Breathing-Coordinated Exercise Improves the Quality of Life in Hemodialysis Patients

Tun-Jun Tsai, Jin-Shin Lai, Su-Hui Lee, Yung-Ming Chen, Ching Lan, Bái-Jia Yang, and Han-Sun Chiang

ABSTRACT
Breathing-coordinated exercise is a traditional Chinese exercise. These exercise maneuvers consist of slow diaphragmatic breathing, end-inspiratory pause, and Kegel's exercise. Interestingly, these exercise maneuvers closely resemble the procedures for cardiovascular autonomic nervous function tests. Therefore, we standardized the exercise program and undertook a prospective, controlled study. We wanted to evaluate the effect of these exercises scientifically, with the hope that they may become an acceptable treatment modality for hemodialysis patients. This paper describes the effect of these exercises on hemodialysis patients. We also investigated the possible mechanisms involved to derive clinical effects.

PATIENTS AND METHODS
Thirty hemodialysis patients were enrolled in this study. All 30 patients were on a conventional thrice-weekly hemodialysis program, and all patients had received dialysis for at least 6 months. Patients' dialysis regimen, diet, medication, and physical condition had all been stabilized for at least 3 months. During the 3-month exercise program, there was no change in the dialysis regimen. None of the patients had undertaken regular exercise before this study. Twenty-one patients had hypertension and were on regular antihypertensive therapy. None had diabetes mellitus or severe cardiovascular complications. No patient received erythropoietin therapy. The patients' clinical details are listed in Table 1. The study was divided into two periods. Period I included 12 patients who were trained to do the standard exercise program, and graded according to the Karnofsky scale (3) only (Group A). Because of the remarkable subjective improvements after Period I, we proceeded to the Period II study, which included 18 patients. The 18 patients were divided into two groups: Group B included 12 patients as a control group, and Group C included 6 patients as the study group that received 3 months of exercise training. These 18 patients all received additional testing by using bicycle ergometry as an objective test for exercise capacity. This study

Key Words: Autonomic training, traditional exercise, diaphragmatic breathing, microcirculation, Kegel's exercise

It is well documented that regular exercise can improve the quality of life in hemodialysis patients. In Western countries, exercise maneuvers can include swimming, running, jogging, bicycle ergometry, and so on. Previous studies have found that the major limitation of exercise therapy lies in physiologic and psychologic abnormalities and poor patient compliance (1,2). In Oriental countries such as mainland China and Taiwan, a form of breathing-coordinated exercise is becoming popular. This traditional exercise can be performed almost anywhere. It is gentle and easy to perform and requires no equipment. Approximately 20 million people in China regularly indulge in this kind of exercise. Recently, we observed many patients practicing this exercise to obtain benefit. Interestingly, these exercise maneuvers closely resemble the procedures for cardiovascular autonomic nervous function tests. Therefore, we standardized the exercise program and undertook a prospective, controlled study. We wanted to evaluate the effect of these exercises scientifically, with the hope that they may become an acceptable treatment modality for hemodialysis patients. This paper describes the effect of these exercises on hemodialysis patients. We also investigated the possible mechanisms involved to derive clinical effects.
TABLE 1. Characteristics of patients on exercise program

<table>
<thead>
<tr>
<th></th>
<th>Control (Group B)</th>
<th>Exercise (Group A)</th>
<th>Exercise (Group C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>12</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Age</td>
<td>38 ± 10° (19–64)</td>
<td>42 ± 9 (26–57)</td>
<td>39 ± 8 (20–51)</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>8/4</td>
<td>7/5</td>
<td>3/3</td>
</tr>
<tr>
<td>Duration of Dialysis</td>
<td>25 ± 6°</td>
<td>27 ± 7</td>
<td>28 ± 8</td>
</tr>
<tr>
<td>Hypertension</td>
<td>9</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Underlying Disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic glomerulonephritis</td>
<td>9</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Hypertensive nephrosclerosis</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Chronic pyelonephritis</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unclassified</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Mean ± SD.

was approved by the Human Research Committee of the National Taiwan University Hospital. Informed consent was obtained from all of the patients. Precautions regarding possible discomfort were given in advance.

