THE THERAPEUTIC BASIS OF BREATHING EXERCISES

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THE value of breathing exercises has not been sufficiently stressed in the past. Most physicians have not been trained to think in terms of prescription of therapeutic exercise as they have in prescription of drugs or in indications for operative procedures. However, with the introduction of courses of physical medicine and rehabilitation into the curricula of many medical schools, encouraging progress is being made in giving younger physicians a basic understanding of therapeutic exercise. It is hoped that with this new emphasis, greater use will be made by all physicians of such simple yet beneficial procedures as breathing exercises in conditions where they are indicated.

Three conditions in which breathing exercises have proved to be of definite value will be discussed. Special consideration will be given to the pathologic physiology present in each instance, particularly in so far as it affects respiration, and to the therapeutic objectives of breathing exercises. The exercises themselves will be outlined briefly in the form that has been found most practical for instruction of patients.

Physiology of Normal Respiration. Since the rationale for breathing exercises is based upon physiologic principles, a brief discussion of the physiology of normal respiration is warranted. Respiration in a strictly physiologic sense is the exchange of oxygen and carbon dioxide between living cells and their environment. However, the term respiration usually refers to the movements of inspiration and expiration which provide an intermittent flow of air through the lungs sufficient for the exchange of the respiratory gases.

In quiet respiration, inspiration is the active process, carried out primarily by contraction of the diaphragm and, to a lesser extent, of the lower external intercostal muscles. The increase in size of the thoracic cavity resulting from descent of the dome-shaped diaphragm, and lateral flaring of the lower thorax, creates a negative pressure which allows air to inflate the easily distended lungs. Expiration, conversely, is almost entirely a passive process in quiet respiration, depending upon the elasticity of the lungs and the force of gravity to expel the air and return the expanded thorax to its neutral position.

In forced inspiration such as occurs after strenuous exercise, the diaphragm is still the most important muscle, accounting for about 60 per cent of the vital capacity. However, in such a situation accessory respiratory muscles act to supplement the action of the diaphragm and to increase the amount of air inspired by elevating and bringing forward the sternum. Other accessory muscles enlarge the nostrils, spread the vocal cords, and adapt body posture for maximal inspiration. The following are accessory muscles of inspiration: external intercostal, sternocleidomastoid, scalene, trapezius, pectoralis minor, serratus posterior, dilator naris, erector spinae and rhomboid muscles.

In forced expiration another group of accessory respiratory muscles act to compress the thorax and thus to expel a stream of air in a manner not unlike the action of bellows. In forced expiration there may be also an adaptation of body posture to allow maximal expiration by slight flexion of the dorsal spine, slumping forward of the shoulders and stabilization of the arms. The accessory muscles of expiration are the following: rectus abdominis, internal and external oblique abdominal, internal intercostal, latissimus dorsi, serratus anterior, pectoralis major, deltoid (lower fibers), and quadratus lumborum muscles.

When breathing quietly certain persons, more commonly women, make use of upper thoracic and intercostal muscles rather than the diaphragm. An important factor here is probably the wearing of tight-fitting girdles and corsets which prevents normal expansion of the abdomen in inspiration. Some women seem to have forgotten how to use the diaphragm correctly. Since they are already utilizing their "reserve" respiratory muscles for quiet breathing, they have reduced tolerance to exercise. In advanced cases, faulty breathing may cause symptoms such as fatigue, breathlessness, difficulty in climbing stairs, tachycardia and lightheadedness. Patients with these complaints occasionally are diagnosed as having neurocirculatory asthenia, effort or hyperventilation syndromes.

The amount of air breathed in and out during quiet respiration is approximately 500 cc.; this is called "tidal air." The total amount of air that a person can take into his lungs in deep inspiration and breathe out in forced expiration is called "vital capacity"; the average vital capacity of an adult is about 4000 cc.

