Effects and Differences of Voice Therapy on Spasmodic Dysphonia and Muscle tension dysphonia: A Retrospective Pilot Study

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Summary: Objectives. Laryngeal and voice findings of adductor spasmodic dysphonia (AdSD) and muscle tension dysphonia (MTD) are similar, and it is difficult to distinguish between both disorders. The purpose of this study is to ascertain the effect of voice therapy on MTD and AdSD and clarify their difference.

Methods. A total of 49 patients, including 22 patients with MTD (MTD group) and 27 patients with AdSD (SD group), were included in the study. The MTD scores were evaluated, and aerodynamic analysis (maximum phonation time [MPT], mean airflow rate [MFR], highest pitch, lowest pitch, and pitch range), perceptual evaluation (Strangulation, Interruption, and Tremor), acoustic analysis (PPQ, APQ, NHR, and DVB), and subjective assessment (voice handicap index-10 [VHI-10]) were performed before and after voice therapy.

Results. The MTD score, highest pitch, pitch range, strangulation, PPQ, APQ, NHR, and VHI-10 showed significant improvement after treatment in the MTD groups. On the other hand, the effect of voice treatment on AdSD was poor despite the improvement in the MTD score.

Conclusions. This study could serve as a basis for conducting prospective studies to verify the effects of voice therapy on MTD and AdSD.

Key Words: Muscle tension dysphonia (MTD)—Adductor spasmodic dysphonia (AdSD)—Voice therapy.

INTRODUCTION

Muscle tension dysphonia (MTD) is a functional voice disorder caused by the dysregulation of the intrinsic and extrinsic laryngeal muscle activities. Verdolini *et al.* considered MTD as the primary descriptor of a large proportion of patient caseloads in which hoarseness is present without organic pathology (qualified as "primary MTD") or in response to organic pathology ("secondary MTD").[1] Poor regulation of the activities of the intrinsic and extrinsic laryngeal muscles is cited as the proximal cause of functional dysphonia, and voice therapy is effective for MTD.

On the other hand, spasmodic dysphonia (SD) is a disorder of the central nervous system rather than the larynx. As with other forms of dystonia, interventions for the end organ have not offered a definitive cure.[2] The SD subtypes include adductor spasmodic dysphonia (AdSD), abductor spasmodic dysphonia (AbSD), and mixed spasmodic dysphonia.[3] SD is a focal laryngeal dystonia. In its most common form, which is AdSD, the abnormal contractions of the thyroarytenoid (TA) and lateral cricoarytenoid (LCA) muscles result in excessive spasms and disproportionate glottal closure.[4] There are currently two major methods of treatment for AdSD: pharmacotherapy and surgery. Voice therapy is disabled for AdSD. No other form of dysphonia is as controversial or enigmatic as SD.

MTD and AdSD are regarded as separate voice disorders. However, when voice symptoms and laryngeal endoscopic findings are similar or voice symptoms are absent during medical examination, it is difficult for therapists to differentiate between them. Distinguishing MTD from AdSD can be difficult. The effects of voice therapy on MTD have been reported.[5-6] The use of voice therapy for the treatment of AdSD has also been reported, but it has not been evaluated in detail.[7]

To compare the effects of voice therapy on MTD and AdSD, it is necessary to conduct a prospective study with a detailed protocol before voice therapy. This pilot study retrospectively examined the differences in the effects of voice therapy on MTD and AdSD to set the protocol for future prospective study.

MATERIALS AND METHODS

Patient characteristics

This study was approved by the Institutional Review Board of Kumamoto University Hospital and Kumamoto Health Science University. The medical records of all the patients finally diagnosed with MTD or AdSD between August 2007 and January 2016 were reviewed, and the following were collected: the results of a detailed clinical history, laryngeal findings with or without videostroboscopy, and the results of the acoustic and aerodynamic analysis. All the patients included in the present study had strained voices and laryngoscopic features, including excessive adduction of the ventricular folds covering the true folds, anterior-posterior compression, and posterior-glottal chink.

