The Importance of Movement Education in the Training of Young Violinists

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Abstract—This paper: (1) explores the role movement training can play in improving playing quality and decreasing musculoskeletal injury in the young violinist, (2) discusses how to recognize and correct postural faults common to the young violin student, and (3) demonstrates the effectiveness of incorporating a specific method of movement and posture training into the treatment of injured musicians. The author describes four years of experience in treating injured violinists with neuromuscular retraining of movement and posture. The author hypothesizes that the incidence of musculoskeletal injury in violinists can be decreased if efficient posture and movement mechanics are taught at an early age either through supplementary education or within violin technique training. The teaching philosophies of four prominent music/movement educators are presented: Emilé Jaques-Dalcroze, Rudolf Laban, John Kendall, and Paul Rolland, whose common goal is to improve the movement quality of the performing artist. Labananalysis and Dalcroze Eurhythmics train awareness of various aspects of movement. Master teachers John Kendall and Paul Rolland emphasize balanced posture and relaxed, efficient movement. Since most music programs do not include such programs, the violin teacher must correct posture and movement mechanics. Effectiveness in this role requires looking at the whole body, not just the arms, hands, and head. A five-component method of retraining posture and movement is presented: (1) relaxation and diaphragm breathing, (2) skeletal balance and movement coordination, (3) centering and stabilization, (4) lengthening, and (5) strengthening. Constructive rest, centered breathing, and imagined-movement exercises based on the teachings of Mable Elsworth Todd and Lulu Sweigard are employed to release tension, correct alignment, and improve movement mechanics. Once tension-free skeletal balance is achieved, the musician is taught to stabilize posture and maintain lengthened tension-free alignment through centering exercises that emphasize proximal control. Strengthening is most successful after the musician internalizes the first four concepts. A two-year outcome study (1996–1998) of musicians with overuse injuries treated at the Northern Arizona University Physical Therapy Clinic utilizing this retraining technique produced the following results: 23 of 45 musicians, including 13 string players, were treated for repetitive stress injuries. All musicians treated for overuse received an average of nine treatments. The musicians returned to their preinjury levels of playing after an average of eight visits. *Med Probl Perform Art* 14:210–219, 1999.

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Several survey studies report a high incidence of upper-extremity injury among professional and student musicians.[1-4] The most commonly reported injury is due to overuse or repetitive stress,[4-7] and violinists are among the most frequently injured.[4,8-10] Despite significant growth in the field of medical care for musicians over the past 15 years, many musicians still do not admit they are injured, for fear of losing their jobs and/or status. It is therefore important that musicians, music teachers, directors, and conductors be cognizant of the fact that most injuries are treatable and many can be prevented. In addition, health professionals must be open to searching for new ways to work with this unique population.

Essential to a violinist's success and longevity is the ability to be at ease with the violin. This is not easy since it is unnatural to support an off-center weight upon the shoulder while coordinating independent, specialized fine movements of the two upper extremities. Playing ability is strongly influenced by how a violinist is "set up" and taught to coordinate these movements. I propose that violinists who learn to balance and support the violin in a manner that maximizes movement efficiency and minimizes tension are less likely to sustain overuse injury. I further propose that a method to accomplish this may be to provide young violin students with supplemental movement classes or movement training.

This paper explores the supposition that movement training can prolong a violinist's career by improving playing quality and preventing overuse injury. It is written from the author's observation, based on the treatment of several injured violinists over the last four years, that movement training is a necessary factor in returning violinists to preinjury levels of performance.

There are many advantages to providing young children with movement experiences. First, young children are kinesthetic learners. They develop a sense of self and the world around them through movement exploration, which heightens creativity and expressiveness. In addition, important musical concepts such as rhythm, dynamics, and phrasing can be learned through specially designed movement exercises. Finally, I propose that children who learn to enjoy movement have better body awareness and are less likely to become locked into static playing postures, which contribute to overuse injury.

Music educators have long been aware of the benefits of movement training. Emile Jaques-Dalcroze introduced move-

ment training to musicians in his book, *Rhythm, Music and Education*, written in 1921.[11] Grace Nash, a leading authority in teaching music to young children, incorporates movement into her teaching via Labananalysis, developed by Rudolf Laban in the 1930s. She states in her book, *Creative Approaches to Child Development with Music, Language and Movement*, "The direct and natural path for the child's understanding of music and musical form, and his development of musicality, muscular coordination and freedom of self-expression, lies in movement. If he moves with the musical phrase, expresses the rhythmic pattern with his body instruments, he consequently feels it and understands it"[12] (p. 80).

I have chosen to present summaries of the teaching philosophies of four prominent music/movement educators whose common goal is to improve the movement quality of the performing artist: Rudolf Laban, Emile Jaques-Dalcroze, John Kendall, and Paul Rolland. Laban is traditionally taught to dancers; Dalcroze trains musicians; and the teachings of Kendall and Rolland are specific to the violinist. My intention is to increase awareness among health care practitioners and music educators of the role movement education can have in preventing and treating musculoskeletal injuries by improving the postural and movement quality of violinists. (The Appendix contains the mailing addresses of institutions supporting these educators' philosophies.)

