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Effortless Diaphragmatic Breathing

The use of electromyography, strain gauge, thermistor and incentive inspirometer biofeedback for training effortless breathing. Strategies to reduce symptoms of dyspnea, hyperventilation, panic and asthma as well as to enhance performance and endurance.

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Introduction

The underlying premise of this protocol is *if the startle response or alarm reaction is embedded in the performance of an activity which adversely affects the respiratory patterns (e.g. gasping, thoracic breathing, breath holding), then changing the respiratory patterns with effortless diaphragmatic breathing may lead to an improvement in health and performance.* This protocol includes an assessment of dysfunctional breathing and training strategies towards effortless breathing.

Respiration is under both voluntary and involuntary control, and often occurs without awareness unless symptoms such as breathlessness are present. Yet even without awareness or symptoms, breathing can be highly dysfunctional. Respiration is customarily described in terms of rate, volume, gas exchange (02 and CO2), airway reactivity, and mast cell activity (Fried, 1993; Wientjes, 1993); however, a major omission is the breath pattern.

Respiratory patterns include location of predominant breathing movements (thoracic or abdominal), presence or absence of upper thoracic muscle activity, timing and flow rates of air during inhalation and exhalation, and the exhalation pause. These respiratory patterns are reflected in language phrases such as "breath of fresh air", "a sigh of relief", "catch my breath", "all puffed up", "inflated", "full of hot air", "gasping for air", "breathing room" and "inspired." These expressions reflect the mind/body/consciousness interrelationships in which changes in breath patterns affect the soma and vice versa.

The common dysfunctional breathing pattern is the tendency to breathe in the upper thorax characterized by an absence of abdominal movement. In upper thoracic breathing, sometimes referred to as paradoxical or reverse breathing, the cross sectional abdominal diameter decreases or stays the same during inhalation and/or increases during exhalation. Other dysfunctional patterns include shallow and rapid breathing punctuated with gasps and sighs (often an indication or hyperventilation), breath-holding, gasping, bracing of the upper chest and shoulders, chest compression at the end of exhalation, and a reduction of respiratory sinus arrhythmia (RSA). RSA is the change of heart rate associated with respiration such that heart rate increases during inhalation and decreases during exhalation.

The most common dysfunctional breathing are dyspnea, fatigue, irritation, tension in the upper thorax (shoulders and neck), less physical stability, and increased effort during the inhalation to "draw in more air." In addition, psychological symptoms can be exacerbated or evoked and may include a sense of panic, doom, anxiety and loss of control (Fried, 1993; Peper & Tibbetts, 1993; Peper and MacHose, 1993).

Breath patterns are covertly conditioned to common or habitual activities. These conditioned patterns include breath holding when the telephone rings, shallow thoracic breathing when entering data at the computer keyboard, and gasping during speech. These responses are components of the alarm reaction which were probably evoked and then conditioned during initial skill acquisition (excessive striving) and were never unlearned. Hence, the dysfunctional breathing patterns have become part of the physiological response during task performance.

When dysfunctional thoracic breathing predominates, a shift occurs towards excessive arousal which as a catabolic state predisposes the soma towards pathology. See Table 1 (Nixon 1989).

ANABOLIC AND CATABOLIC STATES [3]

ANABOLIC STATE

- Increase synthesis of protein, fat carbohydrate (growth, energy storage)
- Decreased breakdown of protein, fat carbohydrate (growth, energy storage)
- Increased production of cells for immune system (white blood cells of thymus and bone marrow)
- Increased bone repair and growth
- Increase in sexual processes (cellular, hormonal, psychological)

CATABOLIC STATE

- Halt in synthesis of protein, fat, carbohydrate
- Increased breakdown of protein, fat, carbohydrate (energy mobilization)
- Elevated blood levels of glucose, free fatty acids, low density lipoprotein, cholestrol (for energy)
- Increased production of red blood cells and liver enzymes for energy
- Decreased repair and replacement of bone
- Decreased repair and replacement of cells with normally high turnover (gut, skin, etc.)
- Decreased production of cells for immune system (thymus shrinks, circulating white cells decrease)
- Decrease sexual processes
- Increased blood pressure, cardiac output
- Increased salt and water retention