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Voice therapy procedure

A speech therapist was present during videostroboscopy by an otolaryngologist during the first visit. A trial of voice therapy was performed for all cases to confirm the effect. The voice therapy procedure was selected based on the effect of the trial voice treatment, and depending on the case, symptom-responsive voice treatment, yawn-sigh approach, humming, tube-phonation exercise, and inspiratory phonation were administered. Palpation around the larynx (posterior edge of the hyoid bone and the posterior edge of the thyroid cartilage) was performed, and manual circumlaryngeal therapy was also administered when pain was observed. After improving the voice to some extent using symptom-responsive voice treatment, vocal function exercise (VFE) was performed, depending on the case. The frequency of voice treatment was once every 1-2 weeks.

Videostroboscopic evaluation

Stroboscopic images (Pulsar 20140020; Karl-Stroz, Tuttlingen, Germany) were obtained during sustained phonation of a vowel sound, /e/ or /i/, at a comfortable pitch and volume using either a rigid oblique-view endoscope (SFT-1: Nagashima, Tokyo, Japan) or a videoendoscope (VNL-1171K: Pentax, Tokyo, Japan), depending on patient tolerance. A digital videocassette recorder (DVCPRO; Panasonic, Yokohama, Japan) was used for recording.

The video recordings of the participants were randomized, and the reviewers (NK, TM, JT) were blinded to the name of each patient and the timing of the video recordings (before versus after voice therapy). The videostroboscopic images were evaluated based on the MTD score[8]. The MTD score is a novel assessment first described by Ogawa *et al.*, who developed it to rate the compressions of three sites in the larynx, including the vocal folds, tentative vocal folds, and the dissecting-epiglottic region, during phonation of sustained vowels under endoscopic examination and estimate laryngeal hyperfunction. MTD scores are calculated as the sum of the tension levels of each site (Table 1). In this study, the MTD scores were determined by three speech therapists (three years, six years, and twelve years of experience) who had 3 or more years of experience with speech therapy for voice disorders, and the median was adopted as the final score.

TABLE 1.
How to calculate MTD score.

A:vocal cord, B: tentative vocal cord, C: dissecting-epiglottic region, which is a method of finding the sum of the tension levels of each level.
A.Vocal cords: One point is one in which vocal cord vibration becomes irregular due to contact between the two vocal cords during vocalization, or one in which regular vocal cord vibration is not observed due to vocal cord deflection (including bowing changes).
B.Vestibular fold: There is hyperinversion of the vestibular fold at the time of vocalization, but only B has one point without contact between both vocal folds. However, if contact between both vestibular folds is observed, the lower findings are unknown. Therefore, assuming that there is tension in the vocal cords, A + B is given as 3 points.
C.Rupture-epiglottis: Rupture-epiglottis shortening of the anterior-posterior diameter is observed during vocalization, but no obstruction at this site is observed at one point with C alone, and if the upper part is completely obstructed, it is lower. Assuming that there is tension in the vocal cords and vestibular folds because the findings are unknown, A + B + C is given as 5 points.

Aerodynamic analysis

To measure the maximum phonation time (MPT), the patients were instructed to produce sustained phonations of the /a/ vowel, for as long as possible, at a comfortable pitch and volume. MPT was measured twice for each patient using a stopwatch, and the highest measurement was used. The mean airflow rate (MFR) was measured using a phonatory function analyzer PS-77E (Nagashima, Tokyo, Japan), or phonation analyzer PA-1000 (Minato, Osaka, Japan). The patients were instructed to produce the /a/ vowel at a comfortable pitch and volume while keeping a mouthpiece around the lips. Each patient was instructed to produce the /a/ sound into the mouthpiece repeatedly in ascending pitches up to the highest pitch and descending pitches down to the lowest pitch and expressed in a semitone scale.

Voice recording and perceptual assessments

Voice recording was performed in a sound-treated room using a Digital Recorder (Model PMD 670; Marantz, Sagamihara, Japan) connected to a microphone (Model WM-421; Panasonic, Osaka, Japan). The microphone was held at a distance of 20 cm from the mouth during recording. The recording included the name of the patient, date, and sustained phonation of the vowel at a comfortable pitch and volume. The voice was digitalized at a 44.1 kHz sampling rate through an anti-aliasing filter and stored in the pulse-code modulation format. The speech segments of the recordings were used for auditory perceptual assessment.

