

## The Efficacy of the Bel canto Singing Technique as a Method of Improving Voice Quality of Vocal Bowing and Sulcus Vocalis

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### ABSTRACT

The purpose of this study was to investigate the effects of the Bel canto singing technique on voice quality in patients with vocal bowing and sulcus vocalis. Five patients with vocal bowing, and five patients with sulcus vocalis participated in the study. Each subject was assessed acoustically (Jitter, Shimmer, NNE) in the first and last session. Dr. Speech (version 4.0, Tiger-DRS) was used to compare acoustic parameters of pre- and post-treatment. The Bel canto singing technique consisted of breathing exercises, relaxation exercises, and phonation exercises. The results showed that the Bel canto singing technique tended to be effective on improving voice quality in patients with organic voice disorders.

**Key words:** Bel canto singing, voice therapy, vocal fold bowing, sulcus vocalis

### 1. Introduction

Holistic voice therapy programs integrate all of the voice subsystems (respiration, phonation, and resonance) into the rehabilitation of the voice disorder. Holistic voice therapy techniques have been frequently used to treat a variety of voice disorders. The holistic approaches generally deal with all aspects of voice production, such as breathing, phonation, articulation, and resonance. In addition, they focus on relaxation, breathing exercise, body movement, phonation exercise, and articulation/resonance exercise in common (Seo et al., 2002).

The Seo Dongil's voice therapy technique was developed based on early Bel Canto technique by Seo, a classical singer and singing teacher. He and his colleagues have been using the technique to treat a variety of voice patients (Seo et al., 2002a, Seo et al., 2002b, Seo et al., 2002c).

Bel Canto literally, means 'beautiful singing.' It is a term used to describe all Italian singing, but in particular the light, bright quality that Italian opera singers use to charm audience. Italian singing itself is very dependent upon the Italian language. Italian words often contain consonants strung together with vowel sounds. Therefore, Italian language is very fluid and, when spoken correctly, it resonates in the facial structure. Italian singers make full use of these vowels, because they allow long, continuous lines in singing ([www.essortment.com/bel-canto-technique](http://www.essortment.com/bel-canto-technique)).

Vocal fold bowing result in a small gap in the middle of the vocal fold, causing incomplete vocal fold closure. Several diagnosis may be the cause of vocal fold bowing, although the common cause is due to age and atrophy of the larynx. Voice symptoms can include weakness, breathiness, hoarseness or a strained voice if a person is using too much effort with speaking. Patient is instructed with specific exercises that strengthen the vocal folds and improve flexibility ([www.kansasvoicecenter.com](http://www.kansasvoicecenter.com)).

Sulcus vocalis is thinning or absence special layer of tissue, which is the tissue covering the vocal fold requires to vibrate in order to produce sound ([www.voicemedicine.com/sulcus](http://www.voicemedicine.com/sulcus)). This condition may be congenital or acquired secondary to vocal trauma, infection, degeneration of benign lesions, or surgery. This

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condition may increase the stiffness of the cover and cause vocal symptoms such as breathiness, hoarseness, vocal fatigue, voice weakness, and impaired flexibility.

We used the Bel canto singing technique to improve voice quality of patients with vocal fold bowing, sulcus vocalis based on the notion that it is effective in strengthening and balancing the laryngeal musculature and in balancing the airflow. In other words, the technique was thought to improve vocal efficiency in patients with organic voice disorders (vocal fold bowing, sulcus vocalis).

## 2. Methods

### 2.1 Subjects

This study was conducted on 10 patients (5 vocal fold bowings, 5 sulcus vocalises). The pathological conditions were confirmed by a videostroboscopic examination by otolaryngologist. <Table 1> shows the individual characteristics of the subjects.

Table 1. Characteristics of the subjects

sex	Dx	age	session	symptoms
M	bowing	65	20	breathiness, hoarseness
F	bowing	61	7	harshness
F	bowing	28	25	breathiness
M	bowing	22	16	breathiness
F	bowing	21	7	breathiness
M	sulcus	21	17	breathiness, hoarseness
F	sulcus	27	17	breathiness, low loudness
F	sulcus	37	60	breathiness, hoarseness
F	sulcus	30	20	breathiness, hoarseness
F	sulcus	32	20	breathiness, hoarseness

### 2.2 Procedures

Behavioral voice therapy appropriate for patients was Bel canto singing technique, supplemented by a formal hydration program and vocal hygiene counseling. And all patients didn't have any surgical or medical treatment.

Voice therapy using the Bel canto singing technique consisted of relaxation, breathing exercises, and phonation exercises (See <Table 2>). The therapy was taken place individually twice or three times a week.