Table 1

Effortless diaphragmatic breathing reduces sympathetic arousal and promotes an anabolic state, which encourages regeneration. See Table 1. This regeneration through breathing has been demonstrated in the treatment of a variety of disorders such as asthma (Peper and Tibbetts, 1992) coronary heart disease (van Dixhoorn, 1990; Nixon, 1989), hypertension (Fahrion et al, 1986), epilepsy (Fried, 1987), pain (Luan-Massey & Peper, 1986), hot flashes during menopause (Freedman & Woodward, 1992), hyperventilation syndrome (Lum, 1976; Fried, 1987) and panic attacks (Ley, 1991). This anabolic state mobilizes health and may improve performances in activities such as, swimming, diving and singing (Clavenna & Peper, 1993).

What is Effortless Breathing?

Effortless diaphragmatic breathing consists of a slower respiration rate (<8) with large tidal volume (>2000ml)4, and smooth flow rates, predominant abdominal expansion during the inhalation and abdominal contraction during exhalation. The exhalation time which includes and exhalation pause is significantly longer than the inhalation time (Umezawa, 1993) and the end-tidal CO2 is ^{3} 5% (Fried, 1993). In addition, respiratory sinus arrhythmia is increased and in phase with the breathing pattern. In practicing effortless diaphragmatic breathing, passive attention is encouraged, allowing the breath to move in and out without effort or striving. This approach evokes internal quieting (mindfulness), relaxation, and peripheral warning. Clients report that diaphragmatic breathing is one of the most useful stress reduction techniques (Peper & Holt, 1993; Schwartz, 1987; Stroebel, 1982; Umezawa, 1993).

Assessment of Dysfunctional Breathing

The assessment consists of two phases: A) excessive efforts of breathing and B) dysfunctional breathing patterns during the performance of various tasks. The patterns can be physiologically recorded with upper thoracic surface electromyography (sEMG), incentive inspirometry, thoracic and abdominal strain gauges, capnograph, nasal thermistor, heart rate (photoplethysmograph of blood volume pulse), and/or electrodermograph (EDG) using either the ProComp or FlexComp systems.

Assessment of Excessive Efforts of Breathing

Purpose: To assess the excessive upper thoracic efforts (scalene/trapezius, the accessory muscles of breathing) associated with increasing inhalation volume (Peper, 1988). Surface EMG is recorded across the neck and shoulders while the subject inhales increasingly larger volumes. The inhalation abdominal and thoracic strain gauge measurements to measure relative volumetric changes. The incentive inspirometer is a helpful volumetric visual feedback device since the attained inhalation volume matches the subjective experience of most people when they report difficulty inhaling.

Sensor and Equipment Placements

Upper thoracic sEMG: Place one sensor over the upper right trapezius midway between the acromion and vertebra prominents, the other sensor over the left scalene, and ground on vertebra prominents (T1). (See Fig. 1).

Strain gauges: Place the thoracic strain gauge around the upper chest beneath the axilla, and place the abdominal strain gauge around the abdomen one inch above the umbilicus.

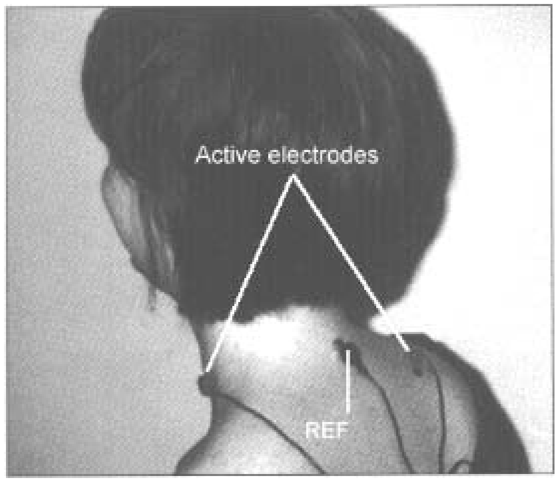

Figure 1. Electrode placement for monitoring upper throacic sEMG.