The names and dates were removed from the recordings of all speech segments. The sustained phonations of the vowel were randomized and presented to three listeners (NK, TM, JT) for perceptual judgment of the three characteristics of each sample: strangulation (tightness of voice production), interruption (abrupt voice initiation and arrest), and tremor (rapid fluctuations in pitch or loudness). These three parameters were rated on three equal point scales with 0 as normal, 1 as moderate, and 2 as severe. For each parameter, the mean of the ratings by the three listeners was calculated.[9]

Acoustic analysis

Acoustic analysis was conducted using the Multi-Dimensional Voice Program (MDVP) Model 5105 (ver. 3.1.7; Kay Elemetrics, Lincoln Park, NJ). The vowel segment was cut from the complete voice sample, and duration of 1s was trimmed from a stable portion of the vowel phonation and analyzed. The following acoustic data were recorded: (1) Pitch period Perturbation Quotient (PPQ), i.e., cycle-to-cycle variation in frequency; (2) Amplitude Perturbation Quotient (APQ), i.e., cycle-to-cycle variation in signal amplitude; (3) Noise - to- Harmonic Ratio (HNR), i.e., the ratio of acoustic energy in the noise versus the harmonic components contained in the acoustic spectrum; (4) Degree of Voice Breaks (DVB), i.e., the total duration of the breaks between the voiced parts of the signal divided by the total signal duration.

Subjective assessment

The Voice Handicap Index (VHI) quantifies a patient's perception of his or her vocal handicap based on the responses to questions about their condition within the previous 2 weeks.VHI-10 is a shortened version of the VHI, which is a patient-based self-assessment tool developed by Jacobson et al.[10]; it consists of 30 questions covering the functional, physical, and emotional aspects of voice disorders. The patients were asked to rate each of the 10 statements on a scale from 0 to 4 (0 = strongly disagree, 4 = strongly agree) which would yield the worst possible total score of 40.

Statistical analysis

All measurements are shown as mean ± standard deviation (SD). The Wilcoxon signed-rank test was used to compare the measurements before and after treatment in each group (Stat View 5.0 for Windows; SAS Institute, Cary, NC). Because of the wide range of distribution, the median values are also shown in the parameters of age and period from onset to treatment. For each parameter, the values for the MTD and SD groups, before and after treatment, were compared using the Mann-Whitney U-test (Stat View 5.0 for Windows; SAS Institute, Cary, NC). The inter-rater reliability for each parameter (MTD score and perceptual assessment) was examined using the inter-rater correlation coefficient (the Spearman correlation coefficient between each pair of data evaluated by three raters). For all the analyses, $P < 0.05$ denoted statistical significance.

RESULTS

In total, 67 patients with strained voices underwent voice therapy from August 2007 to January 2016 at Kumamoto University Hospital. Eighteen patients satisfied the exclusion criteria: 1 patient was diagnosed with amyotrophic lateral sclerosis and 17 patients were lost to follow-up. A total of 49 patients including 22 patients in the MTD group and 27 patients in the AdSD (SD group) were included. The profiles of the participants for both groups, including age, disease duration, and voice treatment duration, are presented in Table 2.

The intra-rater correlation coefficient of each parameter for the MTD score was 0.429−0.864 (P = 0.0055−P < 0.0001). In addition, the intra-rater correlation coefficient for each parameter for perceptual assessment was 0.426 −0.760 ($P < 0.0001$).Tables 3-5 show that the result underwent vocal function testing on five occasions in the MTD and SD groups.

Videostroboscopic findings

The MTD score was obtained for 21 out of 22 cases based on the videostroboscopic findings in the MTD group; in the SD group, the MTD score was obtained for 16 out of 27. The videostroboscopic findings showed significant improvement after voice therapy in the MTD group (P = 0.0126). Representative videostroboscopic findings of the MTD group are presented in Figure 1. The videostroboscopic findings also showed significant improvement after voice therapy in the SD group (P = 0.0385). In addition, the MTD scores before and after the assessment showed no significant differences between the two groups.

Aerodynamic studies

The lowest pitch, highest pitch, and pitch range were evaluated for 19 of 22 cases in the MTD group. In the SD group, these were evaluated for 19 of 27 cases. The measurements of the highest pitch and pitch range showed significant improvement after voice therapy in the MTD groups (highest pitch P = 0.0036, pitch range P = 0.0003). In the SD

TABLE 2.
Subjects profile.

