z*=2.876*	0.004*
Mean±SD	7.28±3.54	4.84±1.74		
Median	6.65	4.0		
NHR				
Minimum–maximum	0.10–0.70	0.09–0.20	*Z*=2.739*	0.006*
Mean±SD	0.19±0.17	0.12±0.03		
Median	0.14	0.10		
DSI				
Minimum–maximum	−4.38 to 4.80	0.01–5.0	*t*=2.641*	0.016*
Mean±SD	0.77±2.46	2.39±1.52		
Median	1.33	2.37		
ELOW				
Minimum–maximum	33.60–48.70	28.20–42.0	*t*=2.641*	0.016*
Mean±SD	39.25±3.95	36.21±3.47		
Median	38.40	36.25		
MPT				
Minimum–maximum	2.0–8.0	5.0–10.0	*t*=8.393*	<0.001*
Mean±SD	5.0±1.41	7.95±1.36		
Median	5.0	8.0		

DSI, Dysphonia Severity Index; *t*, Paired *t* test for comparing between preoperative and postoperative; *Z*, *Z* for Wilcoxon's signed-rank test for comparing between preoperative and postoperative. *Statistically significant at *P* value less than or equal to 0.05.

voices pretherapy and post-therapy was statistically insignificant with a *P* value of 0.081, but the shimmer was statistically significant with a *P* value of 0.004. Pretherapy the noise to harmonic ratio of the children's voices mean was 0.19±0.17, but post-therapy the mean was 0.12±0.03. The noise to harmonic ratio of the children's voices pretherapy and post-therapy was statistically significant with a *P* value of 0.006 using paired *t* test .

Pretherapy the Dysphonia Severity Index (DSI) of the children's voices ranged from −4.38 to 4.80, but post-therapy it ranged from 0.01 to 5.0. As for minimum energy pretherapy the mean was 0.77±2.46, but post-therapy the mean was 36.21±3.47. The effect of voice therapy on DSI and minimum energy of the children's voices was statistically significant with a *P* value of 0.016 for both. As for maximum phonation time (MPT) pretherapy ranged from 2.0 to 8.0 s, but post-therapy it ranged from 5.0 to 10.0 s. Voice therapy had a statistically significant effect on MPT of the children's voices with a *P* value of less than 0.001 (Table 3).

Discussion

The present study showed that 65% of the studied children were men. This goes with a study that showed that the presence of vocal fold nodules has been higher in boys. It is, however, possible that this sex difference could reflect different voice usage in boys and girls. During childhood, the behavior of boys is more impulsive and aggressive than that of girls and is allied to excessive hyperactivity, anxiety, and spirit of leadership. Such a profile reflects directly in the phonatory mechanisms, resulting in vocal abuse. Another study showed that the girls'voice usage in a day care environment tended to become noisier as the day progressed, whereas the boys were constantly loud throughout the day [20]. According to different authors, voice disorders are more frequent in boys than in girls [2,21]. All of our studied children were high vocal demand students, 75% of them were exposed to noisy environment and 85% had tense temperament. In an unpublished study by Barker and Wilson reported in the book by Colton and colleagues that in children's voice use in a classroom environment, children with dysphonia were reported to produce almost three times as many vocalizations as the children without dysphonia. Another study found that the occurrence of dysphonia was related to the amount of time spent in day care or afterschool care environments [22,23]. Of the studied children 65% were diagnosed as having bilateral vocal fold nodules and 35% were diagnosed as hyperfunctional dysphonia. This could be explained by the fact that children with

vocal nodules often use more efforts for adducting vocal folds as a compensatory voice behavior for the presence of vocal nodules. This compensatory adduction tends to press the folds tightly for minimizing the irregularity in the border of the folds. This finding is consistent with Tezcaner *et al*. [24] which stated that in school-aged children, the incidence of vocal fold nodules is ~17–30%. The current study demonstrated a pattern of improvement across roughness, asthenia, and strained voice quality, showing a highly significant difference between pretherapeutic and the post-therapeutic values of the auditory perceptual evaluation. Colton and Casper (2009) stated that the presence of vocal nodules provides the voice with some psychoacoustic characteristics, especially the parameters of roughness and breathiness. The present study also showed significant improvement in register break, voice pitch, loudness, and glottal attack among most of the studied children pretherapy and post-therapy. This could be explained by the improved awareness of the children about their voices' problem. Lee *et al.* [25] reported that a few sessions of voice therapy, focusing on certain aspects such as awareness, relaxation, respiration, and easy onset phonation to reduce the tension around the laryngeal muscles, resulted in dramatic improvement of their voice quality and their pitch adjustment.