Incentive inspirometer5: Position the incentive inspirometer on a stable surface so that the inhalation tube is level to the mouth.

End-tidal CO_2: Insert a nasal catheter about ¼ inch into the nostril which is most open and tape it to the upper lip (Fried, 1993).

Procedure:

- Have client sit comfortably erect. Attach scalene/trapezius sEMG sensors and strain gauges and/or place incentive inspirometer at mouth level.
- Have client practice breathing comfortably with the incentive inspirometer.
- Ask client to inhale sequential volumes of air (500, 1000, 1500, … 4000ml) as indicated by the marker on the incentive inspirometer (Peper, 1988). Allow two tries for each target volume before the next larger volume is attempted. If client is unable to inhale to the target volume, stop.

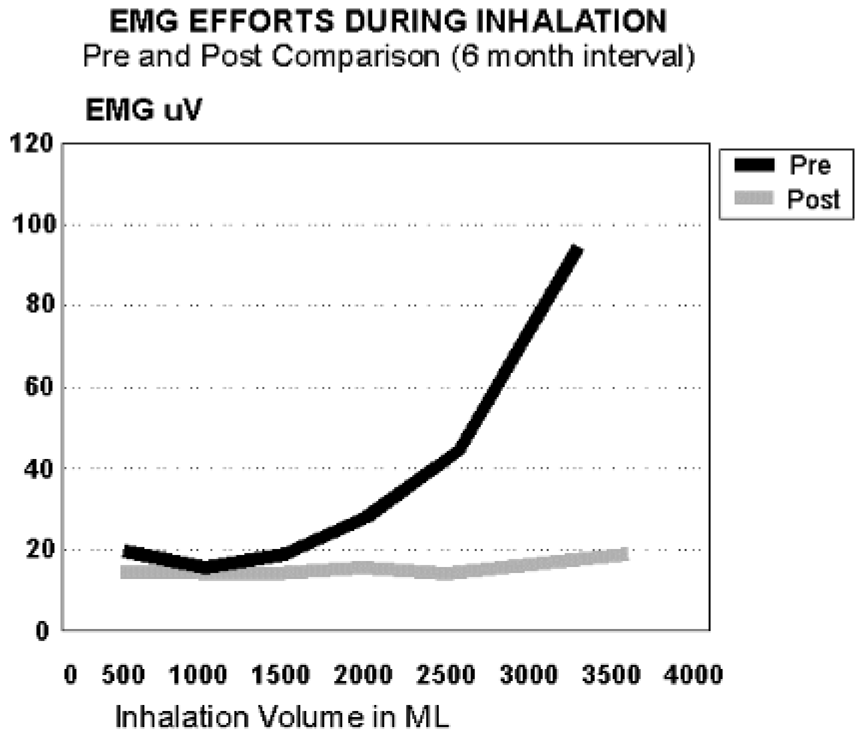

Figure 2. EMG Pre-training/Post-training baselines

- Record sEMG activity at the peak of the inhalation volume. When using the MyoDac2, use the EMG scan and set the scale X10. A sample data collection form, consisting of sEMG pre-training and post-training baselines is shown in Figure 2.

Observing Dysfunctional Breath Patterns

Purpose: To assess the dysfunctional breathing patterns associated with task performance.

Procedure:

- Have client sit or stand in a comfortable position and monitor for one minute with sEMG, respiratory strain gauges, incentive inspirometer, and/or end-tidal CO2 from dominant nostril.
- Ask client to perform a variety of tasks, which can include writing, talking, walking, or imaging stressful scenes. After each task, relax and breathe comfortably.
- Repeat step 1. Have the client sit or stand in a comfortable position. (Figure 3 illustrates dysfunctional and effortless breathing).