Table 2. Exercises of the Bel canto singing technique

Procedure	Exercises
Relaxation	① relaxation in supine position
	② contemplation in sitting position
	③ head, face, neck, and shoulder massage
	④ thorax massage during smooth phonation of /a/
	⑤ stretching of upper body (reduction of total body tension)
Breathing	① strong inspiration + strong expiration
	② strong expiration + weak inspiration
	③ weak inspiration + strong expiration
	④ deep & smooth inspiration + smooth expiration
	⑤ prolongation of /s/ as long as possible
	⑥ humming with laryngeal massage
Phonation	① /nu/ - /i/ while rotating shoulders
	② /nu/ - /mi/ while rotation shoulders
	③ /mi/ + tongue trill in staccato rhythm
	④ /mi/ in legato rhythm (projected sound)
	⑤ /mi/ - /me/ (gliding from high to low tone)
	⑥ /mi/ - /a/ (gliding from high to low tone)
	⑦ /a-e-i-o-u/ (phonation on optimal pitch)

### 2.3 Voice samples and analyses

Acoustic measurements were taken for each patient to establish a baseline before the treatment began and last session. The patients were re-assessed after the treatment. We used microphone (SONY ECM-221) to sample patient's voice. Dr. Speech (version 4.0, Tiger-DRS) was utilized to measure  $F_0$ , jitter, shimmer, and NNE for patients with vocal fold bowing and sulcus vocalis. Each subject was seated upright and positioned at a mouth-to-microphone distance of 15cm. The acoustic analysis was performed on the voice of the patients' best attempt of a stable production of a prolonged /a/ with habitual pitch. The most stable portion of /a/ for 1 sec was selected for analysis.

### 2.4 Statistical analysis

SPSS 12.0 software was utilized to statistically compare and graph the data from the patients with organic voice disorders. A Wilcoxon signed rank tests were used to compare the acoustic variables (jitter, shimmer, and NNE).

## 3. Results

### 3.1. vocal fold bowing

<Table 3> shows the raw score of acoustic measures before and after the treatment of 5 patients with vocal fold bowing.

Table 3. Acoustic measures of patients with vocal fold bowing

sub	acoustic measures							
	F <sub>0</sub>		jitter		shimmer		NNE	
	pre-	post-	pre-	post-	pre-	post-	pre-	post-
1	158.12	144.34	.27	.14	5.26	4.88	-7.50	-11.05
2	263.98	279.35	.30	.19	6.12	3.12	-9.17	-19.00
3	245.67	227.45	.48	.18	11.11	3.73	-9.20	-11.56
4	129.34	126.67	.30	.12	6.28	3.25	-12.12	-13.10
5	220.23	260.65	.24	.17	6.81	3.71	-10.37	-12.99

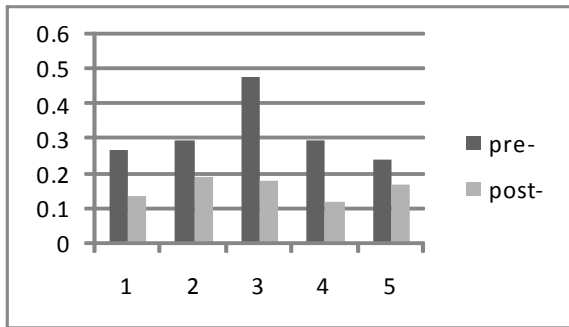


Figure 1. Jitter value of patients with vocal fold bowing

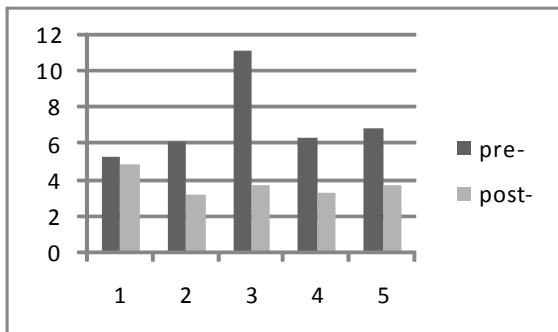


Figure 2. Shimmer value of patients with vocal bowing

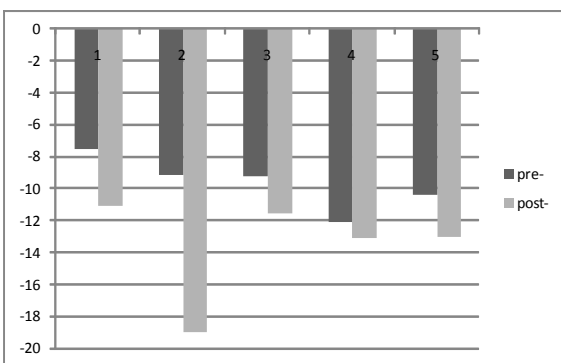


Figure 3. NNE value of patients with vocal bowing

There was a strong tendency that voice quality of the patients was improved after the voice therapy. Namely, the jitter, shimmer, and NNE were reduced considerably.

