# Considerations for Maintenance of Postural Alignment for Voice Production

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**Summary:** There is general agreement that postural alignment is important in optimizing voice function. A number of articles have illuminated the way in which posture, particularly of the cervical spine, is directly related to vocal resonance and pitch control. Despite frequent involvement in muscle training, few speech pathologists have the background in exercise physiology necessary to appreciate the contribution of muscular length-tension relationships to postural alignment. The purpose of this article is to provide voice therapists with information to help them formulate appropriate recommendations for improving postural alignment. This article synthesizes information from the literature regarding the role of muscular length-tension balance in the attainment and maintenance of postural alignment. Important considerations in the assessment of muscle tension and weakness are presented along with advice regarding application to the treatment of voice-disordered patients. Concepts detailed include agonist/antagonist relationships, the biomechanics of stretching, postural assessment, and the relationship between muscle tension and muscle weakness. The role of both stretching and strength-based training is discussed. Specific exercises with emphasis on altering the alignment of the cervical and thoracic spine are presented with suggestions for their use in the clinic. There is growing understanding of the physiology behind recommendations of voice teachers and therapists to maintain optimal alignment. To effectively mediate postural misalignment, clinicians must have knowledge of the length-tension relationships between muscles. This understanding will lead to better interventions for postural alignment.

**Key Words:** Voice and posture—Postural alignment—Exercise and voice.

## INTRODUCTION

There is general agreement that good postural alignment is an important element in optimizing voice function.[1–8] One experiment regarding the role of posture in voice production focused on sound change in the context of postural

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manipulation. In this experiment conducted by Jones,[9] an improvement in the integrity of vocal harmonics in spectrographic analysis was noted during a head repositioning task. The weakness of this study as it applies to voice teachers and therapists is that head repositioning was achieved by manual intervention on the part of the experimenter and maintenance of the improved positioning was not addressed. Both Heman-Ackah[6] and Chapman[10] associated misalignment of the head and neck with changes in the shape of soft tissue of the pharynx and consequent impingement on resonance of the voice. A survey conducted by Behrman revealed that a vast majority of speech pathologists treating voice-disordered patients on a regular basis consider assessment of body position and movement important, both in the selection of therapy goals and in the elicitation of better voicing.[7] Despite the cited importance of postural assessment and intervention, few speech-language pathologists have the background or training in muscle physiology necessary to understand the complex interactions between muscles that support or hinder the maintenance of good alignment.

In recent years, there has been increased interest among voice professionals in understanding the physiology behind the postural recommendations made to voice students and patients. Dennehy et al[8] contributed to this discussion by providing voice professionals with an introduction to some basic principles of exercise training: overload, specificity, and progressive resistance. Rubin et al[5] provided a detailed description of the major muscle groups involved in postural alignment and proposed a number of functional relationships that may be relevant to vocal function. This included a discussion of their hypothesis that misalignment of the head and neck region results in adaptive changes to the muscles that elevate the larynx and disrupts pitch control and resonance. Both of these sets of authors emphasized the importance of achieving balance between related muscle groups, but did not elaborate on the details of achievement of length-tension balance between muscle groups.

The purpose of this paper is to provide voice professionals with insight into some general considerations regarding the achievement of optimal length-tension relationships between muscle groups for maintenance of postural alignment. We will proceed to describe the way in which this relates to a common postural presentation in the voice clinic and studio. Finally, we will provide descriptions of several specific exercises, the purpose of which is to address these malalignments.

To date, the vast majority of research regarding length-tension imbalances in the musculature has been undertaken in the physical therapy literature. Physical therapists must address organic and functional length-tension imbalances throughout the body. Magaray encourages physical therapists to think in terms of body systems rather than discrete structures when treating musculoskeletal disorders.[11] Speech-language pathologists can learn from this approach by acknowledging the importance of understanding muscle length-tension relationships throughout the body and not just the larynx itself.

## GENERAL CONSIDERATIONS

### Agonist versus antagonist muscles

One basic consideration is the length-tension balance between agonist and antagonist muscle groups. An agonist is a muscle contracting against the force of another muscle.[12] An antagonist is any muscle working in opposition to the agonist.[12] The label applied to a muscle is dependent on the action that is being performed. In a biceps curl (elbow flexion), the biceps is the agonist, while the triceps is the antagonist. In an arm/elbow extension, the triceps is the agonist, while the biceps is the antagonist. One example of the agonist/antagonist relationship in the postural musculature is found between the suboccipital muscles at the base of the skull, which extend the neck, and the neck flexors. For a complete discussion of the muscles in these groups, please refer to Rubin et al[5] and Moore.[13]

The process by which the antagonist muscle group is automatically relaxed upon activation of the agonist muscle group is called reciprocal inhibition.[14–16] Strong contraction of any antagonist relaxes the agonist in any muscle group.