Finally, common movement and postural faults of the teenaged and young adult violinist are presented, since the responsibility of correcting these faults often falls upon the violin teacher. Correction of these faults through neuromuscular retraining of posture and movement is discussed, and a specific method of retraining is presented.

EMILE JAQUES-DALCROZE

Emile Jaques-Dalcroze (1865–1950) was a pioneer in music education and is well known for his innovative theories. He began teaching music in 1891 after a diverse career as an actor, singer, conductor, poet, composer, pianist, and ethnomusicologist.[13]

Dalcroze based his theories on what he observed as deficiencies in the current trends of music education. He felt that music educators were not holistic in their approach to teaching in that they discouraged interrelationships between musical elements such as form, sight reading, and harmony. Dalcroze also believed that musical training was too intellectual and failed to teach students how to *experience* basic musical elements. According to Dalcroze, this was why certain composition students could not sing the chords they had to write, while others could not perform correct rhythms on their instruments.

These observations led Dalcroze to the realization that sensory and intellectual musical experiences should be fused and presented to the young child before beginning the study of a musical instrument. Dalcroze stated his philosophies and theories in two books: *Rhythm, Music, and Education* (1921) and *Eurhythmics, Art and Education* (1930). Today, most people refer to the Dalcroze method as Eurhythmics; however, it encompasses three areas of study: solfège, improvisation, and Eurhythmics. A course of Dalcroze training includes singing, ear training, harmony, counterpoint, form, music history, movement training, applied music, and participation in vocal and instrumental ensembles.[13]

Dalcroze developed Eurhythmics in Europe in the late nineteenth century. It was introduced in the United States in 1915. Eurhythmics is based on the concept that musical rhythm springs from the natural locomotor rhythms of the human body.[13] Dalcroze believed rhythm to be the animating factor that gives continuity and impetus to sounds. He observed that young children first relate to music via a physical response to rhythm and that the inability to respond physically to music created faults in musical rhythmic expression.[14] In his book, *Dalcroze Today*, Bachmann describes Eurhythmics as mobilization of the mind and body.[11] He states that it transmits through the body, by means of movement, concepts that were acquired only intellectually or technically in the past. In a typical Eurhythmics class, students move freely in bare feet to music improvised on the piano. Individualism and expressiveness are encouraged. The body becomes the musical instrument through which the child experiences and feels musical concepts such as meter, tempo, phrasing, rhythm, and dynamics. The music dictates performance of basic locomotor patterns such as skipping, walking, running, and leaping. By moving to the music as it is heard, children realize the interrelationship between time, space, and energy. They learn, for instance, that the giant step requires more space, energy, and time than the tiptoe step.[11,13,14]

It seems logical that young violinists trained in Eurhythmics would be comfortable in using movement to express musical ideas and feelings and less inhibited in their movement when playing the violin. Ideally, Dalcroze movement training should extend into the teenage years and beyond so that this skill and comfort level are not lost.

RUDOLF LABAN

Hungarian-born Rudolf Laban (1879–1958) was a dancer, choreographer, philosopher, researcher, architect, and theoretician whose creative ideas reformed current concepts of dance and movement. Laban was active in the major European artistic activities of his time, especially modern dance. He strove to make dance more accessible to the layperson and to free it from the constraints of music, drama, and ballet. His first dance school and company were founded on these principles in Munich in 1919. During this time Laban developed his principles of "free" or "absolute" dance whereby "the fundamental means of expression for dance were to be drawn from the rhythm of bodily movement and its spatial and dynamic components."[15]

At the beginning of World War I, Laban sought to unify the varied dance techniques and styles by creating a universal language that could be learned and understood by all dancers. In 1928 he published a method of writing dance scores that he called Kinetography (known as Labanotation or Labananalysis in the United States). This method of notation provided a vocabulary for describing movement qualitatively and quantitatively that is applicable to any body movement. Laban

founded institutes dedicated to the recording of old and new dances as well as the training of dance notators and researchers. During the Bauhaus and Expressionist periods in Germany (1920–1937), Laban developed theatrical and recreational dance programs, schools, and publications. It was during this time that he worked closely with Mary Wigman, his student, and a renowned modern dancer. The following quote by Wigman is found in Vera Maletic's book, *Body–Space–Expression*, "He (Laban) gave to dance a structural foundation analogous to music: the spatial theory of movement and with it a point of departure, a basis for each dance creation"[16] (p. 22).

The three major components of Labanotation are body, space, and effort.[15] The first component relates to the study of body structure and the exploration of the body's many movement possibilities. The second major component is the study of the paths and spatial tensions of the movements available to the body. Movement possibilities are organized with reference to geometric shapes called kinespheres and sequences called space harmony scales. The third component, effort, describes the attitude of the mover in relation to four motion factors—space, weight, time, and flow. Laban describes possible interactions between the mover and these factors via a continuum of qualities defined by opposing pairs of effort elements. Space effort ranges from direct to indirect; weight effort from strong to light; time effort from sudden to sustained; and flow from bound to free. Effort elements do not exist in isolation. Aspects of each combine to form what Laban defines as eight basic effort action drives, which are identified by four contrasting pairs and their modifications: punch/float, glide/slash, dab/wring, and flick/press.[15,16]

Labananalysis is a part of several performing arts programs around the world. It effectively teaches body and movement awareness in a manner that musicians can relate to and grow from.