It is unnecessary to discuss in detail the regulation of respiration by the nervous system. Respiratory movements are both voluntary and involuntary. Normally, however, respiration is almost entirely an unconscious process determined by automatic activity of the cells of the respiratory centers in the medulla, which are in turn influenced by certain chemical and reflex factors. Each respiratory center in the medulla consists of an inspiratory and an expiratory center. The inspiratory center originates impulses which cause contraction of the diaphragm and the accessory muscles of inspiration. The inspiratory phase of respiration continues until a sufficient number of inhibitory impulses arrive at the inspiratory center from either the expiratory center or through the vagus nerve from stimulated nerve endings in the distended alveoli (Hering-Breuer reflex). The inspiratory center is specially sensitive to amounts of carbon dioxide in the blood slightly in excess of normal, which result in an intensified shower of impulses from the center to the inspiratory muscles. The carotid body and carotid sinus structures in the neck, although also sensitive to changes in carbon dioxide content of the blood, play a negligible role in the regulation of normal respiration.

Respiration is easily inhibited reflexly by a wide variety of stimuli: coughing, sucking, talking, swallowing, sudden pain, or a whiff of sulfur dioxide, to men-

tion a few examples. Respiration is also influenced in a variety of ways (e.g. in rate, depth, and rhythm) by certain emotions or mental attitudes, such as laughter, crying, interest, rage and fear. From this consideration it is apparent that there must be many subcortical reflex connections involved in the control of respiration.

Indications for Breathing Exercises

Breathing exercises are prescribed in a number of medical and surgical conditions. They are employed ordinarily for one or more of the following purposes: (1) to increase vital capacity; (2) to abort asthmatic attacks; (3) to prevent or to correct postural abnormalities; and (4) to gain better control over respiratory movements.

Rheumatoid spondylitis is a disease in which increasing the vital capacity is of paramount importance. In asthma, breathing exercises are prescribed both for the purpose of increasing the vital capacity and aborting acute attacks. Prevention and correction of postural abnormalities are important in both rheumatoid spondylitis and asthma, and in the postoperative care of patients who have had thoracic surgery. Following thoracic surgery it is also important to re-educate the patient to breathe correctly using both sides of the thorax equally.

Intercostal Breathing in Rheumatoid Spondylitis. Rheumatoid spondylitis is a systemic disease of unknown etiology which runs a chronic, progressive course over the years but which may undergo remissions and exacerbations. Although it is a systemic disease similar in many respects to rheumatoid arthritis, the major manifestations of rheumatoid spondylitis occur in the joints of the spinal column, particularly the sacro-iliac and the small intervertebral and costovertebral articulations.

The pathologic process begins as a synovitis with exudation into the joint cavity and erosion of the cartilage. The joint cavity is eventually obliterated by fibrous connective tissue and finally, after a period of a few years, by bony ankylosis. Osteoporosis of the vertebral bodies and calcification of the longitudinal spinal ligaments also occur.

Physicians are familiar with the tragic picture of the untreated patient with rheumatoid spondylitis in whom the pathologic process has run its course. His spine is bent forward in a position of pronounced kyphosis and he is completely unable to straighten up. With his head held forward and his chin depressed toward his flattened chest, he is unable to turn his head more than a few degrees in any direction. His thoracic cage is fixed in a position of expiration, permitting him to breathe only with his diaphragm.

There are many measures that are important in the treatment of rheumatoid spondylitis: roentgenographic therapy, orthopedic procedures and braces, use of heat, exercises, drugs such as cortisone, and limitation of activities. None of these is more important, however, than intercostal breathing and postural exercises. Such exercises are more effective in the early stages of rheumatoid spondylitis and are prescribed to increase the breathing capacity by mobilizing the thorax and to maintain or obtain posture as nearly normal as possible by strengthening the erector spinae and rhomboid muscles and stretching the pectoral muscles. So easily do these exercises supplement one another that it has

been found convenient to combine them into simple routines for instruction of patients with rheumatoid spondylitis. The following exercises should be taught these patients:

1. Lie on your back on a firm surface without a pillow under your head. Clasp both hands under your head and pull your elbows firmly downward while inhaling deeply. Hold this position for five seconds, then exhale and relax. Repeat 5 to 20 times.
2. Lying on your back, place a rolled towel between your shoulder blades. Inhale slowly and raise your arms upward and back over your head as far as possible; then exhale and lower arms to sides. Repeat 5 to 20 times.
3. Lie on your abdomen. Stretch your arms outward at the sides to shoulder level. Raise your head, chest, shoulders and arms off the bed. Relax and repeat 5 to 20 times.
4. Stand facing the corner of a room at arm's length from the walls. Place one hand on each wall at shoulder level. Bend elbows slightly and hold abdomen in. Slowly let the weight of the body go forward forcing the chest toward the corner, at the same time inhaling deeply. Return to original position and exhale. Relax and repeat 5 to 20 times.
5. Suspend the body without bending elbows by grasping an overhead bar with hands width of shoulders apart. Except for clenched hands, remain as relaxed as possible for five seconds. Rest, and then repeat 5 to 10 times.