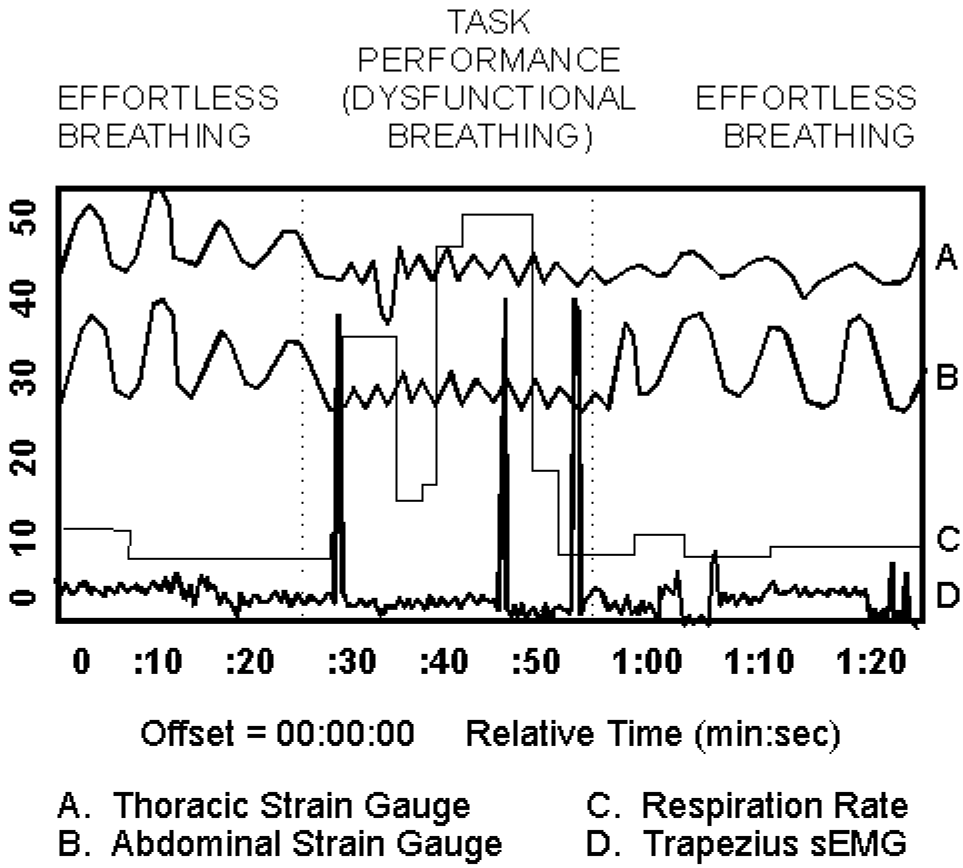

Figure 3. Dysfunctional & effortless breathing.

Training of Effortless Breathing

Training of effortless breathing consists of skill mastery and generalization so that diaphragmatic breathing predominates under most conditions. In order to learn this skill, many clients will need to loosen their clothing because of "designer jeans syndrome." The clothing as well as habitual upper thoracic bracing restricts abdominal displacement (MacHose and Peper, 1991; Shaffer et all, 1993).

Mastery of Effortless Breathing

Train clients to reduce their upper thoracic efforts during early phases of inhalation, to increase exhalation time, and increase abdominal displacement and to increase the percentage of end-tidal CO2. The most important component is to have clients exhale completely so that inhalation can occur without effort. Prolonged exhalation feels counter - intuitive since the subject usually strives to inhale more (gasping for breath).

COACHING STRATEGIES FOR EFFORTLESS BREATHING[6]

CLIENT:

- Place hands on abdomen and chest and observe patterns
- Place hands on lateral side at the waist, touching the lower ribs; press towards the center of the body during exhalation; pull hands outward during inhalation
- Imagine a balloon expanding and contracting in their abdomen
- Imagine smelling a rose, inhale very slowly while enjoying the fragance.
- Imagine the air flowing in and out through the legs and feet.
- Draw stomach in and relax (expand), then repeat more rapidly.
- Stroke arms from shoulder to hands in rhythm with exhalation.
- Exhale through a very small opening between the lips.
- Whisper "HAAAaaa" during exhalation.
- Loosen belt and other constrictive clothing that inhibit abdomenal expansion (designer jeans syndrome).