Two innovative pedagogues have been very influential in the violin world in the past 20 years: John Kendall, who currently teaches the Suzuki method for violin, and Paul Rolland (deceased), who developed his own method of teaching dynamic action in string playing. They are well known for their teaching techniques that emphasize the development of a comfortable, relaxed, and balanced posture while playing the violin.

JOHN KENDALL

John Kendall has been a strong force in the Suzuki method of violin instruction. He has served the Suzuki Association in many capacities and is a well-known clinician at Suzuki Institutes and workshops worldwide. He is presently professor emeritus of string development at Southern Illinois University.

Kendall presents his theories of posture and movement training of young violinists in a videotape produced in 1991.[17] The following three concepts are discussed:

1. *Train the big muscles first.* It is more efficient to use the larger proximal muscles as opposed to the smaller distal muscles of the wrist whenever possible. Kendall advocates teaching the student to move the shoulder to accomplish string crossings. This prevents fatigue of the wrist and allows the elbow to move freely.

2. *Calisthenics for violinists.* Kendall advocates exercises to increase the strength of the shoulder and trunk muscles to avoid what he calls "the compression syndrome." Strengthening exercises are done without weights, and Kendall stresses that they are not body-building exercises. Examples include movements such as swinging, bouncing, and arm circles to loosen up the shoulders and back; small repetitive movements such as arm circles with the arms out to the sides and small bowing motions with the arms extended in front to emphasize proximal stability; and dynamic tension exercises such as pushing and pulling the hands together while circling the arms overhead. Kendall addresses posture via exercises to lengthen the spine, avoid the forward chin, and unlock the joints. He encourages the use of visual cues such as "lift the sternum."

3. *Body movements.* Kendall advocates playing the violin simply and with grace. To do so, the whole body is involved from the floor up. He describes three families of motion: (1) Balanced stillness for intricate movements during which no movement is visible. (2) Pull–pull motion for slow-power bow strokes. He uses the image of the two-man saw to describe this motion. (3) Bilateral or open/close motion for quick bowing to counterbalance the movement of the bow arm and the upper body.[17]

PAUL ROLLAND

Paul Rolland was a professor of violin at the University of Illinois and is well known for his participation in the 1974 University of Illinois String Research Project, the main goal of which was to improve the teaching of basic movements in string playing. He produced 14 videos of groups of children playing the violin at various technical levels and wrote *The Teaching and Action of String Playing*. His writings and videos emphasize balanced, relaxed posture and position, which allow movement to be free. Children are taught to move freely and balance dynamically through rhythmic and movement training. The project embraced the philosophy of Francis Tursi, who stated in his book *Excessive Tension in String Training*, "Because posture is fundamental, we should begin with it. In 1932, it was estimated that two out of three children exhibited faulty body mechanics as a result of their failure to accommodate to erect posture. If posture is poor, breathing, which is so critically important in performance, is certain to be poor also."[18]

A major Rolland teaching concept is "total body action," which he defines as the involvement of the whole player in the act of playing the violin. This includes "the fine, almost undetectable movements of the body which occur when the player is well-balanced and relaxed. . ."[18] (p. 32). Rolland emphasizes that the body must be lightly balanced at all times so that all of its parts are free to move. He warns of "static tensions," which create excessive and unnecessary strain. Such tensions adversely affect natural movement and coordination and interfere with proper breathing mechanics.

The videos produced by the University of Illinois String Research Project present movement exercises and training techniques aimed at achieving the following goals (note the similarity to those of Kendall):

- Smooth, efficient weight transfer.
- Unilateral and bilateral upper body movements to counterbalance bow motion.
- Bow arm balance and release of the weight of the arm through the bow.
- Prevention of body stiffness especially "the freeze of the left shoulder."

Similar to Dalcroze, Rolland believed that the pulse and rhythm of music are essential to the development of good movement quality. His book and videos describe various games and exercises to improve the child's natural sense of rhythm.[18,19] His wide range of videos are listed in the Appendix.

Unfortunately, many strings programs are not able to provide movement education for their students. Posture and movement training thus become the responsibility of the violin teacher. Since established movement habits are difficult to change, it is optimal to recognize and correct postural and movement faults before they lead to poor playing habits and injury. This requires an understanding of what good posture and movement mechanics are, in an awareness of alignment faults common to the violinist, and the ability to teach the violinist to move efficiently. The following two sections define good alignment and describe how to recognize and correct postural faults common to the young violinist.

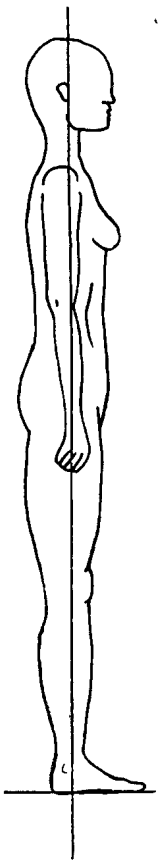

FIGURE 1. Organization of posture around a central axis. When the body is balanced and centered, it is organized close to and around a central axis, which efficiently carries the weight downward.