### Tension versus weakness

Muscle tension is generally thought to be responsible for the pain experienced by voice patients

presenting with hyperfunctional dysphonia.[17–22] In addition to causing pain, tense muscles lead to a cascade of events that disrupt the balance of the entire muscle system. Muscles that are tense for a period of time become physically shortened due to a loss in number of contractile units called sarcomeres.[23,24] Shortening of an agonist muscle forces the antagonist muscle into a lengthened position, which over time, leads to "stretch weakness" through the adaptive addition of sarcomeres.[24,25] Kendall et al[26] define stretch weakness as weakness resulting from muscles remaining in an elongated position, even if this elongation is slight.

Inappropriate shortening and lengthening of muscles compromise the length-tension balance within that muscle system. When an imbalance exists between agonist and antagonist muscles, the tight/shortened muscle must be lengthened to allow for strengthening of the weak lengthened muscles.[24,27] It should be noted, however, that restoration of optimal function and appropriate balance between the agonist and antagonist unit is not complete unless the release of tension and stretching of the shortened agonist group is combined with appropriate strengthening of the weak antagonist group.[23,24,28,29]

Imbalances within a muscle system are thought to place individuals at a higher risk of sports injury.[30] Regarding voice disorders, an understanding of length-tension relationships between muscles leads us to conclude that the exclusive focus on muscle release and stretching found in many clinics and studios may encourage recurrence of symptoms from residual length-tension imbalances. Specifically, subtle stretch weakness in some muscle groups may aggravate vocal symptoms by reducing the framework support available for maintenance of optimal function. Brown provides an example of stretch weakness that can occur in the crura of the diaphragm with habitual increased curvature of the lumbar spine.[1]

## Biomechanics of stretching

The Golgi tendon organs are the primary mechanism by which muscle tissue is released during a static stretch. These proprioceptive stretch receptors respond to intentional prolonged stretch and inhibit the contractile response of the muscle spindles via the inverse stretch reflex.[14,15] The Golgi tendon organs require approximately 6 seconds to initiate their response to a muscle stretch.[16] More time is required for the muscle to relax to its full length. Beaulieu and Bandy et al concluded that stretch-based programs that do not require the patient to maintain stretched postures for 20 to 30 seconds are not providing the full benefit of the stretches to the patient and may inadvertently increase muscle tension by activating the stretch reflex mediated by the muscle spindles.[31,32]

Conversely, overstretching of muscle that results in pathological muscle lengthening may increase an individual's susceptibility to injury as an overcompliant muscle-tendon unit results in decreased sensitivity of the Golgi tendon organ.[33] An additional caution against excessive muscle stretching comes from Behm and colleagues who demonstrated that overstretching resulted in a decrease in balance, stability, and proprioception and increased reaction time.[33]

## Body type

In addition to considering the pattern of muscle tension and weakness, it is important to consider body type, specifically whether the patient has "lax" connective tissue, a condition called benign generalized ligamentous laxity. Warner et al estimate the prevalence of generalized ligamentous laxity at 4% to 7% of the population.[27] Those with lax body types can be identified by their greater than normal range of motion in their joints. In this population, strengthening of major muscle groups is largely considered to be the most appropriate intervention and large amounts of stretching should be avoided.[27,34]

## Postural configurations

Postural assessment provides a foundation for the assessment of the state of the tonic balance in the musculature. According to Kendall et al,[26] the plumb line is used to represent the line of reference and deviations from these points lead to compensatory changes above and below with adaptive shortening of the surrounding soft tissues. The plumb line is an imaginary vertical line that is drawn through the body from the crown of the head to the feet (Figure 1).