COACH/TEACHER/THERAPIST:

- Place hands on lateral side at the waist, touching the lower ribs; press towards the center of the body during exhalation; pull hands outward during inhalation.
- Place hands on abdomen and apply pressure to abdomen during exhalation.
- Rock/shake shoulder gently during exhalation and inhalation to relax bracing.
- Exhale audibly at the same time and slightly longer than when the client is exhaling.
- Discuss psychological associations related to abdomen expansion such as self-image, emotional release, and vulnerability.
- Guide exhalation with imagery such as exhaling through straws in the legs.

Table 2

Have the therapist/coach/teacher demonstrate breathing. This can include role modeling by the therapist (Shaffer et all, 1994), extended exhalation by the clinician in synchrony with the client's exhalation (Tibbets & Peper, 1993), and physically pressing the abdomen and lateral waist/lower ribs inward during the exhalation phase (Roland and Peper, 1987; Peper, 1990). A more detailed description of coaching and generalization techniques are described in Table 2 and more extensively in the tape series Breathing for Health (Peper, 1990).

In the early phases of training, focus on increasing the exhalation phase without compressing the chest downward and thereby increasing upper thoracic sEMG while the circumference of the abdomen decreases. The abdominal wall is pulled slightly in and up. To facilitate exhalation, give abdominal and thoracic strain gauge feedback using either the ProComp or FlexComp system. If unavailable, use MyoTrac2 or MyoDac2 for sEMG feedback from the lower abdomen to feed back increased sEMG activity during later phases of exhalation and decreased sEMG activity during inhalation. (Place active sEMG sensors midway between the umbilicus and pubis and one inch medial from each iliac crest).

To encourage longer exhalation, have the client whisper a very soft "HAAaaa" sound. At the end of the exhalation, encourage the person to relax, allow the lower ribs and back to widen, and the abdomen to expand while the air flows in without effort. Promote a slower rate of breathing with larger tidal volumes. Mastery of effortless breathing is attained when subjects can breathe in a slow rhythmical pattern so that the exhalation phase is significantly longer (³2 times) than the inhalation phase, and upper thoracic EMG remains low during the initial inhalation phase. To encourage the regenerative/anabolic state, train clients to breathe at the rate of 3 to 4 times per minute without any sense of effort or air hunger.

Regardless of the training procedure and modality used, many clients feel awkward when they begin to breathe diaphragmatically (e.g. self-image changes as the abdomen expands; too much striving while attempting to breathe "perfectly"). It may take a number of sessions before mastery of diaphragmatic breathing is achieved.

Cautions: Be aware that when learning diaphragmatic breathing, clients may:

- Experience light-headedness due to exhaling too rapidly and possibly hyperventilating. Coach them to breathe and especially exhale more slowly.
- Become aware of and experience strong emotions sometimes related to past trauma. Give support and allow expression.
- Desire to discontinue prematurely medication at the first signs of improvement. Have medication reduction supervised by appropriate health professional.

There are NO absolute respiration values; range varies with the individual. Respiration is a continually nchanging homeostatic system. Pathology may be induced by forcing the system to match normative standards such as breathing at a fixed pace or volume. The breathing rhythm needs to be dynamically adapted and varied for each person.

Additional Monitoring Strategies

Monitor heart rate, electrodermal response (EDR) and peripheral temperature as indicators of the relaxation response. Relaxation tends to be accompanied by an increase in RSA, a decrease in EDR and an increase in peripheral temperature. If EDR increases or temperature decreases, the client is probably striving or hyperventilating. When monitoring RSA, have subjects breathe so that the RSA is synchronized with respiration.

The breathing rhythm can also be monitored with a nasal thermistor. Tape the lead of a rapid responding thermistor at the opening of the nostril that is most open. Ensure that the thermistor does not touch the inside skin of the nostril. During nasal exhalation the temperature will increase; during inhalation the temperature will decrease.