In the laryngeal examination using continuous light the present study showed a pattern of improvement regarding the mucous membrane color, vascular markings, and vocal folds girth in most of the cases. Regarding the swellings there was significant improvement in the swelling size and color. Post-therapeutic all the children had small-sized nodules; this coincides with the results of endoscopic ratings of vocal status in another study which showed that none of the vocal nodules had disappeared after completion of the therapy. This finding is in agreement with histologic studies that suggest that more permanent types of tissue damage may be associated with the formation of nodules, for example, fibroblastic response involving increased fibronectin decomposition [26]. The positive impact of therapy is not necessarily associated with a complete amelioration of the nodular lesions. However, the fact that the nodules had decreased in size after therapy as well as the findings of reduced edema strongly suggest that voice therapy had a trauma-reducing effect for the majority of the clients. The hyperfunctional vocal behavior appears to have decreased. Thus, there seemed to be a good potential that the compensatory 'vicious circle' of further increased muscle tension and increased subglottic pressure leading to escalating trauma could be stopped by voice therapy. Regarding vocal fold examination by stroboscopy, voice therapy had a significant effect on the size of the glottic gap, glottic mucosal wave, and its amplitude. Research correlating laryngeal (videostroboscopy), acoustic, and perceptual parameters in children showed significant correlations between the vibration quality of mucosa wave and perceptual evaluation and between acoustic and perceptual evaluation [27,28]. The results of this study showed high jitter, shimmer, and NHR of dysphonic children pretherapy as it was stated in the normative study of acoustic parameters in normal Egyptian children that jitter was around 1.9% in boys and 1.6% in girls; shimmer values recorded were around 3.7%; harmonic to noise ratio was 0.13 [29].

This finding was also consistent with previous studies indicating that the use of acoustic analyses has led to high jitter, shimmer, and NHR values, and lowering of fundamental frequency for the voices of children with vocal nodules, differentiating them from normal voices [30,31]. This can be explained by the fact that strained voices have more longitudinally tense (stretched) vocal folds and/or higher subglottic pressure. The current study demonstrated a significant improvement in DSI values of the children's voices pretherapeutic and post-therapeutic. The DSI for perceptually normal voices equals +5 and for severely dysphonic voices −5. The more negative the patient's index, the worse is his or her vocal quality [32]. The present study showed that there was a significant increase in the MPT of the children's voices pretherapy and post-therapy, this was agreed by other authors, who stated that the MPT is shortened in patients with vocal nodules depending especially on the coordination of pneumophonoarticulation and perfect glottal closure, which are compromised in most cases [33,34].

Conclusion

(1) Data from the current study suggest that voice therapy may prove to be a valid alternative to just planned follow-up.
(2) The program showed effectiveness regarding mainly roughness, asthenia, strained voice quality, pitch, and register break in auditory perceptual assessment.
(3) The studied children demonstrated significant improvement in MPT, DSI, NHR, ELOW, and shimmer values of the acoustic analysis.
(4) By laryngeal examination vocal folds girth, color, swelling size, glottic closure, and mucosal wave showed some improvement post-therapy.

Recommendations

(1) Long-time follow-up assessments would be of interest to show the long-term effect of the remediation program.
(2) Therapeutic approaches should be adapted to every single case.
(3) More importance should be given to the vocal behavior of teachers that are the first vocal model for children out of home. It should be worthwhile to organize some meetings with teachers of primary schools to make them understand the communicative capabilities in different ages and to prevent voice problems.

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Conflicts of interest
There are no conflicts of interest.

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