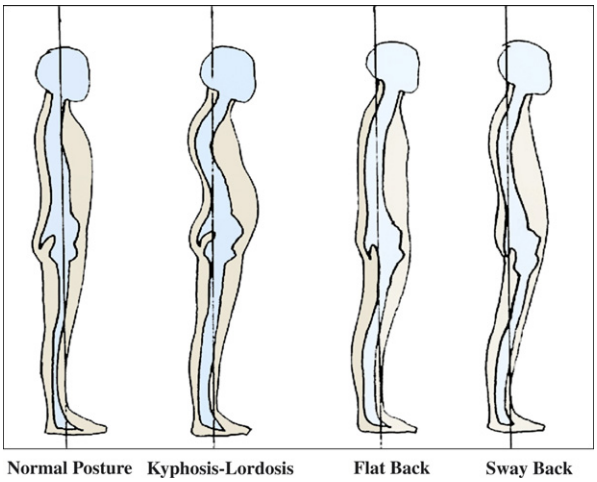


**FIGURE 1.** Normal alignment and the three major postural deviations, with plumb lines (drawing adapted from Kendall et al[26]).

*Normal posture*

Referencing Kendall et al,[26] when viewing the patient laterally, the plumb line should pass through the external ear, midway through the shoulder, slightly posterior to the center of the hip joint, slightly anterior to the axis of the knee joint, and slightly anterior to the lateral prominence of the ankle joint. Note that there are four natural curves in the spine: the cervical lordosis (forward curve at the neck), the thoracic kyphosis (backward curve in the upper back), the lumbar lordosis (forward curve in the lower back), and the sacral kyphosis (backward curve at the end of the spine).[5,26] These are gentle curves and none should be pronounced.

The three most common postural malalignments are kyphosis-lordosis posture, flat back posture, and sway back posture[26] (Figure 1).

*Kyphosis-lordosis posture*

This represents an increase in all the natural curves of the spine such that there is an increase in the cervical and lumbar lordoses (ie, exaggerated forward curvature)[35] and in the thoracic kyphosis (ie, abnormal rearward curvature of the spine).[35] Increased thoracic kyphosis is thought to be the most common form of spinal malalignment.[24] This posture is commonly referred to as the ''forward head posture''. In side view, the plumb line will be posterior to the lobe of the ears and the shoulder joint; posteriorly, the midline of the head and the spinous processes of the cervical spine will be shifted anteriorly.

*Flat back posture*

A side view shows the ears anterior to the plumb line and a decrease or flattening of the normal thoracic kyphosis and the lumbar lordosis.

*Sway back posture*

This posture is similar to the lordosis-kyphosis posture, but there is less exaggeration of the cervical and thoracic curves. The greater difference is in the position of the pelvis, which is held in more of an anterior tilt with the knees in hyperextension.

## CLINICAL DECISION MAKING—ASSESSMENT

### Ergonomics across environments

When dealing with an individual who has length-tension imbalances in the musculature, one must also consider the ergonomics of the activities that the person engages in on a regular basis.[11,24] It is appropriate to consider and discuss with patients the placement of their television, telephone use (in terms of posture and handset support), and computer positioning to aid patients in optimizing their environment for the development of proper alignment of skeletal musculature. Anyone who is having difficulty managing length-tension relationships should be encouraged to implement ergonomic improvements across his or her environments.[24] This may support the recommendation of some voice therapists as well as singing teachers and acting coaches that patients and students pursue Alexander Technique, Feldenkrais training, and other holistic alignment training systems.[2,17,36,37]

Sometimes postural alignment is negatively impacted by the conditions present during a vocal performance. These may include the presence of heavy costuming, with or without corsets, the use of high heels, and the postural requirements of various character choices. Even the physical environment of the stage, such as the presence of a raked stage may produce negative postural adaptations of the head and neck.[5,10]

### Basic postural assessment

When assessing postural alignment, begin by having the patient stand comfortably and without cueing in an open area of the room. Physical therapists often have patients disrobe to expose the part of the body being examined. In the voice clinic, at minimum, extra jackets and heavy sweaters should be removed to facilitate the screening of spinal alignment. Observe the patient from the anterior, lateral, and posterior views.[11,34]

*Anterior view*

Look for asymmetry including shifting of the head toward one shoulder and slight rotation of the head.[34] The nose should be vertically aligned with the middle of the chin.[26] Observe to see that the sternocleidomastoid muscles are symmetrically placed without having one more prominent than the other.[34] Prominence of one side of the sternocleidomastoid muscle is an indication that the neck is rotated to the opposite side, which puts the side with the prominence in a state of flexion. Also observe for shifting of the torso to one side.[34]

*Lateral view*

Look along the length of the spine for the natural curves described previously. Observe whether any of these curves are exaggerated. Look for a forward head position and hyperextension of the knees.

