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BIO-FEEDBACK AND THE YAWNING BREATH PATTERN IN VOICE THERAPY: A CLINICAL TRIAL

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A breathing technique, or effective breath method is important for both singers and speakers for effective vocalization, and also useful for helping people with a voice problem. Here a diaphragm support breath pattern was used in voice therapy for patients with vocal nodules, recurrent laryngeal nerve paralysis, and incomplete glottal closure. Singing teachers use a technique, called the diaphragm breath support. This is called the yawning breath pattern (YBP) in our voice clinic and is used in teaching the patients with some kinds of voice disorder. In order to correct patients' breath pattern, an equipment system was designed to check their breath patterns conveniently in voice therapy practice. A respiratory kinematic sensor which connected to a TV monitor was attached to the patients' rib cage near the diaphragm, and by bio-feedback, patients could observe and adjust their breath pattern to the desired pattern during vocalization. In each of the 10 outpatient sessions, the patients performed for 20 to 30 min, and were instructed to practice at home for 3 or more times daily. The YBP method was applied to 91 patients, 17 males and 74 females, with ages ranging from 17 to 79 years. Of the 91 patients 41 had vocal nodules, 20 had recurrent laryngeal nerve paralysis and 30 had incomplete glottal closure associated with chronic laryngitis and sulcus vocalis. Most of the patients could master the YBP technique successfully. The higher the patients' ability to master the YBP was the better the results of both voice tests and subjective evaluation. The scientific background of the YBP method and its clinical effects in voice therapy was reviewed.

Proper control of respiration is necessary for optimal vocalization in singing (VENNARD, 1967; CORNELIUS, 1972; GERALD, 1978). Some of the methods

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devised by singers and voice teachers may be useful also in a clinical setting for treating patients with vocal problems (MOSES, 1959). We have adopted the diaphragm breath support method developed by singing teachers. We call this method the "yawning breath pattern" (YBP) method, because patients seem to understand this term better than the original term in treating patients suffering from singer's nodules (N), recurrent laryngeal nerve paralysis (RNP), and incomplete glottal closure (IGC) associated with chronic laryngitis and sulcus vocalis. They were taught to correct their breathing by using this breath pattern. When yawning, during the exhalation stage, the diaphragm and the lower part of the chest are kept in a sustained extended state. This situation may justly be regarded as an important part of breath technique not only in singing vocalization (MILLER, 1977), but also in voice therapy practice.

In this report, we describe the details of this method in our clinical trial and its efficacy by evaluating the results for 91 patients who were treated with the YBP method. The evaluations included a voice test, a laryngoscopic examination, an evaluation of the patient's subjective improvement, and the patient's ability to master the YBP technique as evaluated by the therapist. The results showed an extension of the patient's voice range, an increase of voice intensity, and a decrease in the air flow rate compared to pre-treatment. The laryngoscopic examination, the patients' subjective evaluation of their symptom showed the same improvement. This clinical attempt indicated that most patients can master this special breath technique when vocalizing and that their symptoms can be removed or improved distinctly after this therapy. It also tended to show a relationship between clinical efficacy and the patients' ability to practice this breath pattern as evaluated from the YBP curves.

METHODS

Equipment for breath pattern measurement. To check the correct execution of the yawning breath pattern, we used a special equipment system with a breath pick up band (TR-601T, Nihon Koden) and a TV monitor (Fig. 1).

A rubber tube sensor filled with a saturated solution of cupric sulphate is set in the band and attached to the patient's rib cage near the diaphragm. During respiration, movement of the rib cage can be recorded as a kinematic curve appearing on the monitor. By bio-feedback, the patient can easily adjust his breath pattern by observing the curve's shape forming an optimal curve pattern.

Instruction in the correct practice of the yawning breath pattern. Instruction is divided into 2 steps:

The 1st step: First, the patient was instructed to yawn repeatedly. Using the instrument described above, the patient was told to observe the curve's shape shown on the monitor. Next, he was instructed to inhale deeply as in yawning to extend the diaphragm area fully, then to exhale by gradually pulling

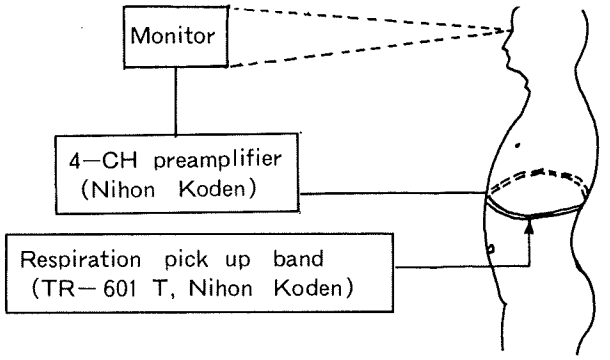

Fig. 1. Training for applying yawning breath pattern (YBP) technique.