Generalization of Effortless Breathing

After clients develop mastery, have them practice diaphragmatic breathing while performing other activities without changing their breath patterns. This generalization may begin with very simple activities such as breathing while imagining positive or stressful scenes, writing or data entry, standing and sitting, walking, and talking. (For detailed instructions see: Peper, 1990; Peper and Tibbetts, in press). During talking, be sure the inhalation is effortless and not initiated with a gasp. If the activity includes aerobic activity, then the rate and volume may increase while maintaining an overall pattern of diaphragmatic breathing and complete exhalation. After mastery, begin a physiological desensitization strategy in which the subject may also practice exhaling to stressful stimuli, allergens, pain, or any noxious stimuli. Finally, have the client practice role rehearsal of imagined and actual stressors while continuing to breathe diaphragmatically.

Home Practice

Home practice is an integral component of the mastery and generalization process. It includes:

- Self-observation of dysfunctional breathing patterns such as sighs, gasps, breath holding, and/or shift to thoracic breathing (Peper & Crane-Gockley, 1990).
- Using the onset of the dysfunctional breathing pattern as the stimulus to evoke and re-establish effortless breathing.
- Prolonged diaphragmatic breathing practice (>15 minutes) while lying supine with a five pound weight on the abdomen.
- Counting out loud to increasingly higher numbers with a single breath (one, two, three, four, … twelve, thirteen,… etc.) to encourage longer exhalation.
- Practicing 5 to 10 diaphragmatic breaths periodically throughout the day. (This may also be done in front of the mirror as a visual home feedback device).
- Breathing diaphragmatically in anticipation to stressors or situations which previously evoked dysfunctional breathing.
- Using sEMG feedback from the MyoTrac as a home trainer device to monitor excessive covert upper thoracic activity during the early phase of inhalation. Speaking while keeping the sEMG levels low to inhibit gasping and urgency during speech.
- Using GSR2 feedback as indicator of effortless breathing, practice breathing so that the feedback tone decreases as an indicator of lower arousal (Peper, 1990).

Applications

- Reduction of sympathetic arousal and stress (Schwartz, 1987; Nixon, 1989; Stroebel, 1982). Use breathing to focus attention, reduce arousal during the day, and inhibit the somatic responses induced by stressful stimuli and pain.
- Reduction of asthmatic and breathlessness symptoms (Peper and Tibbetts, 1992). Practice slow diaphragmatic breathing in response to all stimuli. These can range from emotional situations to walking up hill or exposure to allergens.
- Reduction of anxiety, panic attacks, and hyperventilation syndrome (Lum, 1976; Ley, 1987). Practice effortless breathing and especially prolonged slow exhalation in anticipation of the stressor as well as at the initiation of anxious feelings and thoughts.
- Decrease of discomfort and frequency of menopausal hot flashes. Practice effortless breathing (six to eight cycles per minute) between and in anticipation of hot flashes (Freedman & Woodward, 1992).
- Reduction of the occurrence of a second coronary (van Dixhoorn, 1990). Practice gentle awareness of body experiences during and following whole body breathing. Develop a non-judgmental awareness during breathing and in daily life.
- Enhancement of endurance and physical performance. Breathe diaphragmatically with slow complete exhalation while performing strenuous activities (Clavenna and Peper, 1993).

Conclusion

Respiration reflects the mind/body interphase. Effortless breathing encourages health and healing. Through mindful practice and generalization of effortless breathing, the anabolic state is encouraged;

regeneration occurs. Mastery of the skill promotes empowerment since the person can actively participate in their own self-healing.

Notes

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2. We thank Dianne Shumay for her helpful contributions.
3. From: Nixon, P.G.F. (1989). Human functions and the heart In: Seedhouse, D & Cribb, A. (eds). Changing Ideas in Health Care. New York: John Wiley & Sons, 37.
4. Rate and volume will vary upon age, size, sex, and metabolic load.
5. We recommend incentive inspiometers which encourage very slow inhalation such as the 4000ml Voldyne, produced by Sherwood Medical Inc., 11802 West Line Industrial Drive, St. Louis, MO, 63146 or the 4000ml Coach, produced by DHD Medical Products, 125 Rasbach Street, Canastota, NY 13032.
6. Adapted from: Roland, M. & Peper, E. (1987).

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