*Posterior view*

Observe whether the shoulder blades are protruding from the plane of the back.[34] Place your hands on the medial aspect of the shoulder blades. Have the patient raise their arms above the head. Observe whether the shoulder blades remain relatively well anchored in the torso, or if they shift largely out to the sides.

### Laxity screening

As a basic screening for laxity of connective tissue, ask the individual to fully extend both elbow joints. Bilateral extension beyond neutral (0°) suggests generalized laxity of the connective tissue. Bilateral extension of the knees beyond a neutral position is also easily discernible during the postural screen. If unilateral, then a traumatic injury is suspected. Screening for laxity is important in deciding how appropriate it is to include stretching in your exercise prescription.

### When to refer for further assessment

When length-tension imbalances are evident, there are a number of questions you should ask to determine whether further assessment by a physician and/or physical therapist may be warranted.

- History of cervical spinal pain/degeneration and/or surgery
- History of scoliosis/kyphosis
- History of osteoporosis
- History of joints popping out of place, the shoulders in particular
- Does the patient wear bifocals? (There may be manipulation of head position to accommodate the different focal lengths of the lenses.)[21]
- Complaints of dizziness/light-headedness with movement/exercise
- Blurred vision, headache, or nausea with or without vomiting
- Complaints of numbness, tingling, or other altered sensation in the arms or hands

The last three bullet points in particular will be important in your decision making. If simple movements or exercises cause or increase these complaints, patients should be advised to call their physician to discuss further assessment of the cervical spinal region and possible referral to a qualified physical therapist.

## CLINICAL DECISION MAKING—EXERCISE ASSIGNMENTS

Indications regarding patterns of muscle tension and weakness can be determined from the pattern of asymmetries and deviations from the plumb line noted during the postural assessment. One feature common to all three major postural malalignments discussed in Kendall et al[26] is the combination of forward head thrust and rolled forward shoulders, which is referred to as upper crossed syndrome. Given the intimate relationship of the cervical and thoracic spine to the vocal mechanism, we will focus on upper crossed

syndrome as a framework for applying the principles we have discussed thus far.

### Upper crossed syndrome

A combination of high/rolled forward shoulders and neck thrusting is referred to as ''upper crossed syndrome'' (Figure 2). Janda associates this presentation with defensive reflexes mediated by the limbic system.[34] The exercise implications for this presentation are outlined below.

### Rounded shoulders

Individuals who maintain their shoulders in a rounded forward position increase thoracic kyphosis and are likely to have shortening (tightness) in the pectoral region of the chest[28] as well as adaptive shortening of the abdominals. The scapular muscles are likely to be weak as they are being held in a persistent state of stretch.[28,34] The shortening of the pectoral muscles can be predicted to impede the ability of the scapular muscles to reposition the shoulders due to the forward force that will be placed on the scapular muscles from the shortened pectoral muscles.[28] This will impede the ability of an individual to maintain alignment of the shoulder region.

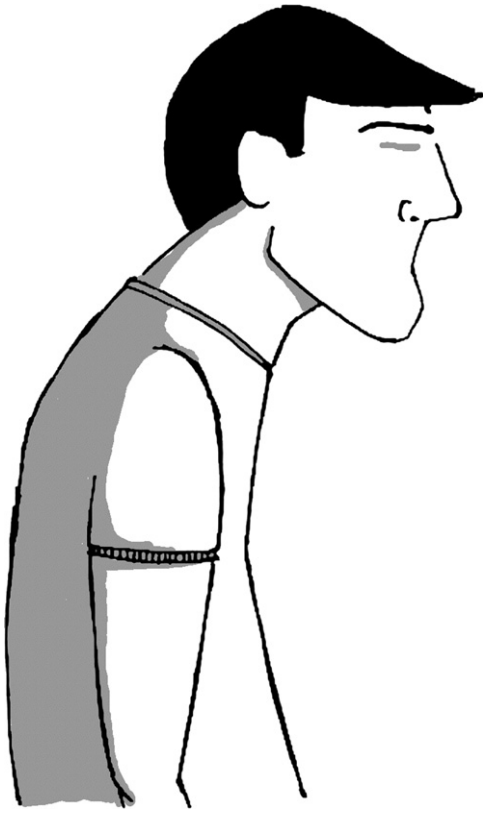

**FIGURE 2.** Upper crossed syndrome.

Normal inspiration requires lateral expansion of the ribs as well as inferior descent of the diaphragm.[6] When we consider the kyphotic posture, both the intercostals and the abdominal muscles assume adapted shortened positions. This directly impacts lung volume for inspiration by restricting both descent of the diaphragm and lateral expansion of the ribs.[6,38] Airflow for voicing is compromised under this condition and may result in vocal fatigue and difficulty in projecting the voice.[6]

A program of stretching for the pectoral region in conjunction with a program of strengthening for the scapular muscle group is most appropriate for a patient demonstrating this pattern of length-tension imbalance.