The standard exercise maneuvers were as follows (see Figure 1).

**Figure 1.** Slow diaphragmatic breathing with Kegel’s exercise. The body bends forward during exhalation and resumes the erect position during inhalation. Abdominal wall bulging with mild strain was performed during end-inspiratory pause (EIP). Kegel’s exercise was also added during EIP.

**Period I**

This is the training period, lasting about 2 to 3 wk. The standard exercise program consists of five phases (about 5 min/phase).

1. Slow diaphragmatic breathing at a rate of 6 to 8 breaths/min. a. Slow exhalation with the body bent forward. b. Slow inhalation with the body straightened. c. End-inspiratory pause (EIP) for 1 to 2 s, with slight bulging of the lower abdomen.

2. Progressive slowing of the respiratory cycle aimed at achieving a rate of 2 to 3 breaths/min (including gradual lengthening of EIP).

3. Slow diaphragmatic breathing with up and down movements of the body at a respiratory rate of 2 to 3 breaths/min, with EIP lasting 2 to 3 s.

4. Gradual prolongation of the EIP, cycle by cycle, up to 3 to 5 s for each pause.

5. During EIP, the patient constricts the anal sphincter (Kegel’s exercise) (4). The duration of constriction begins at 1 s, and is gradually increased (by 1 s every 2 days), until up to 3 to 5 s each time. The total frequency of anal constriction exercises per exercise session depends on the tolerance of the patients, and is usually around 5 times per exercise.

**Period II**

This is the self-adjustment period. When the patient becomes familiar with the maneuvers described above, the duration of each phase becomes flexible but the sequence does not change. All of the exercise steps could be varied by the patients, but only if they felt comfortable and did not overstrain. Details of these exercise maneuvers are described in the Appendix.

All patients, including those in the control group, were questioned periodically about their appetite, sleep, bowel habits, physical strength, libido, frequency of sexual activity, etc. These parameters were assessed by the use of questionnaires developed by the authors. These questionnaires were designed on a quantitative basis and expressed as a score system (see the Appendix). The hematocrit level, dry weight, blood pressure, and predialysis BUN and creatinine levels were also monitored for each patient. The blood pressure for each patient was recorded as the mean of three recordings taken while the patient was in a resting position on a nondialysis day. Sexual function was also evaluated by a
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urologist, who used questionnaires, a snap gauze test (5), and measurement of penile blood flow as factors for the evaluation. Six patients in the control group and seven in the study group had erectile dysfunction; however, their penile arterial blood flow was normal, according to the Doppler study, and their penile-brachial index was within normal limits (range from 0.71 to 1.0). Therefore, the erectile dysfunction of these 13 patients was classified as psychophysiologic impotence.

Exerc{e} tolerance was monitored by bicycle ergometry. The exercise protocol was as follows: Each subject performed a continuous incremental bicycle exercise test with a pedaling rate of 60 ± 10 revolutions per minute until intolerable dyspnea or muscular fatigue occurred. An electromagnetic-braked cycle ergometer (Er{t}ch Jaeger, Ergotest, Würzburg, Germany) was used for the test. The workload was 10 watts during of the first 3 min (the familiarization period), and was then increased by 10 watts each minute thereafter. During the exercise, an electrocardiographic lead (CM5) was monitored continuously for early evidence of any myocardial ischemic changes or cardiac arrhythmias.

All of the patients entered the exercise program and participated in the program for a minimum of 3 months. The effect of the exercise program on all of the above-mentioned parameters was evaluated before and after 3 months of training. Because this exercise required patients to hold their breath, and involved abdominal wall strain (Valsalva’s maneuver-like) and sustained anal constriction (an isometric exercise), changes in blood pressure and heart rate during exercise were monitored in six randomly selected patients by use of a continuous blood pressure (BP) monitor. To investigate the effect of breathing exercises on the peripheral microcirculation, we monitored the respiratory cycle with a model PT5 volumetric transducer (Grass Instruments, Quincy, MA) that was connected to a digital plethysmograph. The change in peripheral microcirculation was simultaneously measured by (1) using a photoelectric pulse transducer (model PTTL and RPT, Grass Instruments) to determine any change in circular volume of the distal part of the ring finger, and (2) using a laser Doppler perfusion monitor (6) (Perimed, Perifux PF 3, Stockhöl{m}, Sweden) to determine any change in index finger cutaneous perfusion. We also performed abdominal sonography to study the change in the diameter of the inferior vena cava during the complete respiratory cycle.

