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Practical issues in musculoskeletal function, treatment and rehabilitation

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Certified Pilates and GYROTONIC® Trainer

D. M. Duschatko

Introduction

Based on the case history, the symptoms Molly is presenting with could indicate the presence of several possible conditions. The most likely scenario is that Molly originally suffered a strain to a rotator cuff muscle while playing softball. The original injury was left untreated and now Molly has lost range of motion (ROM) in her shoulder in most directions and primarily in movements that include external rotation and abduction of the arm indicating she is now suffering from frozen shoulder.

Frozen shoulder is a common condition that is frequently misunderstood. Numerous possible causes of frozen shoulder are mentioned in the literature. Although the cause of frozen shoulder remains under debate, it is generally accepted that an individual suffering from this condition will report pain during the initial stages followed by a gradual decrease in ROM until the joint is virtually immobile or 'frozen.' The protocol for treating frozen shoulder is varied and management of this condition becomes difficult because the patient often does not seek medical attention until the shoulder ROM has deteriorated to the point of disability. Traditional treatment plans usually encompass passive/active ROM exercises, heat, ice, massage, ultrasound and electric stimulation. In severe cases, manipulation of the joint under anesthesia may be recommended. Another effective method for treating frozen shoulder includes using a structured movement system in which functional articulation of the joints is enhanced and neuromuscular re-education improved through kinetic sequencing of the entire body.

It is my belief, as a movement coach, that when treating any shoulder dysfunction it is vital for the practitioner to address the problem locally at the shoulder as well as correct any postural, strength or mobility problems that originate in the trunk. This is due to the fact that the shoulder is closely integrated with the trunk through the muscular system. My approach to treating clients presenting with frozen shoulder is to address not only the obvious limitation in range of motion at the shoulder but to also facilitate integrated movement of the shoulder with the entire body. This will serve to correct habitually faulty movement patterns that may have been a contributing factor in the original injury that precipitated the onset of the frozen shoulder. Approaching treatment in this manner will allow the immediate problem to be addressed more effectively while making long-term corrections that will reduce the possibility of future complaints or injury. Again, this treatment approach is most successfully accomplished using a structured movement system.

Gyrotonic Expansion System®: a structured movement system

One system, in particular, that focuses on integrated movement of the entire body is the Gyrotonic Expansion System (GXS)®. This system is the creation of Juliu Horvath, a former Romanian Ballet Dancer who became interested in yoga and the study of movement while rehabilitating a knee injury. GXS® employs a unique array of multi-dimensional exercises that are circular in motion and span multiple joints.

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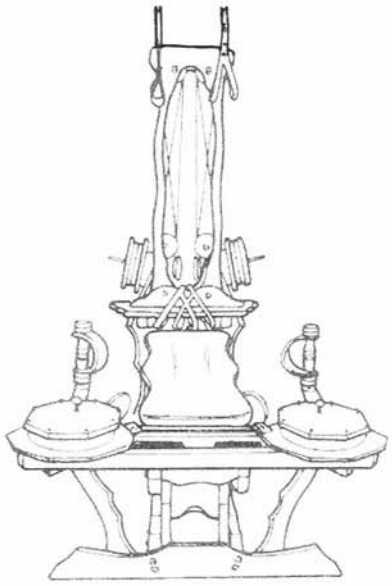

Fig. 1 GXS combination tower/handle unit.

The exercises are performed on custom designed pieces of equipment with the most popular piece being the Combination Tower/ Handle Unit (Fig. 1). The Handle portion of this machine consists of two handles that are independent of one another and move in a circular fashion to facilitate the rotational capabilities at the shoulder, hip and spine along with simultaneous articulation of each vertebra. The Tower portion of the unit consists of a pulley suspension system with a weight stack. There are two sets of pulleys with one set located high on the tower and the other at the base of the tower allowing for more ranges of movement. Each pulley is independent of the other so that the right and left sides can work independently of one another. Although weight resistance is used in many of the exercises, the weight stack primarily functions to counter balance and suspend the weight of the limbs to allow for movement that facilitates neuromuscular re-education and enhances kinesthetic awareness. This is significant because '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. Kinesthesia, the feeling of movement and of weight, is the important source of our information. Through it we are able to bring about a better balancing of parts, and thus coordination of the whole.' (Todd 1997).