### Neck thrusting

Individuals who maintain their head in a thrust forward position wherein the ears are forward of the shoulders will likely demonstrate an extension of the head in an upward direction to straighten their gaze.[24] The neck thrusting head posture places the head in a position that projects the eyes to a downward gaze. To facilitate a horizontal gaze, the upper cervical spine must hyperextend to allow the eyes to be positioned for a horizontal gaze. This positioning of the head and neck places the anterior muscles of the neck (both the suprahyoid and the infrahyoid groups) into a state of stretch and places the suboccipitals in a shortened position. This individual will likely have weakness in the muscles of the anterior neck and neck retractors with adaptive shortening of the suboccipital group.[24] One implication for voice production is a change in shape of the pharynx, in the form of narrowing, which can be expected to negatively impact vocal resonance.[6]

A patient with chronic neck thrusting will likely respond best to a program of strengthening for the neck flexors and retractors, in particular, the infrahyoid muscle group to encourage appropriate vertical placement of the larynx, and a stretching program for the suboccipital group.

## SPECIFIC EXERCISES

A few specific exercises for the abovementioned muscle groups are outlined below. These exercises as well as others can be found in *Exercise Pro*, Version 4,[39] as well as other physical therapy resources. Similar exercises were successfully used by McDonnell et al[40] to address the postural malalignment of a patient with cervicogenic headache, which is another physical manifestation of upper crossed syndrome.

### Stretching group

Each stretch should be held for 20 to 30 seconds.

*Suboccipital stretch*

The stretch will occur at the base of the skull.

Have the patient stand against a wall with his or her feet shoulder-width apart and a few inches away from the wall. The patient's back should be flat against the wall. Place a towel roll behind the patient's neck. Have the patient tuck his or her chin while pushing the back of the neck into the towel roll. This may also be performed in a sitting position and clasped hands may be substituted for the towel roll (Figure 3).

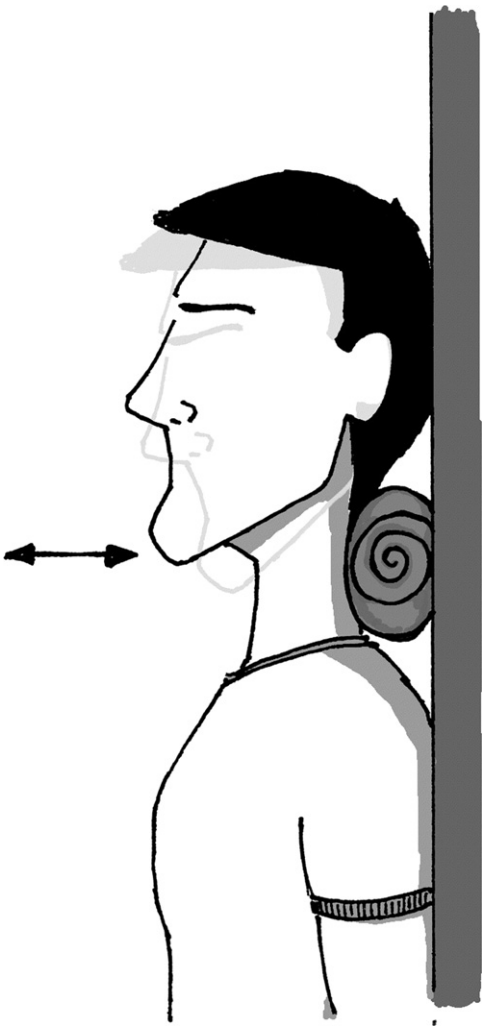

**FIGURE 3.** Suboccipital stretch.

*Pectoral stretch*

The stretch will occur across the front of the chest.