Statistical Analysis

All data were expressed as mean ± SEM unless noted otherwise. The comparison of data before and after exercise was performed with the paired t test.

RESULTS

Changes in Blood Pressure and Heart Rate During Exercise

Throughout the respiratory cycle no remarkable changes were revealed. Heart rate and mean blood pressure were (mean ± SD): 88 ± 16 min⁻¹ and 96.5 ± 11.2 mm Hg, respectively, at baseline; 92 ± 15 min⁻¹ and 90.1 ± 14.5 mm Hg during slow inspiration; 90 ± 19 min⁻¹ and 105.2 ± 14.6 mm Hg during EIP; 92 ± 17 min⁻¹ and 102.5 ± 13.8 mm Hg during anal constriction; and 91 ± 6 min⁻¹ and 101.2 ± 12.5 mm Hg during slow expiration.

Changes in Subjective Feelings

Within 2 wk after exercise, most patients experienced more frequent bowel passage. This was followed by frequent hunger sensations and a greater appetite. Table 2 lists the subjective improvements in the trained group. Because Groups A and C were similarly trained, the subjective improvements are listed together. Improvements in appetite, bowel habits, sleep, and physical strength were remarkable. Hypotension during dialysis disappeared or became less severe. Many patients in the trained group (10 of 13) noted more profuse sweating in warm temperatures or after exercise, whereas the control group did not exhibit this phenomenon. Libido increased in some patients in the trained group. The frequency of successful sexual behavior also increased in the trained group. Three male patients in the study group noticed a resumption of nocturnal penile tumescence, which had almost disappeared for more than 1 yr. One of them had recovered to the extent as to be able to successfully indulge in sexual intercourse. Three female patients in the study group noted an increase in their libido and more satisfying sexual activity.

<table>
<thead>
<tr>
<th>TABLE 2. Comparison of subjective improvements between control and trained groups a</th>
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<tbody>
<tr>
<td>Control (Group B, N = 12)</td>
</tr>
<tr>
<td>Before</td>
</tr>
<tr>
<td>Anorexia</td>
</tr>
<tr>
<td>Constipation</td>
</tr>
<tr>
<td>Insomnia</td>
</tr>
<tr>
<td>Fatigue</td>
</tr>
<tr>
<td>Dialysis-Associated Hypotension</td>
</tr>
<tr>
<td>Libido</td>
</tr>
<tr>
<td>Frequency of Sexual Activity</td>
</tr>
</tbody>
</table>

a Data are expressed by mean ± SEM of scores. High scores indicate high frequency of occurrence.

b P < 0.05.
Objective Parameters

Table 3 lists these changes. There were no significant changes for any of the parameters in the control group. In the exercise group, there was a statistically significant but small change in patients' creatinine levels. Patients' dry weights also increased. Both diastolic and systolic BP were reduced. Use of antihypertensive drugs was reduced to achieve a treatment goal of 140/85 to 95 mm Hg to 150/85 to 95 mm Hg. More patients in the study group (8 of 19) were able to reduce their antihypertensive drug dose, compared with patients in the control group (1 of 12). A significant increase in the Karnofsky scores was seen in the exercise group. Maximal oxygen consumption decreased in the control group but remained the same in the exercise group (V_{O2max} in the control group [Group B] was 21.1 ± 1.8 mL/min per kg before exercise and 19.5 ± 1.9 mL/min per kg after exercise, N = 12, P < 0.05. In the exercise group [Group C], V_{O2max} was 15.8 ± 0.9 mL/min per kg before exercise and 17.1 ± 1.0 mL/min per kg after exercise, N = 6, P > 0.05 [Figure 2]). The hematocrit level changed from 23.3 ± 0.4% to 23.4 ± 0.5% (P > 0.05) in the control group (Group B). In the exercise group (Group C), the hematocrit level changed from 24.0 ± 0.6% to 24.5 ± 0.8% (P > 0.05).