PROPER POSTURE

Proper alignment is dynamic; it is dependent upon the balance of the skeletal framework and the effort of the muscles to counter gravity. Dr. Lulu E. Sweigard was a pioneer in the areas of posture and movement. In her book, *Human Movement Potential*, she considers posture in terms of the design of the skeletal framework and its ability to conform to the mechanical principles of balance in order to maintain an upright equilibrium.[20] Sweigard further considers standing alignment to be a dynamic phenomenon that is dependent upon muscular force to maintain its equilibrium.[20] Rudolf Laban concurs. He defines posture as "the whole body swaying slightly while 'standing still' in a figure of eight pattern in continuous, subtle fluctuation between stability and mobility to maintain balance"[16] (p. 21).

The trunk, the head, and the extremities (the arms and the legs) make up the skeletal framework. The trunk consists of three units of weight: the shoulder girdle, rib cage, and pelvis. Along with the head, these units are organized around and supported by a central axis, the spinal column. The main part of the spinal column is made up of 24 vertebral bodies (7 cervical, 12 thoracic, 5 lumbar), which stack up to form a long, flexible column of continuous and opposing curves. When the body is well balanced, the spine closely approximates the center axis of the body through which weight falls. The weight of the head, shoulder girdle, and rib cage is transferred to the spinal column and carried downward to the pelvis and then to the legs. Weight transfer through the body is cumulative. It is therefore essential to properly position the pelvis, which is at the base of the spinal column. When the trunk is well balanced, weight flows easily downward through the long, balanced curves of the spinal column. Minimal effort, in the form of muscular work, is needed to maintain balance (Fig. 1).

Babies instinctively understand how to balance as they move through the stages of sitting, crawling, standing, and walking. Humans generally lose this ability as they age and fall into slumped, inefficient postures. This may be due to the enormous task of maintaining the upright posture, misconceptions about proper posture, and/or the adaptation of a sedentary lifestyle. Most people vacillate between two postures, the "strain and the slouch," in an attempt to win the fight against gravity. The former posture has too much tension, the latter not enough. Both postures are inefficient.

The following "balanced posture" images based on Sweigard's "lines-of-movement" are designed to aid visualization of good body posture.[20]

Balanced Alignment

Balanced Sitting Posture

- The pelvis is vertical and balanced on the center of the two rounded bones at its bottom. It is neither tilted forward,

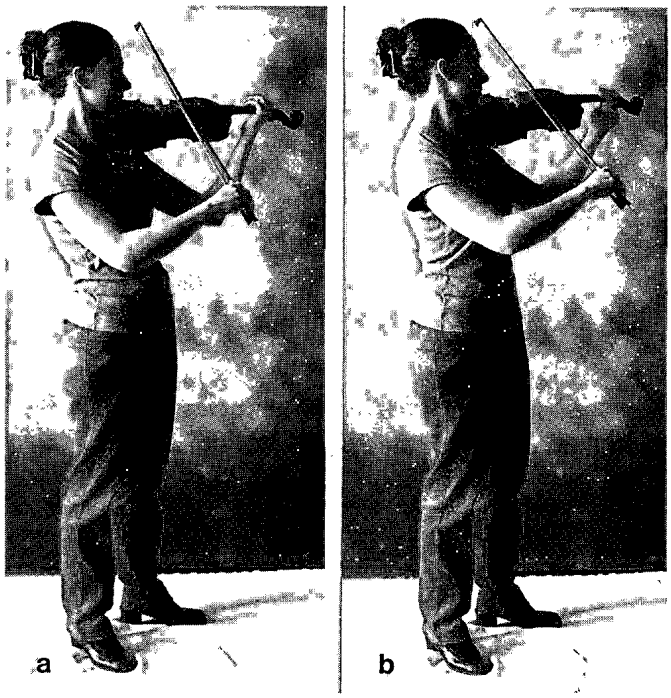

FIGURE 2. Postural faults in violinists. Note the subtle differences between postures a and b. Postural faults present in a: knees are hyperextended, hips are swayed forward, lower back is hollowed out, shoulders are behind pelvis, left elbow is too close to body, and chin is forcibly tucked in to compensate for forward head posture; b: corrected posture.

causing the lower back to sway, nor tilted back, causing the buttocks to tuck under.
- The lumbar curve assumes a forward curve.
- The rib cage hangs down toward the pelvis.
- The shoulder girdle rests on top of the rib cage and the shoulders are relaxed. The chest floats up and the upper body widens.
- To position the head properly, the spinal column lengthens upward through the center of the neck as the head floats up to balance on top of it.

Balanced Standing Posture

- The feet are placed directly under the thigh sockets (about 6 inches apart) with the toes facing approximately straight ahead.
- The knees are relaxed and in line with the thigh and ankle joints.
- The pelvis rests on top of the thighs and is neither pushed forward nor tilted back.
- The trunk is balanced as in the sitting posture.
- The arms hang long at the sides.

Balance, once achieved, must be maintained. This is accomplished via "centering." "Centering" is the ability to maintain equilibrium by balancing the external compressive and internal tensile forces acting upon the body. Irmgard Bartenieff was a dancer and physical therapist who applied Laban's philosophies to her work. She describes "centering" as "being able to connect with the source of one's strength (support) even when in motion so that balance is maintained in all activities"[16] (p. 108). For Bartenieff, as Laban, centering is crucial for the maintenance of dynamic alignment.