The patient is instructed to do each of the foregoing exercises several times each day, and gradually increase the repetitions. Special instruction is necessary to acquaint the patient with correct posture and to impress upon him that he must always be "posture conscious." He will be most comfortable sleeping upon a firm mattress with a board underneath and sitting erect in firm, straight back chairs. Finally, the patient is advised to measure both his chest expansion and his height every month so that he will be aware of his progress in the program of exercises.

Diaphragmatic Breathing in Asthma. In contrast to rheumatoid spondylitis where limitation of inspiration is the major problem, the primary difficulty in asthma occurs during expiration. Often a paroxysmal attack of dyspnea occurs without warning within a few minutes in an asthmatic patient; such an attack is first manifested by a feeling of oppressive tightness over the chest. Even though the patient employs his accessory respiratory muscles during an attack, little excursion of the thorax actually takes place. The acute attack may last from 15 minutes to several days, and is usually of milder intensity in attacks of longer duration.

Although the underlying cause of asthma is not established, the mechanism of the asthmatic attack seems to be generally understood. It is believed that an attack is initiated by generalized spasm of the smooth muscle in the finer bronchioles, followed by edema of the mucosa and accumulation of secretion. This process creates a barrier to escape of air from a considerable portion of the pulmonary alveoli, thereby making it extremely difficult for the patient to exhale. However, upon deep inspiration he can often slightly enlarge the constricted lumina of the bronchi, allowing additional air to enter the already expanded alveoli; this action might be compared to that of a ball valve. During an

asthmatic attack, the lungs become overdistended, or emphysematous and the thorax is kept in a position of partial inspiration. As the acute attack subsides, both the lungs and the thoracic cavity eventually return to normal size.

In the patient who has suffered from asthma for many years, the attacks gradually increase in duration and chronic changes occur in the lungs and thorax that are not reversible. The thorax gradually assumes a barrel shape, adapting itself to the secondary emphysema; widening of the costal angles and Harrison's grooves may also appear. The patient has a musical, wheezing respiration and must utilize his accessory muscles. He frequently has a chronic productive cough.

The objectives of breathing exercises for the asthmatic patient are the following: (1) to re-educate the patient to use his diaphragm more effectively in quiet respiration, rather than his upper thoracic accessory respiratory muscles; (2) to increase vital capacity; (3) to restore the enlarged chest to proportions as nearly normal as possible and, in the younger asthmatic patients, to prevent such enlargement; (4) to abort asthmatic attacks.

Most programs of breathing exercises follow the routine outlined by the Asthma Research Council of Great Britain. These exercises are usually begun with the patient in a supine position. Later they may be supplemented with exercises in a sitting or standing position, which should be done before a mirror if possible. Before starting the exercises, the patient should clear his airway by blowing his nose. The following are the basic breathing exercises taught asthmatic patients:

1. (a) Lie on your back with head and knees comfortably supported by pillows. Take in a breath through your nose and then exhale slowly through the mouth, making an "f" or "s" sound. Gradually try to increase the length of the time you are able to make this sound in one breath. However, it is most important not to prolong the sound to the point where you must gasp for a new breath. Repeat three times.

   (b) Learn to keep the upper part of the chest still when inhaling so that inspiration is carried out mainly by the diaphragm. When exhaling, the abdominal muscles should contract, sinking in toward the spine. Then let the next breath drawn into the lungs come automatically, so to speak, by simply allowing the abdominal wall to relax (or swell).

   (c) Unless the chest is absolutely clear, exhale during the preceding exercises just sufficiently to hear wheezing noises in the bases of your lungs. This may cause coughing and increased wheezing at first but keep trying gently as it will soon be possible for you to do this exercise without distress.

2. Sitting on a chair, preferably in front of a mirror, wrap a wide belt at least five inches in width once around your lower ribs above the waist. Holding onto the ends of this belt, breathe out slowly, sinking first the upper chest, then the ribs, and finally compressing the ribs by tightening the belt. Then while breathing in quietly, feel the lower ribs expand against the pressure of the belt. Repeat five times.