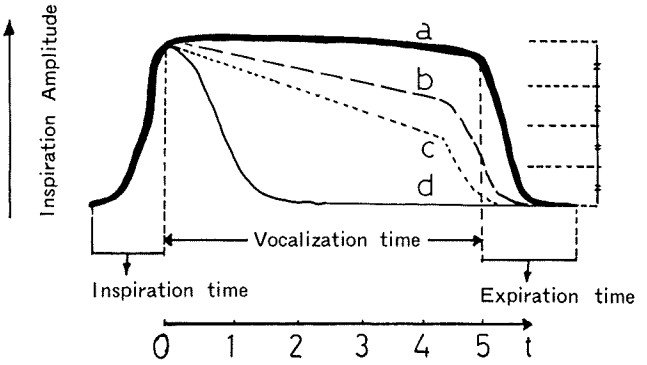

Fig. 2. Evaluative standard for learning skill of the yawning breath pattern (from the respirative curve at the diaphragm region).

his abdomen in and without deflating his diaphragm area until the exhalation was completed. After the patient learns to do the YBP correctly, he will find this breath method is much like the pattern in a real yawn, and can form on demand the curve "a" shown in Fig. 2. The pre-treatment shape of the curve is shown in "d."

The 2nd step: After the patient had mastered the correct YBP technique and was able to form curve "a" during respiration, he was taught to vocalize continuously for 5 s by humming in a low voice, and then to try to vocalize by using the vowel "ah" in an easy voice register while maintaining the ideal shape of the breath pattern curve. When vocalizing using YBP, in order to maintain the stability of the larynx, patients were also taught to try to keep the larynx in a low position as happens automatically during yawning. This is another important point in singing techniques too (MOSES, 1959; VENNARD, 1967; BRODNITZ, 1971; MILLER, 1977; GERALD, 1978). Combined with staccato voicing and humming exercises, the YBP method training exercises were repeated for 20–30 min each

session, and the patient was instructed to practice at home per 10 min a session at least 3 times a day.

Subjects and frequency of treatment. The YBP method was used on 91 patients, 17 males and 74 females, ranging in age from 17–79 years, averaging 51 years. Of these, 41 had vocal nodules (N), none of them had had phonosurgery, 30 had incomplete glottal closure (IGC) associated with chronic laryngitis or sulcus vocalis, 20 had recurrent laryngeal nerve paralysis (RNP) following thyroidectomy. Most patients participated averagely in 10 training sessions on an outpatient basis once a week for about 3 months.

The breath curve evaluation criteria for judging the ability to master the YBP method. The desired respiratory curve, as displayed on the monitor, is shown as "a" in Fig. 2. This shows satisfactory performance of the YBP. The main characteristic of curve "a" is that it does not fall from maximum or near maximum amplitude until the end of phonation, whereas respiratory curve "d" falls immediately on phonation. This is the pattern seen in most people who are untrained or not well-trained in singing techniques (LIN, 1960) or in the YBP method. Between these two extremes, we arbitrarily filled two more curves ("b" and "c") that divided the kinematic space equally. Curves "b" and "c" shows the better and unsatisfactory performance of YBP respectively.

Laryngoscopy and voice evaluation. In order to evaluate the efficacy of this therapy objectively, an examination procedure was set up. It consisted of a laryngoscopic examination, a vocal function test, a listening judgement test and a subjective improvement evaluation. By means of laryngoscopic examinations we compared conditions before and after treatment. Vocal nodules were characterized on the basis of change in size and slit area as shown in Table 1. For other diseases only the glottal slit change was evaluated. As shown in Table 2, the voice tests were carried out to measure the patients voice range, sound pressure level (KOMIYAMA, 1984; WATANABE, 1984), and expiratory mean flow rate. The listening judgement used to evaluate patients' voice was the GRBAS scale (IMAIZUMI, 1986), the degree of hoarseness was scored by therapist's general impression (G), and the impressions of rough (R), breathy (B), asthenic (A), strained (S) to patients voice of pre and after treatment. The patients were asked to report their impression of improvement of their voice and other symptoms. For the purpose of evaluating the results of the laryngoscopy, the voice examination, and the subjective judgments were classified into 3 groups as follows: group I (GI:

Table 1. Evaluative standard of laryngoscopy examination.