	MTD Group	SD Group
Number of patients	n = 22 (5 males & 17 females)	n = 27 (3 males & 24 females)
Age range (years, mean ± standard deviation, median)	14~78 (53.0 ± 18.1, 57.0)	17~49 (33.0 ± 12.0, 31.0)
Disease period (months, mean ± standard deviation, median)	1~156 (31.4 ± 44.9, 10.9)	2~297 (66.8 ± 71.5, 47.5)
Voice therapy period (months, mean ± standard deviation, median)	1~29.9 (7.4 ± 7.1)	0.4~37.3 (2.9 ± 7.0)

TABLE 3.
MTD group.

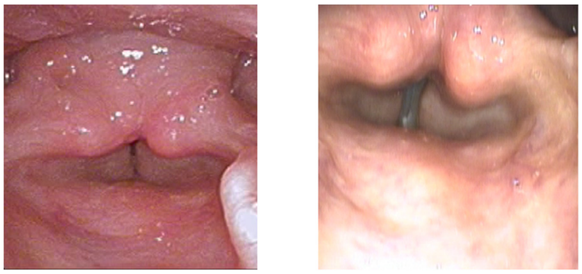
		n	Pre	Post	Pre vs Post
Videostroboscopy evaluation	MTD score	21	2.2 ± 1.2	1.7 ± 1.2	**P=0.0126**
Aerodynamic analysis	MPT (s)	22	16.0 ± 8.8	17.3 ±5.2	P=0.3986
	MFR (ml/s)	22	110 ± 63	128 ± 54	P=0.0691
	lowest pitch (Hz)	19	164 ± 48	160 ± 47	P=0.1128
	highest pitch (Hz)	19	445 ± 228	528 ± 169	**P=0.0036**
	Pitch range (semi tone)	19	14.1 ± 9.7	20.7 ± 6.4	**P=0.0003**
Perceptual assessment	Strangulation	22	1.0 ± 0.7	0.8 ± 0.4	**P=0.0143**
	Interruption	22	0.0 ± 0.2	0.0 ± 0.0	P=0.3287
	Tremor	22	0.0 ± 0.0	0.2 ± 0.4	P=0.0674
Acoustic analysis	PPQ (%)	19	2.3 ± 1.9	0.7 ± 0.6	**P=0.0002**
	APQ (%)	19	8.1 ± 5.2	3.6 ± 1.9	**P=0.0003**
	NHR	19	0.3 ± 0.1	0.2 ± 0.1	**P=0.0012**
	DVB (%)	19	0.0 ± 0.0	0.0 ± 0.0	P>0.9999
Subjective assessment	VHI-10	18	18.2 ± 9.0	10.1 ± 8.2	**P=0.0007**

TABLE 4.
SD group.

		n	Pre	Post	Pre vs Post
Videostroboscopy evaluation	MTD score	16	2.3 ± 0.9	1.8 ± 0.9	**P=0.0385**
Aerodynamic analysis	MPT (s)	27	13.7 ± 7.1	13.8 ± 6.1	P=0.9521
	MFR (ml/s)	27	117 ± 85	104 ± 69	P=0.8717
	lowest pitch (Hz)	19	178 ± 31	174 ± 26	P=0.3059
	highest pitch (Hz)	19	619 ± 238	628 ± 216	P=0.8721
	Pitch range (semi tone)	19	20.6 ± 7.5	21.3 ± 6.2	P=0.2312
Perceptual assessment	Strangulation	27	1.1 ± 0.7	1.2 ± 0.5	P=0.5637
	Interruption	27	0.2 ± 0.5	0.3 ± 0.6	P=0.4142
	Tremor	27	0.1 ± 0.4	0.3 ± 0.5	P=0.1025
Acoustic analysis	PPQ (%)	19	2.0 ± 1.2	1.5 ± 1.7	**P=0.0442**
	APQ (%)	19	7.2 ± 3.3	6.3 ± 3.9	P=0.2122
	NHR	19	0.3 ± 0.1	0.3 ± 0.2	P=0.5288
	DVB (%)	19	0.9 ± 3.2	1.8 ± 6.8	P=0.7150
Subjective assessment	VHI-10	24	27.6 ± 7.2	27.7 ± 7.4	P=0.7817

TABLE 5.
MTD group vs SD group.