Utilizing principles of movement from swimming, gymnastics, ballet and yoga the GXS® system easily allows the individual to simultaneously stretch and strengthen the musculature while mobilizing and stimulating the joints. The exercises within the GXS® system are designed to incorporate the entire body, including the breath, to build true functional strength as well as influencing central nervous system. The exercises are taught in progressions to accommodate people at all levels of ability. The Combination Tower/ Handle Unit is fully adjustable with variable resistance allowing for easy modification of the exercises for the individual who is rehabilitating from an injury.

Structured movement systems such as GXS® are beneficial within the rehabilitation setting because they promote stimulation of the affected area while maintaining a complete relationship to the body as a whole. Other forms of structured movement programs popular today include Pilates-based Systems and Feldenkrais®, which along with GXS® are becoming increasingly more visible in physical therapy clinics and sports medicine facilities.

Anatomical considerations

Shoulder region

The shoulder is a unique and complex region of the body that demands attention. It is our arms and shoulders that we depend on not only for sporting activities such as baseball, swimming, gymnastics and tennis but also for performing vital daily activities that necessitate motions of the upper extremity that include reaching, pulling, pushing, lifting and carrying. The shoulder is designed to accommodate our need for both mobility and power.

Examining the shoulder complex, we find a bony structure with little restriction. Mobility is possible due to the 'free floating' nature of the shoulder girdle and the loose construction of the shoulder joint. The shoulder girdle serves as support for the arms (Todd 1997) and is comprised of the clavicle and the scapula, connected only by means of the acromio-clavicular joint which is fairly immobile and moves in relation to the scapula. The shoulder girdle hangs loosely on top of the thoracic rib cage with its closest connection to the trunk being at the sternum via the sterno-clavicular joint. The shoulder joint, also referred to as the gleno-humeral joint, is formed by the articulation of the humerus with the shallow surface of the glenoid fossa of the scapula and is loosely bound together by ligaments. The minimal bony connections present in both the shoulder girdle and the gleno-humeral joint and the lack of ligamentous support makes these structures rather unstable in and of themselves but contributes greatly to enhance the mobility capabilities of the arm at the shoulder.

Mobility coupled with a desire for power leads to an increased need to focus on stability. Stability is important for optimal contraction of a muscle. If stabilization is not present, both ends of a muscle will produce movement decreasing the effectiveness of the movement. When one end of the muscle is stabilized this allows the power of the contraction to be focused on the

moving lever and fewer motor units are required to be recruited to perform the desired movement and thereby making the movement easier and more efficient (Fitt 1996). Due to the lack of skeletal stability in the shoulder it then becomes the responsibility of the surrounding shoulder musculature to provide the stability necessary for the arm to function optimally. Within the gleno-humeral joint, it is the small rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis) that function to hold the head of the humerus into the shallow surface of the glenoid fossa especially when the arm is acted upon by the larger muscles primarily responsible for movement. Because all the rotator cuff muscles span from the surface of the scapula to the head of the humerus it is vital for the scapula to be dynamically stabilized during certain movements to avoid injury of the rotator cuff and provide conditions for optimal leverage. As Wirhed (1995) states, 'in order to move the arm with sufficient force, the articular surfaces of the shoulder blade must be positioned in such a way that the arm has an optimal starting point for its movement.'