A Wilcoxon signed rank test revealed that jitter, shimmer, and NNE had significant changes between pre- and post- therapy (Z=-2.023, P<.05)(table 4).

Table 4. The result of Wilcoxon signed rank test in acoustic data in vocal fold bowing

	negative ranks			Ties	positive ranks			Z	P
	N	M <sup>1)</sup>	S <sup>2)</sup>		N	M <sup>1)</sup>	S <sup>2)</sup>		
	jitter	5	3.00	15.00	0	0	.00		
shim	5	3.00	15.00	0	0	.00	.00	-2.023	.043
nne	5	3.00	15.00	0	0	.00	.00	-2.023	.043

1) : Mean rank

2) : Sum of ranks

### 3.2. Sulcus vocalis

<Table 5> shows the raw score of the acoustic measures before and after the treatment of 5 patients with sulcus vocalis.

Table 5. Acoustic measures of patients with sulcus vocalis

sub	acoustic measures							
	F <sub>0</sub>		Jitter		Shimmer		NNE	
	pre-	post-	pre-	post-	pre-	post-	pre-	post-
1	124.84	111.36	.30	.15	6.57	2.51	-9.94	-16.58
2	250.03	285.32	.38	.16	3.12	2.21	-6.63	-12.68
3	256.68	256.68	.44	.23	7.10	3.08	-6.25	-13.33
4	260.33	230.22	.45	.28	5.32	2.99	-6.98	-14.09
5	245.98	210.22	.38	.20	4.12	2.23	-5.54	-13.13

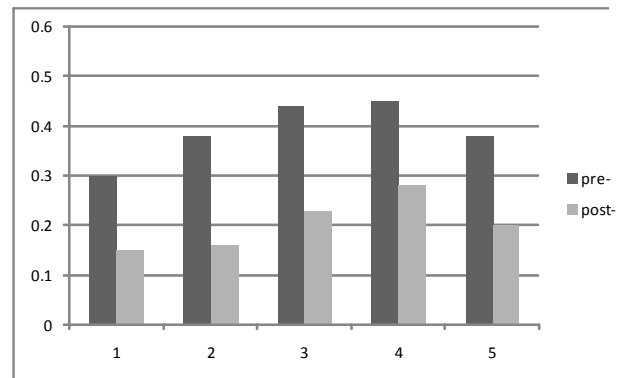


Figure 4. Jitter value of patients with sulcus vocalis

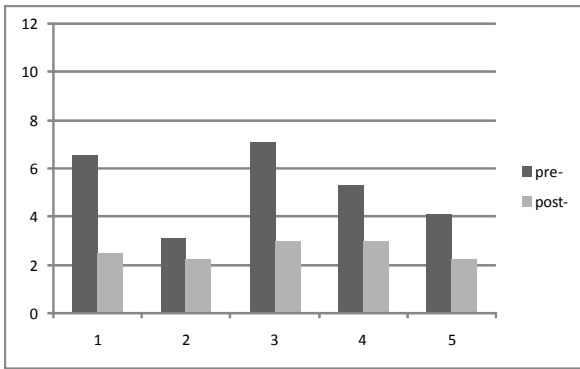


Figure 5. Shimmer value of patients with sulcus vocalis

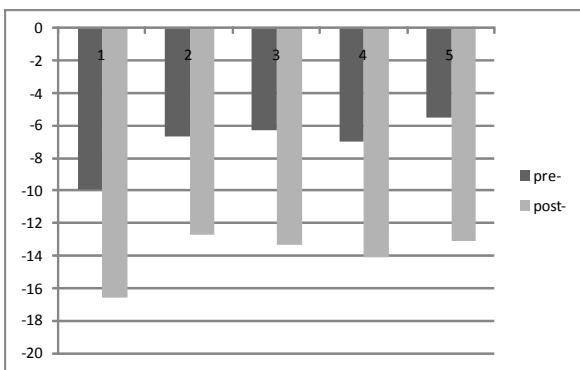


Figure 6. NNE value of patients with sulcus vocalis

There was a strong tendency that voice quality of the patients was improved after the voice therapy. Namely, the jitter, shimmer, and NNE were reduced considerably.

A Wilcoxon signed rank test revealed that jitter, shimmer, and NNE had significant changes between pre- and post- therapy( $Z=-2.023, P<.05$ )(table 6).