The body's anatomical center of gravity is located within the pelvis. Sweigard likens the pelvis to the hub of a wheel. The upper and lower extremities are the spokes of the wheel. The legs are attached directly to the pelvis at the thigh sockets and the arms are attached indirectly to the pelvis through muscle and fascial connective sheaths. Like the hub, the pelvis is the center of control for movement. When stabilized properly, the pelvis initiates and controls movement.[20] Bartenieff states that movement takes on form when it is initiated from the center and its shape is maintained if the central point of reference remains strong.[16] Alignment, which is centered and balanced, allows movement to be realized without overexertion and stress.

POSTURAL FAULTS IN VIOLINISTS

Many biomechanical faults of the upper body are due to improper alignment of the lower body, particularly the pelvis. However, violin teachers often ignore the lower body while focusing correction on upper-body position. The shoulder girdle is the supportive framework for the upper extremities. It must be balanced to ensure fluid, efficient arm movement. Its balance is dependent upon good trunk alignment, which occurs only when the pelvis is positioned properly. Pelvic position, in turn, is influenced by the placement of the legs. Thus, lower-body alignment should always be addressed when correcting upper-body posture and mechanics, e.g., a left elbow that is shoved too far forward may be due to a posteriorly tilted pelvis (hips swayed forward). The following corrections are often necessary to change postural faults common to adolescent and young adult violinists (Fig. 2).

Correction of Standing Posture

- Foot placement: The left foot is turned out slightly so that the toes point in the direction of the scroll instead of pointing straight ahead. Body weight is over the toes instead of the heels to facilitate weight transfer.
- Knee position: The knees are relaxed and flexible instead of locked and rigid.
- Pelvic position: The pelvis (the body's center) hangs under the rib cage and balances on top of the legs. It is stabilized by a lengthened contraction of the abdominal muscles to prevent the most common positional fault of swaying the hips forward.
- Low back: The lumbar spine assumes a slight forward curve when the pelvis is positioned properly. When the pelvis tips forward into an anterior tilt, the lumbar curve becomes exaggerated; when it tips back into a posterior tilt, the curve becomes flattened.
- Chest, upper back, and rib cage: The chest and upper back are open and broad instead of sunken and rounded forward, causing the rib cage, sternum, and clavicle to sink. This should not be achieved by pinching the scapulae together.

- Shoulders: There is width between the shoulders, which are relaxed to allow weight to drop into the elbows. They should not be elevated or pulled forward.
- Scapulae: The scapulae relax downward on the back; their inner borders are neither pulled inward toward the spine nor allowed to migrate too far forward on the rib cage, as often happens with rounded shoulders and a sunken chest.
- Head and heck: The neck is lengthened and the head floats upward to balance on top of the spine, instead of hanging forward.
- The arms: When the pelvis, rib cage and shoulder girdle are relaxed and balanced, weight falls easily from the shoulder girdle to the arms. The elbows are weighted and move freely. The left elbow should not lock into a forward position and the right elbow should not be held too high.

Additional problems occur in sitting. The violinist must position himself or herself properly in respect to the music stand and conductor. In addition, the chair is often uncomfortable and not conducive to good posture. Correct sitting posture is best achieved by sitting forward on the chair instead of depending on the back of the chair for support.

Correction of Sitting Posture

- Chair placement: If possible, the chair should be placed so that the scroll points toward the conductor.
- Foot placement: Feet are placed firmly on the ground, instead of wrapping around the chair legs. Their position should accommodate the placement of the scroll instead of facing straight ahead. The right foot can be positioned behind the left.
- Pelvic position: Pelvic weight is centered on the bottom of the rocker-like ischial tuberosities. The pelvis is not tipped forward or back and the right hip should not be pulled back. Weight should be distributed evenly on both pelvic bones.
- Low back: The lumbar spine maintains its forward curve but is not exaggerated.
- Upper/mid back and rib cage: The thoracic curve is long and supple and not stiffened into a flattened or rounded position. The rib cage hangs down toward the pelvis, instead of thrusting forward.
- Head and neck: The head and neck are balanced and lengthened upward. Straining the head forward to read the music or watch the conductor should be avoided.

NEUROMUSCULAR RETRAINING OF POSTURE AND MOVEMENT

The retraining process developed by the author to accomplish tension-free balanced alignment and movement consists of five elements. The violinist learns to improve body awareness through exercises that begin on the floor and are later applied to sitting, standing, moving, and playing the violin. The quality of movement experienced in the exercises enhances the quality of movement desired in the musician's playing.

1. Relaxation and Diaphragmatic Breathing

Inability of the muscles to relax is a symptom of muscular overuse, often due to faulty posture and poor breathing mechanics. Muscles fatigue as they work to support static postures and off-balance units of weight. The smooth reciprocal action of muscle fibers within a muscle and the synergy of muscles within a functional group are lost. Sweigard states, "The body's response to poor structural alignment, regardless of cause, is to develop patterns of greater muscle activity to cope with the added workload required to maintain equilibrium in an unbalanced structure"[20] (p. 184). Chronic tension results, which adversely affects muscle action and coordination. It most often first presents proximally in the back, neck, and shoulders and, if untreated, eventually moves distally to the arms and hands. When proximal stability fails, the muscles of the forearms and hands tighten and lose their ability to relax as they overwork to stabilize the instrument as well as produce music.