Item	Group		
	I	II	III
Nodule size	Disappeared	Reduced half or more	Reduced less than half
Glottal slit area	Disappeared	Small	Few change

Table 2. Evaluative standard of voice examination.

Item	Group		
	I	II	III
Voice range increasing (semi-tones)	>5	3–5	0–2
Sound pressure increasing (dB)	>5	3–5	0–2
Air flow rate decreasing	♀: >100	50–100	0–50
(ml/s)	♂: >150	50–150	0–50
Listening impression changes (grades of G and B)[a]	2	1	0
Subjective improvement	Satisfactory	Fair	Unsatisfactory

[a] Both G and B changed 2 grades (2), or 1 grade (1), or unchanged (0).

satisfactory improvement), group II (GII: fair improvement), and group III (GIII: slight or unsatisfactory improvement) according the degree of improvement after each evaluation as shown in Table 2.

In addition, the kinematic curve shown on the monitor when the patient practiced the YBP was adopted for evaluating the patients' ability to master the YBP vocalization. The patient's performance curves were classified into types "a," "b," "c," or "d," in descending order of ability.

RESULTS

In order to analyze and investigate the clinical efficacy of the YBP method, the results of each examination program were described in three ways:

1. The results of respiratory curve evaluation

Mastering of the YBP method was evaluated by the respiratory kinematic curves of spontaneous and sustained vocalization of more than 5 s, which were obtained on the monitor (Fig. 2). All the patients were able to perform as in curve "c" or better. The patients were classified into three groups (Table 3) as follows:

Group A: 33 patients who could perform the YBP respiration perfectly as in curve "a": 36% of total, N: 16; IGC: 10; RNP: 11.

Table 3. Results of evaluation from YBP curves.

	Group		
	A	B	C
N (41)	16 (39%)	25 (61%)	0
IGC (30)	10 (33%)	17 (57%)	3 (10%)
RNP (20)	7 (35%)	11 (55%)	2 (10%)
Total (91)	33 (36%)	53 (58%)	5 (6%)

Group B: 53 patients who performed the YBP respiration skillfully as in curve "b": 58% of total, N: 25; IGC: 17; RNP: 11.

Group C: 5 patients who performed the YBP respiration unsatisfactorily as in curve "c": 6% of total, N: 0; IGC: 3; RNP: 2.

After instruction in the YBP method, about 94% of the patients (Groups A and B) were able to master YBP respiration satisfactorily. Only 6% of the patients (Group C) could not perform this technique properly. The results showed that there was no significant correlation between the patients' voice problem and the individual ability to master the YBP respiration (Table 3).

2. The results of the patients' subjective evaluations of their improvement

The results were evaluated by classifying the subjects' answers into three groups as shown in Table 4. Thirty-one subjects (34% of total) felt satisfactory improvement (Group I), 52 (57%) felt fair improvement (Group II), and 8 (9%) felt slight or unsatisfactory improvement in their voice and symptoms (Group III).

3. The results of laryngoscopy and voice evaluation

As shown in Table 5, in Group I, 40 subjects (44% of total, N: 16; IGC: 16; RNP: 8) obtained satisfactory improvement. In those patients, their vocal nodules and glottal slit had disappeared by the time of the laryngoscopic examination. Voice tests showed that these patients' voice ranges and sound pressure had increased more than 5 semitones and 5 dB, and backed to normal ranges. Their expiratory air flow rates had returned to normal or had decreased more than 150 ml/s for males and 100 ml/s for females. Also their hoarseness were satisfactorily

Table 4. Results of evaluation from subjects' impression.

	Group		
	I	II	III
N (41)	16 (39%)	22 (54%)	3 (7%)
IGC (30)	7 (23%)	20 (67%)	3 (10%)
RNP (20)	8 (40%)	10 (50%)	2 (10%)
Total (91)	31 (34%)	52 (57%)	8 (9%)

Table 5. Results of evaluation from laryngoscopy and voice examination.

	Group		
	I	II	III
N (41)	16 (39%)	23 (57%)	2 (4%)
IGC (30)	16 (53%)	12 (40%)	2 (7%)
RNP (20)	8 (40%)	9 (46%)	3 (14%)
Total (91)	40 (44%)	44 (48%)	7 (8%)

improved as evaluated by using the GRBAS scale. We mainly evaluated the scale G (general impression) and B (breath impression). The listener (therapist) judged that there had been significant improvement on both scales. These patients seems to have generally normal voices.