Table 6. The result of Wilcoxon signed rank test in acoustic data in sulcus vocalis

	negative ranks			Ties		positive ranks		Z	P
	N	M <sup>1)</sup>	S <sup>2)</sup>	N	N	M <sup>1)</sup>	S <sup>2)</sup>		
jitter	5	3.00	15.00	0	0	.00	.00	-2.023	.043
shim	5	3.00	15.00	0	0	.00	.00	-2.023	.043
nne	5	3.00	15.00	0	0	.00	.00	-2.023	.043

1) : Mean rank

2) : Sum of ranks

#### 4. Discussion

The present study attempted to explore the effects of the Bel canto singing technique on voice quality in patients with vocal fold bowing, sulcus vocalis. The results suggested that the Bel

canto singing technique was effective in improving voice quality in these patients with vocal bowing and sulcus vocalis.

Vocal fold bowing occurs when the intercartilaginous portions of the vocal folds are adducted while the membranous portion fails to adduct. This condition yields a spindle-shaped glottal gap (Stemple, 2000). The degree of voice disturbance will be determined by the size of the gap. Generally, the voice therapy for vocal fold bowing is designed to reduce muscular tension which is the most evident in the patient's face, jaw, neck, ventricular vocal folds, and upper chest to improve breath support for speech and to improve vocal fold closure. Usually, the voice therapy is consisted of respiratory training, relaxation, and phonatory training. The singing which combines respiratory and phonatory exercises is effective to produce phonation that has the appropriate respiratory support, has no voice breaks, is free of muscle tension, and maintains the appropriate open posture of the mouth.

Sulcus vocalis may be either congenital or acquired and of unknown etiology, although vocal abuse may play a role in the acquired form. It may present with a long oval shaped glottal opening during adduction or by a line running longitudinally, parallel to the glottis, down one or both vocal folds (Boone & McFarlane, 2000).

If sulcus vocalis is identified, the treatment is primarily surgical followed by voice therapy to develop an optimal phonation. Three surgical approaches have been found to improve glottal function including intracordal injection, medialization by thyroplasty, or multiple small incisions across the sulcus (Pontes and Behlau, 1993). After surgery, glottal function needs reassessment by the speech-language pathologist. Although voice therapy after surgery for sulcus vocalis is highly individualized, reducing effort associated with breathing and phonation often results in a better-sounding voice. Generally, the voice therapy for sulcus vocalis is focused on adjusting the balance between proper glottal closure, pitch, and loudness. Pitch shifts, loudness changes, lateral digital pressure, and experimentation with firmer glottal closure are productive techniques (Boone & McFarlane, 2005).

Holistic voice therapy programs integrate all of the voice subsystem (respiration, phonation, and resonance) into the rehabilitation of the voice disorder. This voice therapy may be applied to many patients with various pathologies of varying etiologic origins. The strength of each holistic approach is its comprehensive and holistic nature. Each approach attends to all three subsystems of voice production and may be applied to both hyperfunctional and hypofunctional disorders.

The Seo Dongil's voice therapy technique was developed based on early Bel Canto technique. The therapy technique consisted of relaxation, breathing, and phonation exercises. This voice technique focuses on strengthening and balancing the laryngeal musculature and creating a balance among the airflow, the laryngeal effort, and the tone placement similar to other holistic voice therapy techniques.

There was a strong tendency that voice quality of the patients was improved after the voice therapy. Namely, the jitter, shimmer, and NNE were reduced significantly. From the point view of reducing values of acoustic parameters, Bel canto singing technique is helpful in improve voice quality of patients with vocal fold bowing, sulcus vocalis based on the notion that it is effective in strengthening and balancing the laryngeal musculature and in balancing the airflow.

In this study, the patients with vocal fold bowing and sulcus vocalis showed improvements in acoustic parameters perhaps due to an improved glottal closure through breathing and phonation exercises with proper body movement. The Bel canto singing technique includes body movement which facilitates appropriate voice production. The body movement is useful not only in relaxing shoulders, trunk, neck, and larynx but producing proper rate and loudness of speech.

The therapy session varied from 7 to 60. The variety of therapy session resulted from difference of improvement of voice quality in each patient and patient's voice satisfaction.

The Seo Dongil's voice therapy technique includes singing exercise. The relaxation, proper breath support and glottal function can be developed through singing exercise.

In this study, a control group with no treatment and a group with a surgical or medical treatment was not employed. Therefore, it requires some caution in interpreting the results of the current study. Comparisons among the Bel canto singing technique, no treatment, and medical-surgical treatment should be conducted in order to substantiate the results of this study.

In addition, to investigate the effectiveness of this Bel canto singing technique as a higher evidence-based treatment for this population with vocal bowing and sulcus vocalis, it is advisable to include a videostroboscopic examination as well as aerodynamic, and physiologic measurements in a following study.

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