Muscle tension also interferes with proper breathing mechanics. It interferes with diaphragm descent and prevents expansion of the rib cage by decreasing the flexibility of the thoracic spine and ribs. In essence, the breath is held high in the chest, encouraging overuse of the accessory inspiratory muscles of respiration.

Posture, breathing, and movement patterns are difficult to change when the body is tense. For this reason, the process of retraining begins with relaxation exercises. Anatomy-based imagery exercises teach the musician to release tension while in a supine hook-lying position on the floor (Sweigard's constructive rest position) (Fig. 3). The musician is then taught efficient diaphragm breathing through centered breathing exercises that encourage full vertical descent of the diaphragm during inhalation without neck and shoulder tension. During exhalation the musician learns how to engage the deep transversus abdominis (Fig. 3). These muscles are important stabilizers of the spine and trunk during movement and maintenance of static postures.[24,25] Functional training of this muscle is discussed further in the centering section.

2. Skeletal Balance and Movement Coordination

Imagined movement exercises developed by Sweigard and presented in her book, *Human Movement Potential, Its Ideokinetic Facilitation*, are employed to change poor postural and movement habits. Images are correlated with lines-of-movement,[20] which are designed to improve the relative position of skeletal parts and bring them into better alignment. They are based on the premise that the central nervous system subcortically plans the most efficient muscle action to achieve the visualized goal of movement if voluntary movement is not imposed. Overemphasis of volitional muscular action impedes efficient motor learning. It is ineffective to instruct someone to isolate a certain body part or tighten a particular muscle. A more effective approach "directs" the individual to integrate movement patterns through visualization of the desired movement. The nervous system will then take care of "how" the movement is to be accomplished.

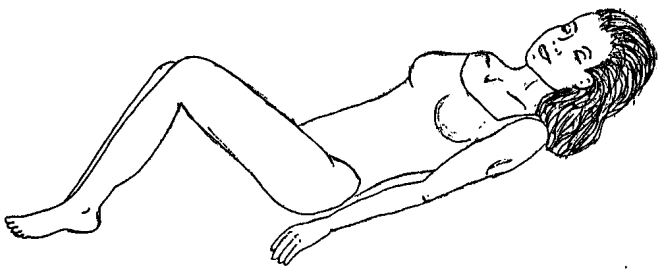

FIGURE 3. Constructive rest position (CRP). CRP is performed on a padded, supportive surface. The head is aligned with the spine. The knees are bent at 90 degrees and aligned with the hips, knees, and ankles. The arms are placed at the sides, on the lower abdomen, across the chest or overhead.

Relaxation Imagery

The back of your body melts into the surface that supports it.
The back of your head melts down.
Droplets of water on the back of your neck drip down.
The area beyond your shoulders melts down. The area between your shoulder blades is jelly-like as it softens down.
The long area behind your rib cage melts down.
The area behind your low back softens down.
The area behind your pelvis broadens and melts down.
Visualize your legs hung by a rod under your knees.
Watch your thigh bones slide deep down into the center of your pelvis.

Breathing Imagery

Notice the rhythmic flow of breath in and out of your body.
Visualize the breath traveling down and up a long central axis through your torso.
Inhale through your nose and watch the breath travel down the long central axis to your pelvis.
Visualize a balloon in your pelvis filling up with air as you inhale.
Exhale through rounded lips and watch the abdominal muscles on the front of your pelvis pull in and up to compress the balloon and send the air back up the long central axis and out the mouth.
Watch the inhalations grow deeper and longer as your abdomen expands.
Watch the exhalations grow longer as your abdominal muscles pull in and up.

This is the basis for Sweigard's *Ideokinetic* facilitation of posture and movement. For instance, to correct head posture, it is more effective to imagine the head floating upward than to tuck the chin and stretch the back of the neck. The latter image creates unnecessary muscular tension that interferes with balanced posture; the former image allows the head position to be achieved with minimal effort, while achieving "lift" through the entire body. Janda states that, "Central motor nervous influence is too often ignored as an integral part of the motor system."[21] He states that balanced muscle coordination is the best way to protect our joints and that good movement habits are dependent upon the functional efficiency of the central nervous system. Janda bases this premise upon many factors: (1) the presence of reflexive mechanisms that control our posture (labyrinthine, tonic neck, and lumbar reflexes), (2) postural and movement patterns common to the painful orthopedic and neurologically impaired patient, and (3) electromyography studies by Belenki et al. (1967) and Bousset and Zattara (1981) that document evidence of anticipatory postural muscle action prior to and during voluntary movement.

Examples of imagined movement used to improve alignment without tension are presented in the descriptions of balanced standing and sitting posture, e.g., the shoulders widen, a string lifts the sternum upward, a string through the top of the head lengthens the head upward, the scapulae hang downward on the rib cage (Fig. 3).