Changes in Respiration and Finger Perfusion

The changes in respiratory pattern, finger volume, and finger perfusion during exercise are shown in Figure 3. The gradual onset of deep breathing was associated with an enhanced oscillation of pulse amplitude. The finger perfusion monitor showed a gradual increase of perfusion during the expiratory phase. Figure 4 shows that breath-holding nearly stopped pulse transmission (and thus finger blood flow) and finger perfusion. The combination of anal constriction and breath-holding exaggerated such a response. Both activities resulted in a rebound increase in pulse transmission and finger perfusion upon relief of anal constriction during early expiration.

Diameter of Inferior Vena Cava

The diameter of the inferior vena cava exhibited dramatic changes during the respiratory cycle (Figure 5). The diameter was smallest during midinspiration and greatest during midexpiration.

Complications

Except for diarrhea (three patients) and backache (two patients) during the initial training period (within 2 wk), no other discomfort was observed. These side effects were the result of overly vigorous self-training. These symptoms disappeared within a few days after readjustment of exercise maneuvers.

DISCUSSION

The exercise maneuvers described in our study are different from currently popular aerobic exercises. Interestingly, these maneuvers closely resemble cardiovascular reflex tests (7). The up and down body movements are similar to the postural test (30:15 ratio and systolic BP change) (7). Slow breathing is similar to the deep breathing test (7). The diaphragmatic

![Figure 2. Changes in maximal oxygen consumption during the bicycle exercise test in control and exercise groups. The control group shows a significant decrease (P < 0.05). The exercise group shows no significant change after exercise.](image)

**TABLE 3. Objective parameters before and after exercise training**

<table>
<thead>
<tr>
<th></th>
<th>Control (Group B) (N = 12)</th>
<th>Trained (Group A + C) (N = 18)</th>
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<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Predialysis BUN (mg/dL)</td>
<td>92.7 ± 3.2</td>
<td>91.2 ± 2.2</td>
</tr>
<tr>
<td>Predialysis Cr (mg/dL)</td>
<td>12.5 ± 0.9</td>
<td>12.5 ± 0.7</td>
</tr>
<tr>
<td>Dry Weight (kg)</td>
<td>54.6 ± 2.7</td>
<td>55.0 ± 2.0</td>
</tr>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>152.7 ± 6.2</td>
<td>153.3 ± 5.5</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>94.3 ± 3.5</td>
<td>93.8 ± 2.9</td>
</tr>
<tr>
<td>Karnofsky score</td>
<td>81.9 ± 2.4</td>
<td>81.7 ± 2.7</td>
</tr>
</tbody>
</table>

a P < 0.05.
breathing with abdominal bulging (strain) resembles Valsalva's maneuver (7). The breath-holding and inspiratory pause are similar to the diving test (8). The anal constriction (Kegel's exercise) is similar to the sustained hand-grip test (7), except that the constriction involves different muscle groups. Therefore, there might be a training of cardiovascular autonomic reflexes during exercise. This autonomic training is similar to the nonpharmacologic treatment for bronchial asthma (9) in which slow breathing and progressive relaxation play an important role. Deep breathing has been known to induce a change in vasomotor activity such as arteriolar constriction (10) or venoconstriction (11). These breathing-coordinated exercises therefore may enhance vasomotor reflexes and cause blood flow redistribution during exercise (12).