Have the patient place his or her forearms on each side of a doorframe at about chest level or on either side of a corner where two walls meet. The patient would then step forward into the doorframe while squeezing both shoulder blades together. Do not arch the back. This exercise may also be performed unilaterally. Patients with shoulder problems may position the arms lower to avoid muscle impingement (Figure 4).

### Strengthening group

*Neck retractors—upper cervical spine*

Have the patient lie face down on a table with a towel roll under the forehead and his or her arms at the sides. He or she may then tuck the chin while lifting the head off the table, hold 3 to 5 seconds and release. Do not lift the shoulders or chest off the table. This exercise can be advanced by starting in a position where the head is off the edge of the table (Figure 5).

*Infrahyoid group*

Ask the patient to open the lower jaw while resisting the motion with the fisted hand under the chin. Hold for 3 to 5 seconds and release (Figure 6).

*Neck flexors*

With the patient lying on his or her back, ask the patient to lift the head off the pillow by bringing the chin to the chest. Ensure that the chin is not being thrust forward. According to Shaker et al,[41] a similar exercise may strengthen the suprahyoid

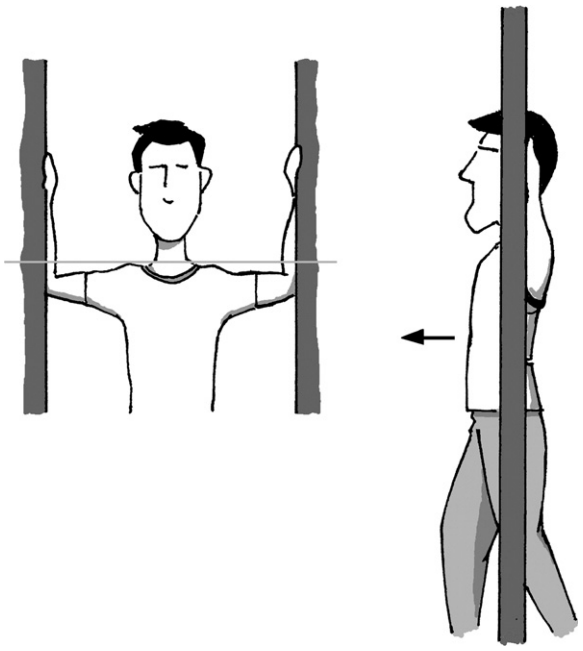

**FIGURE 4.** Pectoral stretch.

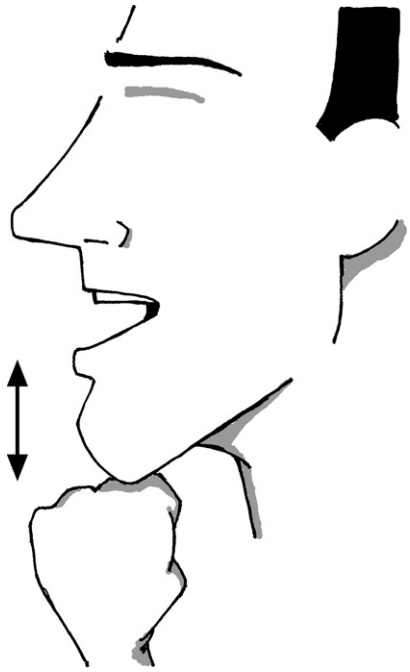

**FIGURE 6.** Infrahyoid strength.

musculature for the purpose of improving the swallow (Figure 7).

*Scapular muscle group*

*Overhead arm raise*. Have the patient lie face down. A rolled towel can be provided to ensure that the patient can breathe properly. Have the patient extend his or her arms, thumb side up, over the head, resting on the table. Contracting from the scapular area, raise the arms up off the table. Hold for 3 to 5 seconds and release (Figure 8).

*Side arm raise*. In the same position as above, have the patient extend his or her arms out to the sides, thumb side up. Have the patient lift the arms off the table by squeezing both shoulder blades together. Hold for 3 to 5 seconds and release (Figure 9).

All of the aforementioned exercises may be progressed by decreasing support of the part, lengthening the lever arm (eg, straightening the elbow or knee), and/or adding weights.