3. Centering

Signe Brunnstrom defines the center of gravity of a body in *Clinical Kinesiology* as "a point about which the mass of the body is equally distributed and if one were to support the body at this point, it would be in equilibrium."[22] She further defines the center of gravity of the human body in erect standing to be "located in the upper sacral region, somewhat above the halfway mark between the soles of the feet and the summit of the head"[22] (p. 274). According to Todd and Sweigard, the pelvis is uniquely positioned because the line of gravity and the center of gravity that it intersects fall within the pelvis.[20,23] This positioning determines the three major functions of the pelvis as related to movement and posture:

- Weight support and weight transfer. The spinal column carries the weight of the trunk, head, and upper extremities to the pelvis, its supportive base. The pelvis then transmits this weight to the lower limbs.
- Movement initiation and movement control. Todd states that organized movement in the body is initiated at the base of the upright column. Attached to the pelvis are 57 muscles that run in every direction, connecting the head, thorax, and upper and lower extremities, to the pelvis.[23] Movement patterns involving the coordination of proximal, distal, and opposing segments from the head to the toes are integrated at the pelvis.
- Stabilization of posture. In order to function properly in the above-stated roles, the pelvis must be stable. This stability is influenced by the many muscles that attach directly or indirectly to the pelvis via fascia (connective tissue sheaths). Of prime importance are the abdominal muscles, which should be functionally trained to maintain pelvic stability and integrate movement. As we age, functional strength of the abdominal muscles declines due to poor posture, deconditioning, and sedentary habits. Common abdominal strengthening exercises that utilize the "crunch" with or without the aid of exercise contraptions do not build functional strength. Rather, they compress the trunk by overengaging the superficial rectus abdominis.[24] The "crunch" creates tension in the upper body, head, neck, and back and encourages a compressed, rounded-shoulder, forward head posture. Properly trained abdominal muscles lengthen the trunk as they support it in a firm cylindrical shape. The transversus abdominis locally stabilizes the lumbar spine,[24,25] while the rectus abdominis, external oblique, and internal oblique muscles maintain their length on the front and sides of the trunk. This action of the abdominal muscles

allows the pelvis to assume a centered, balanced position at the base of the spinal column, which enables it to function effectively in the three aforementioned roles of weight support and weight transfer, movement initiation and control, and posture stabilization. In this manner the abdominal muscles promote balanced, dynamic posture during all functional movements and discourage static holding of the muscles.

4. Lengthening

The concept of lengthening is used in the retraining process to achieve two goals: (1) a "lift" through the body to counter the force of gravity and (2) optimal resting length and length-tension properties of the muscles. Resting length is defined as the length as would occur when the skeleton is well aligned in standing.[20] Length-tension refers to the most effective length at which a muscle can exert tension to contract.[26]

Even when balanced, the skeleton cannot maintain its upright alignment unless the fall of weight through its bones is countered. Todd states that the bones are compression members that carry weight downward in accordance with the law of gravity and that this weight fall is countered by the upward tensile force provided by the muscles.[23] As already discussed, the abdominal muscles are of prime importance in this role. Images to optimize a "lift" through the body include: the head floats up to position itself on top of the spine, the chest floats up, and the abdominal muscles lengthen the front of the body. Images must be carefully chosen so as not to create muscular tension. Words such as tighten and hold should be avoided (Fig. 4).

When the skeleton is balanced and stabilized, muscle function is most efficient, as the muscles acting upon and supporting the joints are balanced and resting at their most optimal length. Resting length and the length-tension properties of the muscles are adversely affected when the muscles struggle to support a poorly aligned skeleton. In several papers written between 1969 and 1974, Janda states that muscle dysfunction plays an important role in the development of painful conditions resulting from postural defects. He points out that certain muscles develop tightness in the presence of postural defects, e.g., the abdominal and the gluteal muscles, whereas other muscles weaken, e.g., the spinal erectors and the hamstrings.[21] In their text, *Muscles, Testing and Function*, Kendall and McCreary state "Muscle weakness or shortness may cause faulty alignment, and faulty alignment may give rise to *stretch-weakness* or *adaptive shortening* of muscles. For example, weakness of the muscles that hold the scapulae toward the rib cage and spine may cause the shoulders to round forward and the pectoral muscles of the chest to tighten.[27] Janda states that clinical experience supports Sherrington's laws of reciprocal innervation that "tight muscles act in an inhibitory way on their antagonists"[21] (p. 32). He thus concludes that it is better to stretch tight muscles before strengthening weak muscles and that it is not uncommon for inhibited weak muscles to regain strength after their antagonists are stretched.[21] Sahrmann states that tight muscles pull the bones they are attached to into faulty alignment. Releasing the tight muscle corrects this alignment and restores a more efficient resting position of the antagonistic muscle, allowing it to contract more efficiently.[28] Good muscle function cannot be restored until the bones are properly aligned and the muscles are in their most efficient resting length. Thus, strength training is not begun until this is achieved.