The earliest observed results of exercise were improvements in appetite and an increase in the frequency of bowel movements. Oscillatory changes in intra-abdominal pressure resulting from diaphragmatic breathing and abdominal wall strain may directly stimulate gastrointestinal movements and facilitate gastrointestinal emptying. Reappearance of diaphoresis was observed in many patients. The mechanism is not clear. Perhaps training of the autonomic reflex leads to an improvement in autonomic function. Hypotension during dialysis is common in dialysis patients and is partly attributed to autonomic insufficiency (13). Reduction in venous system compliance and inadequate venoconstriction during a fall in plasma volume may also be contributing factors (14). The improvement in dialysis-associated hypotension in some patients may be related to enhanced vasomotor response and/or improved venous compliance, because the exercise maneuvers may increase splanchnic and peripheral venous compliance (as shown by abdominal sonography). Most patients reported an increase in general well-being and physical strength. This may be the result of a combination of increase in food intake and autonomic training. An increase in systemic microcirculation during exercise may also be a contributing factor. Most interestingly, sexual activity was improved in both women and men. This may be caused by several factors. First, Kegel's exercise contracts pelvic floor muscles and improves pelvic circulation (4). Second, exercise also trains perineal muscles such as the ischiocavernous muscle, which assists sexual behavior (15). Finally, when exercise is performed in certain parts of the body, blood flow will shift to the involved muscle groups with a compensatory increase in cardiac output through the activation of the cardiovascular reflex (7). Therefore, when Kegel's exercise is coordinated with diaphragmatic breathing and breath-holding, blood flows to the pelvic area. These coordinated movements may further improve circulation in the pelvic muscles be-
cause slow, deep breathing enhances peripheral microcirculation (as shown in Figures 3 and 4), which may be most pronounced in the muscle groups being exercised. Furthermore, we found that blood pressure was reduced in many patients. The oscillatory changes in intrathoracic and intra-abdominal pressure and lung volume increase venous distensibility within the abdomen (as shown by abdominal sonography). This may train the venous system to improve venous compliance, and may contribute to the lowering of blood pressure, because venous compliance is reduced in hypertensive dialysis patients (14) and decreased venous compliance may contribute to a sustained hypertensive state (16). Besides physical improvement, many patients experienced improved sleep quality. This is related to the progressive relaxation induced by slow and deep breathing, similar to relaxation training in psychiatry (17,18). Therefore, this exercise is a combination of mental relaxation and visceral exercise. Bicycle exercise tests showed no significant change in maximal oxygen consumption. This is because such exercise imposes little workload on the patients. All maneuvers are gentle, and exertion primarily influences the viscera.

The mechanism of microcirculatory enhancement could be explained as follows: We found a progressive increase in finger perfusion during deep diaphragmatic breathing (Figure 3). During the end-inspiratory phase, a large quantity of blood is trapped in the pulmonary circulation. Breath-holding with abdominal wall strain at this stage increases intrathoracic pressure and decreases venous return from the lower extremities. Cardiac output decreases during this period. Upon relief of abdominal strain and re-exhalation, a rapid increase in venous return occurring at the same time as a decrease in lung volume causes a sharp increase in stroke volume and cardiac output. This is evidenced by a virtual absence of pulse amplitude during breath-holding and a rebound increase in pulse amplitude and finger perfusion upon expiration (Figure 4). This effect is further augmented by anal constriction, which blocks venous return below the pelvic floor (Figure 4). Abdominal sonographic results are in accordance with such a change. The maximum vena cava diameter occurs during midexpiration, when venous return from the lower part of the body reaches a maximum. Such a phenomenon is similar to the physiologic response to Valsalva’s maneuver, except that strain experienced during the breathing exercises is very mild (19,20). Therefore, breathing-coordinated exercise exaggerates the effect of respiration on cardiac output. A larger swing in cardiac output causes a pulsatile increase in tissue perfusion.

This exercise had some special advantages for hemodialysis patients: (1) It is gentle and requires little effort. Most hemodialysis patients, including the weak patients, are able to perform the exercise; (2) It is effective in relieving the constipation that commonly
Figure 5. Abdominal sonography of a patient from the exercise group reveals sequential change in the diameter of the inferior vena cava. The diameter is smallest during midinspiration (MID IN) when pulmonary volume expands. During EIP (END IN) and abdominal strain (VAL), the diameter increases. Midexpiration (MID EX) is associated with greatest diameter.

occurs as a result of patients' intake of aluminum hydroxide; (3) Sexual function is improved in some patients; (4) An improvement in the sensation of general well-being and working capacity is helpful for rehabilitation; (5) It costs nothing and can be conducted in any location. Therefore, this exercise is very suitable for hemodialysis patients. It may be especially beneficial for weak patients.