	Pre			Post		
	MTD group	SD group	MTD vs SD	MTD group	SD group	MTD vs SD
MTD score	2.2 ± 1.2	2.3 ± 0.9	P = 0.6898	1.7 ± 1.2	1.8 ± 0.9	P=0.8455
MPT (s)	16.0 ± 8.8	13.7 ± 7.1	P = 0.3764	17.3 ± 5.2	13.8 ± 6.1	**P=0.0192**
MFR (ml/s)	110 ± 63	117 ± 85	P = 0.9839	128 ± 54	104 ± 69	P=0.0535
lowest pitch (Hz)	164 ± 48	178 ± 31	P =0.4164	160 ± 47	174 ± 26	P=0.2647
highest pitch (Hz)	445 ± 228	619 ± 238	P = 0.0109	528 ± 169	628 ± 216	P=0.1556
Pitch range (semi tone)	14.1 ± 9.7	20.6 ± 7.5	P = 0.0195	20.7 ± 6.4	21.3 ± 6.2	P=0.9436
Strangulation	1.0 ± 0.7	1.1 ± 0.7	P = 0.5797	0.8 ± 0.4	1.2 ± 0.5	**P=0.0026**
Interruption	0.0 ± 0.2	0.2 ± 0.5	P = 0.0352	0.0 ± 0.0	0.3 ± 0.6	P=0.0197
Tremor	0.0 ± 0.0	0.1 ± 0.4	P = 0.1971	0.2 ± 0.4	0.3 ± 0.5	P=0.6876
PPQ (%)	2.3 ± 1.9	2.0 ± 1.2	P= 0.9033	0.7 ± 0.6	1.5 ± 1.7	P=0.0689
APQ (%)	8.1 ± 5.2	7.2 ± 3.3	P = 0.6855	3.6 ± 1.9	6.3 ± 3.9	**P=0.0031**
NHR	0.3 ± 0.1	0.3 ± 0.1	P = 0.6323	0.2 ± 0.1	0.3 ± 0.2	**P=0.0124**
DVB (%)	0.0 ± 0.0	0.9 ± 3.2	P = 0.0695	0.0 ± 0.0	1.8 ± 6.8	P=0.1234
VHI-10	18.2 ± 9.0	27.6 ± 7.2	P = 0.0015	10.1 ± 8.2	27.7 ± 7.4	**P<0.0001**



Before voice therapy
MTD score 4

After voice therapy
MTD score 2

FIGURE 1. Videostroboscopic findings before and after voice therapy in MTD group.
The figure shows the laryngeal findings of the cases in the MTD group. Prior to voice therapy, the MTD score was 4 due to hyperinversion of the vestibular fold at the time of vocalization. After voice treatment, hyperinversion of the vestibular fold at the time of vocalization improved and MTD score was 2.

group, all the parameters used for aerodynamic analysis showed no significant changes after treatment. The measurements for the highest pitch and pitch range before treatment were significantly values higher in the SD group than in the MTD group (highest pitch $P = 0.0109$, pitch range $P = 0.0195$). The MPT after treatment was significantly better in the MTD group than in the SD group ($P = 0.0192$).

Perceptual assessments

Perceptual assessments were performed for all the cases. The measurements of strangulation showed significant improvement after treatment in the MTD groups ($P = 0.0143$). In the SD group, all the parameters for the perceptual assessment showed no significant improvement after treatment. The measurements for interruption before treatment were significantly better in the MTD group than in the SD group ($P = 0.0352$). In addition, the measurements for strangulation and interruption after treatment were significantly values lowerin the MTD group than in the SD group (strangulation $P = 0.0026$, interruption $P = 0.0197$).

Acoustic analysis

The PPQ, APQ, NHR, and DVB were evaluated in 19 of 22 cases in the MTD group. In the SD group, the PPQ, APQ, NHR, and DVB were evaluated in 19 of 27 cases. The measurements of PPQ, APQ, and NHR showed significant improvement after treatment in the MTD groups (PPQ $P = 0.0002$, APQ $P = 0.0003$, NHR $P = 0.0012$). In the SD group, the measurements for PPQ showed significant improvement after treatment ($P = 0.0442$). The APQ and NHR after treatment were significantly better in the MTD group than in the SD group (APQ $P = 0.0031$, NHR $P = 0.0124$).