In Group II (Table 4), 44 patients (48% of total, N: 23; IGC: 12; RNP: 9) showed fair improvement. Among them, 23 cases of vocal nodules showed a change in the nodules' size. The nodules still remained but their size and glottal slit were reduced half or more. The voice tests found the patients' voice range and sound pressure level were increased 3–5 semitones and 3–5 dB, which were close to the normal pitch and sound pressure range. The expiratory air flow rate of those patients was decreased 50–150 ml/s (male) or 50–100 ml/s (female). However, this was not yet within the normal range for air flow rate.

In Group III, seven patients (8% N: 2; IGC: 2; RNP: 3) were evaluated as having unsatisfactory improvement in voice and laryngoscopic examination according the criteria described and shown in Table 2. Neither examination nor voice evaluation showed remarkable improvement but none were worse than before.

On reviewing the three evaluating results described above (YBP curve change: Table 3; subjects' improvement: Table 4; laryngoscopic examination and voice test: Table 5), one notes that there is a correlation between mastering the YBP technique and voice improvement either on sujbective or objective evaluation (Figs. 3–5).

DISCUSSION

Background of the clinical study for YBP voice therapy. There have been many significant basic studies on the relation between human voice and respiration using EMG (SONNIENEN, 1956; UEDA, 1957; SAWASHIMA, 1958; HIRANO, KOIKE, and TOYNER, 1969; SONNIENEN, 1968; SONNIENEN, JOL, and FOKKENS, 1972; FUKUDA, 1973; MARK, 1976; MURAKAMI, 1976; OKAMURA, 1976; CHARLES, 1980; FRITZELL, 1980; HIRANO, 1981; SCHUTTE, 1984). There have shown that respiration is one of the most important factors in good voice production.

BRODNITZ (1971), LIN (1960), and HIXON, GOLDMAN, and MEAD (1973) observed the kinematics of the chest and abdominal wall, and emphasized that respiratory movement plays an important role in improving voice efficiency. Their significant experiments have demonstrated emphatically that a strong relationship exists between respiratory disorders and organic changes or dysfunctions of the vocal folds. Many reports from voice clinics have indicated similar results about this close correlationship between voice and respiration. However, typically in voice work, the examination, and analysis of the respiratory mechanism has usually not been given sufficient attention. Clinical studies on the improvement of respiratory function in voice production is still insufficient in voice clinical work.

There have been great advances in the field of phoniatric surgery of late, but there are still not many adequate treatment for those dysphonic patients who are not suitable for phono-surgery. The necessity for the scientific examination and investigation on the respiratory mechanism in voice has not been recognized sufficiently. To fill this need, we developed a conservative method, which employs a technique used to teach voice students, to aid and teach patients with voice problem and diseases to use their breath and voice correctly. To develop an effective conservative treatment for voice dysfunctions, it is necessary and important to check and adjust the patients' breath pattern during respiration and vocalization.

The use of bio-feedback to shape behavior and to classify the ability to practice the YBP method. This is an attempt to use instrumental bio-feedback to learn a special respiratory technique. The technique makes it easier for patients to learn to adjust their breath pattern effectively. The latter is normally very difficult work both for the learner and for the therapist without bio-feedback. Also it offers the therapist a technique for observing objectively the kinematics of the patient's rib cage, and for evaluating the patient's performance. According to their ability to practice the YBP, the shape of curves shown on the monitor can be classified into 3 types depending on the ability of the diaphragm and the other inhalation muscles to support or control the breath during phonation. This clinical experiment showed that most of the patients, after an average of about three months' outpatient treatment, improved from their original production curve ("d") to a better one. The results of voice examinations and the subjective improvement evaluations both significantly agree with the therapists' evaluation of the patients' ability to perform the YBP vocalization from the kinematic curves.

The relationship between the patients' ability to master the YBP and the results of voice examination. As shown in Figs. 3 and 5 (also Tables 3 and 5), the statistical results were divided into Group A (best), Group B (better), and Group C (normal). The results indicated that the better the patients' ability to master the

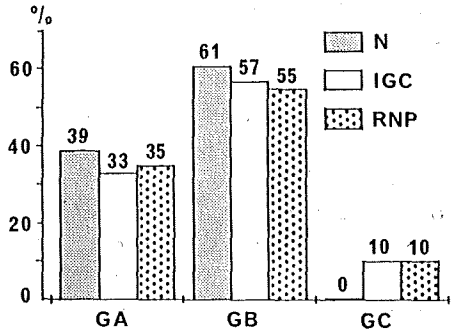

Fig. 3. Results of evaluation of mastering YBP.