A number of exercises are often added for the asthmatic patient, but these are concerned more with the correction of faulty posture than with the mechanism of respiration. The foregoing exercises should be done each day for at least

10 and gradually increasing to 20 minute periods at the following times: (a) before breakfast when the patient feels fresh and is least likely to be dyspneic; (b) at night before retiring, to clear the lungs in preparation for sleep; and (c) at the first sign of an impending attack, in order to avoid it if possible. Also the patient should practice diaphragmatic breathing frequently throughout the day. It is advised that the patient perform the exercises for three months, at the end of which time he may decrease to five minute periods twice daily for the next 12 months.

Breathing Exercises Following Thoracic Surgery. Extensive experience was gained during World War II in the treatment of patients with chest injuries. Thoracic surgeons were quick to realize the tremendous help that intensive rehabilitation programs could give to their patients. An important part of the rehabilitation program for these patients consists of breathing exercises, the purposes of which are the following: (1) to prevent adhesions from forming between visceral and parietal pleura that might limit movement of lungs and ribs; (2) to instruct the patient in correct breathing and thus to prevent any postural abnormalities that might result from faulty breathing; and (3) to strengthen accessory muscles of respiration that had been severed during surgery.

Breathing exercises have an important role in the preoperative preparation of the patient for elective thoracic surgery as well as in the postoperative management. It is customary to begin diaphragmatic breathing exercises as soon as possible following surgery in order to prevent the formation of adhesions. However, because of postoperative pain it is difficult if not impossible to instruct the patient adequately in such exercises after the surgical procedure has been carried out. Therefore, it is advisable to instruct the patient before surgery in the breathing and postural exercises that will be instituted later. He should also be informed before the operation of the amount of pain and disability that he can expect, and of the importance of maintaining good bed posture and doing the exercises prescribed throughout the convalescent period.

Following surgery the patient will invariably splint the side involved and breathe with the normal side of his chest. At first this unilateral breathing requires conscious effort but soon becomes automatic. The day following surgery the patient should be encouraged to do the diaphragmatic breathing exercises if possible. It is important to instruct the patient in proper positioning in bed. If these measures are not given careful attention, the classic deformity that has been known to follow thoracic surgery may develop: tilting of head toward affected side, lowered shoulder on same side with a tendency for it to ride forward, and fixation of diaphragm in a position of full expiration on the involved side. Later in the postoperative period, careful re-education of the muscles of respiration and intensive postural training must be instituted.

Re-education of the respiratory muscles is often required to get the patient to breathe correctly with both sides of his chest. Two exercises that may be used

to make the patient aware of the function of the respiratory muscles follow: the first of these exercises may require a considerable amount of supervision.

1. Lying supine in bed, place hands over lateral chest on involved side. Take in as deep a breath as possible, maintaining gentle pressure on the hands throughout inspiration. Hold for a count of three and exhale. During expiration apply greater pressure on your chest than during inspiration; at the end of expiration, give a sudden thrust to your hands and release. Repeat five to ten times, twice daily.

2. Lying supine in bed with knees drawn up, place hands on lower margin of ribs anteriorly. Take a deep breath and feel the abdomen swell under your hands and the ribs pull wider apart. Hold for count of three. Now exhale slowly, allowing the upper chest to sink lower, and then the upper abdomen. Repeat five to ten times, twice daily.

In addition to these exercises, postural exercises are of great importance following thoracic surgery; these are directed at making the patient aware of correct posture and at mobilization of the neck and the shoulder girdle. The progress made in re-education of respiratory muscles can be evaluated through periodic fluoroscopic examinations.

Conclusions

1. Breathing exercises have an important place in treatment of rheumatoid spondylitis and asthma and in the preoperative and postoperative management of patients who are to have thoracic surgery.

2. In rheumatoid spondylitis, breathing exercises are carried out to increase intercostal expansion and the depth of inspiration.

3. In asthma, breathing exercises are prescribed which stress contraction of the diaphragm and increasing the expiratory phase of respiration.

4. In the management of patients who are to have thoracic surgery, breathing exercises are of value in preventing pleural adhesions, asymmetrical respiration and postural deformities.

5. The utilization of breathing exercises in the cited instances is based upon sound physiologic principles.

References

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