Subjective assessment

The VHI-10 evaluation was performed for 18 of 22 cases in the MTD group and 24 of 27 cases in the SD group. The VHI-10 assessments showed a significant improvement after treatment in the MTD groups ($P = 0.0007$) but no significant improvement in the SD group. The measurements for VHI-10 before and after treatment were significantly better in the MTD group than in the SD group (pre-treatment $P = 0.0015$, post-treatment $P < 0.0001$).

DISCUSSION

Laryngeal and voice findings of MTD and AdSD are similar, and it is difficult to distinguish between both disorders. SD is generally heterogeneous across patients.[11,12] The voice symptoms of SD patients are temporally variable and inconsistent. The most important indicator is the complaint of difficulty with phonation by SD patients, which may manifest as strangulation, interruption, or tremor[9]. Voice therapy can be used to distinguish between MTD and AdSD, and it is effective for MTD. Therefore, voice therapy is important in distinguishing MTD from AdSD. This pilot study retrospectively examined the differences in the effects of voice therapy on MTD and AdSD to set the protocol for future prospective study.

The effect of voice therapy on MTD and AdSD

In this study, the measurements of the MTD score, highest pitch, pitch range, strangulation, PPQ, APQ, NHR, and VHI-10 showed significant improvement after treatment in the MTD groups. The pathology of MTD is the crushing of the laryngeal cavity due to overstraining of the vocal folds and vestibular folds, as well as the base of the epiglottis, during vocalization.[13] Voice therapy improved the MTD score by relaxing the internal and external laryngeal muscle hypertonia. After voice therapy, the MTD patients with limited vocal fold extension could adjust the larynx appropriately to produce high-pitched vocalizations, which improved the upper limit of the pitch and significantly increased the vocal range.

The measurements of strangulation, PPQ, APQ, NHR, and VHI-10 showed significant improvement after treatment in MTD groups. Jafari *et al.* reported that the GRBAS for perceptual assessment and the VHI significantly improved after 6 weeks of voice therapy in 15 MTD patients.[14] Roy *et al.* reported that remarkable improvements in jitter, shimmer, and SNR were observed during the examination using acoustic analysis.[15]

It was considered that the MTD score reduced, and the score of the acoustic analysis and the auditory impression were affected by the improvement in hyperclosure during vocalization. In this study, it was revealed that voice therapy is effective for MTD, and it improves acoustic analysis, perceptual assessment, and subjective assessment of voice.

On the other hand, the effect of voice treatment on AdSD was poor despite the improvement in the MTD score. For AdSD, the abnormal contraction of the thyroarytenoid (TA) and lateral cricoarytenoid (LCA) muscles results in excessive spasms and disproportionate glottal closure.[4] Even if the laryngeal findings were improved by voice treatment, the excessive spasm with the vibration of the vocal folds did not improve. The efficacy of voice therapy for SD is controversial, but several voice pathologists have reported success in decreasing compensatory vocal behaviors in patients with early or mild symptoms of SD or who use therapy in conjunction with botulinum toxin.[16] Murry and Woodson demonstrated that the effectiveness of BOTOX injections is extended in patients who, subsequently, undergo voice therapy.[17] In this study, voice therapy was used alone, and there was poor vocal function after voice therapy.

Differentiation between MTD and AdSD

The effects of voice therapy on MTD and AdSD have been reported. Roy *et al.* reported that manual laryngeal techniques serve as important procedures in ensuring proper diagnosis of and selection of appropriate treatments for both MTD and AdSD.[18] However, the vocal function after voice therapy has not been comprehensively evaluated. In this study, the vocal function after voice therapy between the two groups was comprehensively compared using videostroboscopic findings, aerodynamic analysis, perceptual evaluation, acoustic analysis, and subjective assessment. Comprehensive evaluation and comparison of vocal function after voice therapy in MTD and AdSD helps to distinguish between the two groups.