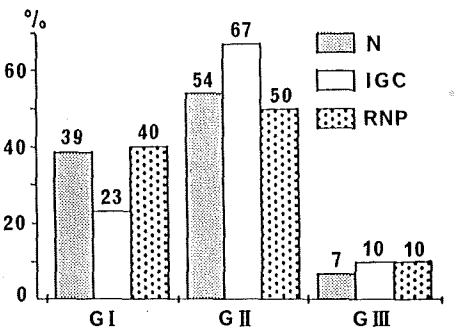

Fig. 4. Results of evaluation of subjects' impression.

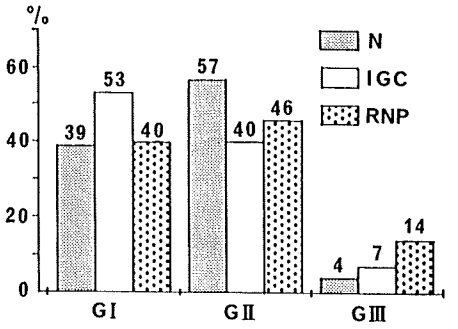

Fig. 5. Results of evaluation of laryngoscopy and voice examination.

YBP were the better the results of voice examination. Comparing Group A to Group I, B to II, and C to III, one notes a correspondence between the voice examination and YBP curve classification. This is especially true for patients with nodules. However, for cases of recurrent laryngeal nerve paralysis (RNP) and incomplete glottal closure (IGC), the results were somewhat incongruous. For those patients with IGC and RNP, it seems that an improvement of the symptom appeared before they were able to master the YBP technique perfectly.

The relationship between achieved YBP curves and subjective improvement. As shown in Figs. 3 and 5 (also Tables 3 and 5), each suitable data pair shows a a strong correlation. These results indicates that the patients' ability to master the yawning breath pattern is related to their subjective improvement. Therefore, the greater the effort which is made to master the YBP, the more improvement is seen in the respiratory curve, and the greater is the degree of subjective improvement felt by the patients.

The YBP method in voice therapy. At present, western opera singers are taught a method of vocalization using the YBP (VENNARD, 1967; CORNELIUS, 1972; GERALD, 1978). This pattern is usually used only when yawning. As a technique for effect singing, it permits the maximum expression of the human voice. If dysphonia originates from attempting to phonation beyond the individual's ability, the YBP will be very useful for expanding their vocal ability. Even though there is no ultimately difference between patients' ability to master the YBP, a sustained effort on the part of the patients is needed in the first 2–3 weeks to master this technique. They have to practice the YBP as much as possible, at least 30 min every day. The clinical findings indicate that much practice causes a remarkable improvement in the symptoms. This YBP method requires no medication and no voice rest, and is shown to be an effective therapy in our clinics.

Directions for the future study of voice therapy. The YBP was used as the breath technique of Bel Canto. It is somewhat difficult to give a definition of this great singing technique, however it is a fact that this special breath technique which permits great expression in the human voice, has been proved, further, this

technique is being utilized skillfully by present singers and their teachers. But in the field of phoniatrics, the relationship between breath and voice phonophysiology has not been investigated sufficiently. Hence our laboratory has been interested in investigating aerodynamics and the observation of breath patterns. For scientific effect of continuously maintaining the constrictive pulling state of the diaphragm and the low position of larynx when vocalizing by the YBP. By studying the basic relationship between breathing and voice, and the quantitative analysis between breath curve's change and breath pattern further, and the methods of voice therapy (MARK, 1976; CHARLES, 1980; FRITZELL, 1980; SCHUTTE, 1984) will progress and become much more effective.

CONCLUSION

1) Details concerning the application of the YBP method as a clinical voice therapy are presented.

2) Voice therapy applying the YBP method was used on 91 patients with dysphonia of vocal nodules, recurrent laryngeal nerve paralysis, and incomplete glottal closure. The clinical results shows that there was no difference in the patients' ability to master YBP respiration.

3) The YBP method was effective in our clinical voice trial. About 1/3 of the patients mastered the YBP perfectly, and their symptoms improved satisfactorily.

4) The results for the mastering of the YBP curve shows a correlationship between the results for laryngoscopy and voice evaluation, and the patients' improvement. The results indicated that it is necessary to check the breath pattern for dysphonia patients. Bio-feedback enables them to do this effectively.

SUMMARY

We treated 91 patients with vocal nodules, recurrent laryngeal nerve paralysis, and incomplete glottal closure by teaching them the yawning breath pattern, which is used by professional singers.

We found that in patients who could learn to master the yawning breath pattern, this method effectively improved their symptoms.

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