ACKNOWLEDGMENTS

We are grateful to Professors Wan-Yu Chen, Jan-Der Wang, and Ming-Lai Sun for assistance and also thank Professor Chau-Fong Chen for technical assistance. This study is supported by a Republic of China Department of Health Grant DOH82-HP-065-2M2 and, in part, by the Ta-Tung Kidney Foundation.

APPENDIX

Questionnaires

The questionnaires were modified from previously reported questionnaires used for measuring quality of life in hemodialysis patients (21,22). The main items were simplified to seven items: (1) anorexia; (2) constipation; (3) insomnia; (4) fatigue; (5) dialysis-associated hypotension; (6) libido; and (7) frequency of sexual activity. All questions were scored on a seven-point scale, on the basis of the frequency of occurrence. For example, a question from the “fatigue” section, “How often in the past 1 month have you felt a fatigued sensation?” was accompanied by a choice of answers: (1) none of the time; (2) rarely, about one to two times a month; (3) four to five times a month (or about once a week); (4) two to three times a week; (5) four to five times per week; (6) about once per day; (7) more than twice a day. The definition of each item was explained well to the patients. Constipation was defined as no stool passage for 2 days. Libido was defined as the desire to have sexual behavior with sexual partners. Frequency of sexual activity was defined as the frequency of successful sexual behavior. Dialysis-associated hypotension was an objective finding verified by BP measurement taken by the nurses. All questionnaires were in Chinese.

Exercise Procedures

The breathing-coordinated exercise should be taught by a trained person who is familiar with the whole exercise program. He or she needs to first master the exercise program and experience the beneficial effects and possible complications of the maneuvers in order to inform the patients or participants in advance.
Our study subjects performed the exercise twice a day for a duration of about 25 to 30 min each time. The ideal exercise time was in the early morning just after getting out of bed, and in the late evening before bed. Patients were taught to perform this exercise in a quiet setting. They were asked to use a clock to monitor the breathing rate. Each subject was shown a demonstration video tape during the first 2 to 3 wk so that they could practice at home. Exercise was prohibited within 2 h postprandially and 30 min before meals, and also during periods of cough, diarrhea, or menstruation. Patients who have shortness of breath are also not suitable for exercise training. Each week, the trained subjects were checked for possible side effects, and their techniques were monitored, until all patients were familiar with the procedures. This usually lasted about 3 wk.

The exercise training was divided into several periods. From Days 1 through 3, patients were taught to familiarize themselves with diaphragmatic breathing, starting from a breathing rate about 12 to 14 breaths/min and gradually decreasing to 8 to 10 breaths/min. The correct posture to be maintained is shown in Figure 1. During exhalation, the body is bent forward. During inhalation, the body is straightened. At the end of inspiration, the patient should pause momentarily with a gentle protrusion of the lower abdomen. This EIP in conjunction with a mild abdominal wall strain lasts about 1 s. This step is the most important. No vigorous straining is allowed at this time. Straining too vigorously may cause the patient to faint. Once the patients become familiar with the diaphragmatic breathing technique, the breathing rate was slowed further. From Days 4 through 7, the patients learned how to adjust their breathing to about 5 to 6 breaths/min. The EIP and abdominal strain were prolonged to 2 s/cycle. From Days 8 through 12, the patients progressively prolonged the respiratory cycle from 6 to 8 breaths/min to 2 to 3 breaths/min in association with a prolongation of EIP and abdominal protrusion to 3 s each cycle. From Days 12 through 14, the diaphragmatic breathing rate was about 2 to 3 breaths/min. The EIP was gradually prolonged from 3 s to about 5 s each cycle. From Days 15 through 18, Kegel's exercise replaced the abdominal protrusion during EIP. In the study's exercise routine, Kegel's exercise, a constringion of the anal sphincter, is performed during the EIP period. Each constringion was performed intermittently after every 3 to 5 respiratory cycles. The constringion started from 1 s each time with gradual prolongation from 1 s/cycle to 4 to 5 s/cycle. This step was adjusted by the patient himself, with a gradual increase in duration of constringion. Usually the increase in constringion was 1 s/cycle each day to avoid overstraining or too prolonged constringion. Otherwise, constringion may cause discomfort. During a total exercise time of 30 min, the anus was constricted about 5 times. After about 18 to 20 days, the patients became familiar with the exercise maneuvers, but each patient could adjust the duration of each maneuver depending on his own level of comfort. However, the sequence of the exercise was not changed. The procedures are summarized as follows:

**Week 1**

Day 1: Practice diaphragmatic breathing with gentle abdominal wall protrusion during each EIP at usual respiratory rate (RR) around 12–14 breaths/min. EIP is 1 s/cycle in duration.

Day 2: Same as above except that RR starts from normal rate for several min, gradually slowing down to 10 to 12 breaths/min.

Day 3: Start from normal RR, gradually slowing down to 8 to 10 breaths/min. The EIP is 1 s/cycle.

Day 4: Gradually slow down RR from normal rate to 6 to 8 breaths/min. The abdominal protrusion during EIP is prolonged to 2 s/cycle.

Day 5: Gradually slow down from normal rate to 5 to 6 breaths/min and extend EIP to 3 s/cycle. Adjust EIP from 1 to 3 s/cycle depending on level of comfort.

Days 6 and 7: Patients practice at home.

**Week 2**

Day 8: Start with a normal RR, gradually down to 4 to 5 breaths/min and EIP of 3 s/cycle.

Day 9: Slow RR from normal down to 3 to 4/min, EIP to 4 s/cycle.

Day 10: Slow RR from normal down to 2 to 3 breaths/min, EIP to 5 s/cycle. Some patients may not be able to slow down further. Just maintain this speed. If patients feel uncomfortable, the EIP could be performed every 2 to 3 respiratory cycles. This would improve patients' breathing action.

Day 11: Further slow down RR from normal to about 2 breaths/min and EIP to 5 s/cycle.

Day 12: Review the patients' breathing technique. Some patients can even slow down the RR to less than 2 breaths/min and extend EIP to longer than 5 s/cycle. As long as patients feel comfortable, the RR could be slowed to as slow as is tolerable. However, this is usually the maximal tolerance.

Days 13 and 14: Patients practice at home.

**Week 3**

Day 15: Start to practice Kegel's exercise. Abdominal protrusion is omitted. Start from a normal RR down to 7 to 8 breaths/min, followed by anal constringion during EIP. The duration of anal constringion is 1 to 2 s/EIP. Constrict the anus once every 3 to 5 respiratory cycles. Too frequent constringion or too vigorous constringion may cause discomfort or even fainting.

Day 16: Slow RR from normal to 5 to 6 breaths/min. Then constrict the anus for 2 s/EIP every 3 to 5 cycles. The frequency of anal constringion should be adjusted by the patients according to their level of comfort. Usually a total of 5 to 6 times is enough for each exercise session (30 min). Immediately after
each anal constriction, the RR should be accelerated slightly for several cycles so that breathing becomes smoother.

Day 17: Slow RR gradually from normal to 3 to 4 breaths/min, then perform Kegel's exercise. The duration of anal constriction could be prolonged to 3 to 4 s/EIP. Patients should perform this procedure according to their levels of tolerance and comfort.

Day 18: Gradually slow RR to about 2 breaths/mm and then constrict the anus every 3 to 5 cycles for 5 s/EIP. Some patients may even perform slower breathing and longer anal constriction. Note that the patient may stop at any point depending on his/her tolerance.

Day 19: Review the complete process. Correct any errors in breathing exercise technique.

Day 20: Patients may adjust the duration of each maneuver according to his or her own level of comfort and familiarity with the whole exercise.

Precautions. Avoid too vigorous abdominal strain or too prolonged anal constriction. Should a choking sensation or dizziness occur, re-adjust the maneuver. The key to successful exercise training is "the more gradual the slowing, the better" and "the slower the breathing rate, the better."

REFERENCES