In both groups, the measurements of the MTD score after voice therapy showed no significant difference. As in MTD, the laryngeal findings improved after voice treatment in AdSD. In this study, there was no difference between the laryngeal findings of MTD and AdSD. However, Patel *et al.* quantified the disorder-specific signature kinematic disturbances of vibratory motion associated with MTD and AdSD, as well as severe voice disturbances, with the use of high-speed digital imaging. Sensitivity and specificity analysis revealed that only motion irregularity was a significant predictor of the presence of AdSD.[19]A detailed assessment of the vibration of the vocal folds is needed to clarify the difference between the laryngeal findings of MTD and AdSD, and not just videostroboscopic findings.

The highest pitch and the pitch range before treatment were significantly better in the SD group than in the MTD group. In the MTD group, the assessments of interruption and VHI-10 before treatment were significantly better compared with the MTD group. The pre-treatment evaluation showed that the highest pitch and vocal range of the MTD were restricted. In the case of MTD, it is difficult to stretch the vocal folds due to hypertonic vocalization, therefore the ability to vocalize falsetto is an index for discrimination. It should be noted that the SD group recognizes interruption during the sustained phonation of vowels. In addition, the measurements of DVB tended to be higher in the SD group than in the MTD group. Roy *et al.* assessed the sensitivity of the acoustic analysis of phonatory breaks in distinguishing AdSD from MTD. As result, the individuals with AdSD showed significantly more phonatory breaks than those with MTD.[20] Involuntary spasms in the laryngeal muscles cause intermittent voice breaks. In AdSD, spasmodic hyperadductions of the vocal folds produce voice breaks with a choked and strained quality.[21] The results of the current study showed significant differences between the acoustic productions by individuals with AdSD and those with MTD for both speaking tasks. Sapienza *et al.* reported that those with AdSD produced significantly greater percentages of phonatory breaks, frequency shifts, and aperiodic segments during vowel production.[22] Woodson *et al.* summarized the acoustic analysis outcomes and stated that the specificity of the changes was insufficient for distinguishing SD from other neurological voice disorders of function.[23]

Further, the SD group showed a higher VHI-10 before treatment than the MTD group. Morzaria *et al.* showed that the pretreatment VHI scores for AdSD patients were similar to their MTD scores.[24] Compared to MTD, AdSD causes various symptoms such as strangulation, interruption, and tremor in the voice. Sanuki *et al.* reported that of the SD patients,97.6% had a strangulated voice, 61% had an interrupted voice, and 48.8% had a tremulous voice.[9] Therefore, it is possible that the VHI-10 score was higher than the MTD, and this may have affected conversations in daily life.

Limitations of this study

The sustained vowels were evaluated for acoustic analysis. Unlike MTD, AdSD is described as "task-dependent," implying that dysphonia severity varies with the demands of the vocal task; for example, connected speech is considered more symptomatic than vowel phonation sustenance.[24] Roy *et al.* used an acoustic index of dysphonia severity (i.e., the Cepstral Spectral Index of Dysphonia [CSID]) to assess the utility of "task dependency" in distinguishing ADSD from MTD and the associations between the CSID and listener ratings. In ADSD, the CSID-estimated severity for connected speech (M = 39. 2, SD = 22.0) was significantly worse than that for sustaining vowel phonation (M = 29.3, SD = 21.9), [*P* = .020].[25]

The second limitation is the large difference in the amount of voice therapy provided to the MTD and AdSD groups. The average duration of voice therapy for MTD was 7.2 months, while the average duration of voice therapy for AdSD was as short as 2.9 months. The greater improvement in the MTD group could be due to the diagnosis or to the difference in the amount of voice therapy provided.

In the future, in order to compare the effects of voice therapy on MTD and AdSD, it is necessary to conduct a prospective study with a detailed protocol before voice therapy. It is necessary to evaluate not only the examination items used in this study but also connected speech. In addition, it is necessary to set the same period of voice treatment for MTD and AdSD.

CONCLUSION

The measurements of MPT, strangulation, interruption, APQ, NHR, and VHI-10 after treatment were significantly better in the MTD group than in the SD group. Of these parameters, MPT, strangulation, APQ, and NHR did not show significant differences in the MTD and SD groups before treatment but after treatment. For MTD, voice treatment improved vocal function, which distinguished it from SD. This study could serve as a basis for conducting prospective studies to verify the effects of voice therapy for MTD and AdSD.

FINANCIAL DISCLOSURE

None.

CONFLICT OF INTEREST

None.

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