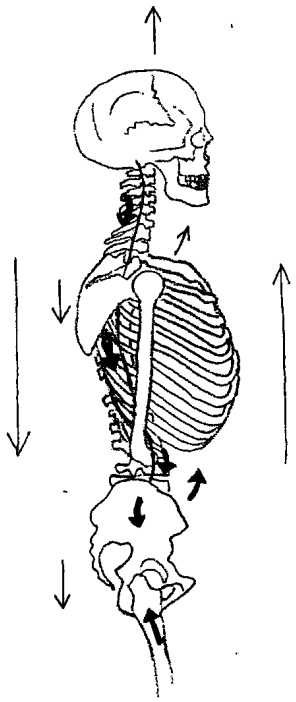

FIGURE 4. The balance of compressive and tensile forces. When the head and the units of weight of the trunk are balanced, the downward flow of weight through the skeleton is balanced by upward tensile forces: The femur thrusts upward into the acetabulum; the abdominal wall lifts the front of the body; the sternum floats upward; a string lifts the top of the head upward.

5. Strengthening

Movement patterns are smoother, stronger, and more energy-efficient when the body is well aligned and centered and muscle tone is balanced. Thus, strengthening is most effectively implemented once the violinist has internalized the four concepts discussed above: relaxation, centering, lengthening, and balance. Increasing muscle strength through traditional conditioning does not necessarily decrease painful symptoms or improve playing endurance and quality. In addition, musicians often mistrust traditional strengthening exercises for fear they will adversely affect technique and artistic expression. An effective strengthening program is sensitive to the needs of the performing artist. It addresses the musician's posture and movement mechanics and helps the violinist develop the type of strength and endurance needed for extended violin playing. It must be kept in mind that movement and postural patterns practiced during exercise transfer to violin playing. Thus, the manner in which the violinist performs the exercises is extremely important. If body mechanics are faulty, they must be corrected. This can be accomplished only by addressing the central nervous system, which controls and coordinates posture

and movement. Movement, weight, and body position are perceived from within via the proprioceptive system of the nervous system, which is responsible for three different types of sensations. Movement sense or "kinesthesia" comes from the muscles and bones; positional sense is derived from the labyrinthine system of the inner ear; and visceral sensations are perceived through the internal organs. Todd states, "The ability to improve a pattern of support and movement for the reduction of mechanical stresses comes, not through the development of bulk and power in individual muscles, but from the study and appreciation of the human body as a weight-bearing and weight-moving structure"[23] (p. 33). Thus, the primary goal of strength training should be reeducation of the neuromuscular system Balanced alignment and proximal strength, stability, and control should be emphasized to encourage the development of integrated movement patterns that allow the violinist to move with fluidity and ease. Once these concepts are understood, strengthening can proceed in a manner that improves movement function without increasing tension.

EFFECTIVENESS OF TREATMENT

The effectiveness of the five-component neuromuscular retraining program was investigated via a two-year outcomes study of musicians treated for repetitive stress injuries. Forty-five injured musicians were treated by the author at the Northern Arizona University Physical Therapy Clinic from 1996 to 1998. Of those, 23 (51%) were treated for overuse injuries. Musicians whose injuries were complicated by the following factors were not included in this study: focal dystonic symptoms, symptoms primarily due to psychological issues, and symptoms of many years' duration previously treated via several interventions. Seventeen patients were female, and six were male. Instruments included: strings (n = 13), woodwinds (n = 6), brass (n = 2), and keyboard (n = 2). Musicians were treated for an average of nine visits. The number of total visits varied according to age. Those aged 12–24 years were treated an average of five times and those aged 27–44 years were treated an average of 15 times. All musicians, regardless of age, returned to their preinjury levels of playing within five to eight visits. They were not all symptom-free; however, all could manage their symptoms through strategies learned in physical therapy.

CONCLUSION

The majority of injuries sustained by violinists can be classified as repetitive stress injuries of the musculoskeletal system, a primary cause of which is improper posture and poor movement mechanics. Young adult and teenaged violinists are especially prone to overuse injuries when increasing their playing time and intensity after entering a strings university or conservatory program. I have proposed that many injuries among this population can be prevented by training young musicians to have correct body mechanics via supplemental movement education and/or movement training integrated into violin technique lessons. Ideally, movement education should begin before children begin to play an instrument. It should then continue, to some degree, throughout their musical training. It is especially important that children be accustomed to movement before they enter the typically insecure preteen years when awkward habits become ingrained. I also propose that music teachers learn how to address postural and movement faults before they lead to injury. Finally, since the central nervous system controls and coordinates postural and movement mechanics, treatment protocol of injured musicians must include neuromuscular retraining to be effective.

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APPENDIX
Institutional Addresses and Rolland Videos

Dalcroze School of Music
139 West 67th Street
New York, NY 10023

Laban/Bartenieff Institute
11 East 4th Street
New York, NY 10003

Suzuki Association of America (John Kendall)
1900 Folsom, #101
Boulder, CO 80302

Rolland String Research Associates
404 East Oregon Street
Urbana, IL 61801

Roland videos: *Young Violinists in Action, Principles of Movement in String Playing, Rhythm Training, Establishing the Violin Hold, Holding the Violin Bow and Violin Playing at the Middle of the Bow, Principles of Left Hand Finger Action, Establishing Left Hand and Finger Placement, Extending the Bow Stroke, Developing Finger Movement and Basic Shifting Movements, Bouncing the Bow and Martelé, Developing Flexibility, First Steps in Vibrato Teaching, Sustained and Detache Bowing,* and *Remedial Teaching.*

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