## FREQUENCY/DURATION/RESTING PERIODS

The literature is consistent regarding the most effective duration of stretch. Stretches should be held for 30 seconds each.[16,32] There is inconsistency in

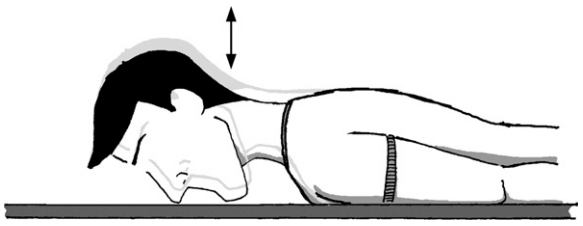

**FIGURE 5.** Neck retractor strength.

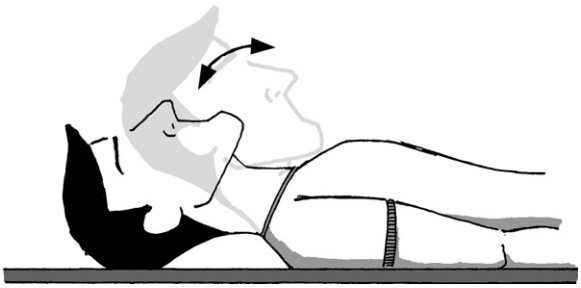

**FIGURE 7.** Neck flexor strength.

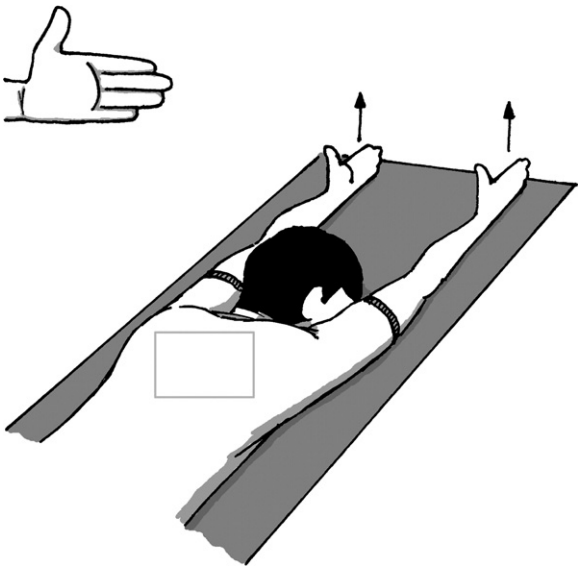

**FIGURE 8.** Overhead arm raise.

the literature regarding optimal frequency of exercise and resting periods. Most exercise programs are performed every other day or four to five times a week. Adequate time must be allowed for recovery from fatigue.[42] When a stretching program is indicated, it should be implemented consistently over many weeks, as gains in flexibility are incremental.[31]

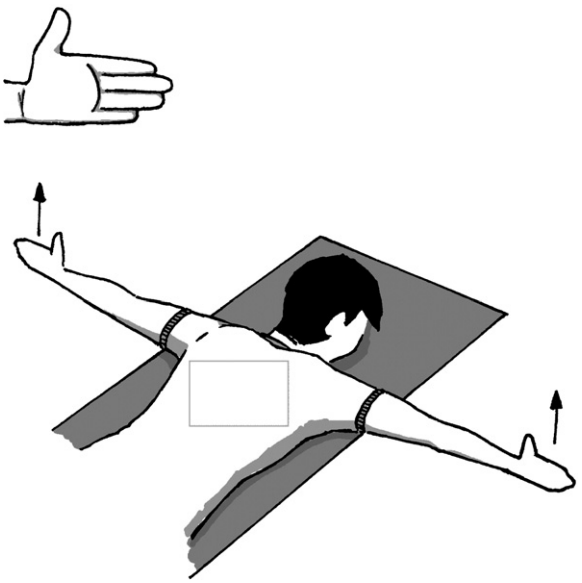

**FIGURE 9.** Side arm raise.

Every patient will be different in terms of the intensity and frequency required to achieve a training effect and certain patients may fatigue more easily than others. Adjust the frequency and duration according to the needs of patients as they demonstrate their capabilities in the treatment room. Whereas the vast majority of voice patients are free of abject neurological compromise, it is likely that the intensity and duration can remain relatively high; however, be alert toward elderly patients and those with underlying medical conditions.

## CONCLUSION

There is a growing understanding of the physiology behind the relationship between body mechanics and voice. This supports the age-old recommendations of voice teachers and therapists to maintain optimal postural alignment. Given the extent to which speech pathologists and voice teachers target interventions to the external framework that supports voice production, it is crucial to increase our knowledge of the length-tension relationships between muscles. It is this understanding that will make it possible for our patients and students to maintain good postural alignment even when we are no longer in the room to guide them.

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