The muscles that have the most influence upon dynamic stabilization of the scapula are the serratus anterior and trapezius. The most significant of these muscles is the serratus anterior which has broad attachments on the lateral border of the first eight or nine ribs and the anterior medial border of the scapula. Functions of the serratus anterior include fixation of the scapula as well as abduction and upward rotation of the scapula (Calais-Germain 1993). The trapezius attaches vertically along the spine from the occiput to the twelfth thoracic vertebrae and laterally along the spine of the scapula to the acromion. Depending on which fibers of the trapezius muscle are activated in any given movement, the trapezius muscle may function to elevate, depress, adduct or upwardly rotate the scapula. It is the continual balance between the serratus anterior and trapezius that controls the position of the scapula and allows release of the larger muscles so that they may move the arm efficiently and powerfully. This is especially true in situations that require stabilization of the scapula such as with push-ups. Stabilization of the scapula occurs as a result of the simultaneous contraction of the middle trapezius and the serratus anterior which function in opposition to one another in the movements of adduction and abduction respectively (Calais-Germain 1993).

Two of the primary muscles responsible for movement of the arm, due to their attachments on the humeral shaft, are the latissimus dorsi and the pectoralis major. The latissimus dorsi attaches to the spinous processes of T7–T12 covering the entire lower back under the trapezius while the lower fibers blend with the thoracolumbar fascia. The pectoralis major spans the front of the chest wall from the clavicle and the sternum with the lower fibers interdigitating with the upper fibers of the rectus abdominus muscle (Todd 1997). Because the larger muscles of the shoulder, trapezius and latissimus dorsi on the posterior and the serratus anterior and pectoralis major on the anterior, attach to nearly every bone in the trunk (Todd 1997) it is important to address the issue of trunk stability and mobility in the presence of frozen shoulder.

Pelvic/lower back region

In my experience, individuals presenting with frozen shoulder will often lack dynamic stability in the deep pelvic and lower back muscles and exhibit varying degrees of kyphosis/hypomobility in the thoracic spine. According to Todd (1997), 'motions of the body as a whole are mainly controlled by the lumbar and deep pelvic muscles.' Therefore, in order to increase functional movement in the shoulder it is important to also gain stability in the lumbo-pelvic region. Stability in this area is initiated by the activation of the deep transversus abdominis muscle. The transversus abdominis runs horizontally around the lower abdominal region with a connection to the spine via the thoracolumbar fascia (Todd 1997). The deep transversus abdominis muscle when engaged along with the internal obliques has been shown to activate the deep multifidi muscles of the back leading to increased dynamic stability in the lumbar region (O'Sullivan 1998). Because of the connection of the transversus abdominis with thoracolumbar fascia and the connection of the latissimus dorsi with the thoracolumbar fascia it becomes clear that activation of the transversus abdominis will help stabilize the lower fibers of the latissimus dorsi thereby increasing power it can exert at the arm. Again, this is because when one end of the muscle is stabilized the power of the contraction is focused on the moving lever increasing the efficiency and power of movement.

Thoracic region

It is also common to find that in many cases of frozen shoulder that the influence of thoracic kyphosis bears significantly in the problem due to the abnormal function of the shoulder that results. As described by Hartley (1995), when excessive thoracic kyphosis is present 'the rhomboids and the lower trapezius muscles lengthen while the internal

rotators and serratus anterior muscles shorten. The humerus internally rotates, which can lead to anterior capsule and glenohumeral adaptive shortening or even adhesions.' The adaptive muscle shortening of the serratus anterior and muscle lengthening of the trapezius inhibits the stabilizing function of these muscles on the shoulder girdle. This lack of stabilization at the shoulder girdle will increase the stress on the rotator cuff muscles and will reduce the efficiency of the latissimus dorsi and pectoralis major as these muscles try to compensate for the stabilization lacking as a result of the dysfunctional trapezius and serratus anterior muscles. The resulting joint dysfunction can lead to injury of the shoulder and possibly frozen shoulder.

Treatment

In treating frozen shoulder our primary goal is to restore ROM to the affected shoulder. Due to the intricate connection of the shoulder with the trunk it is important to choose a treatment plan that not only includes direct mobilization of the shoulder but also allows for mobilization of the shoulder in conjunction with the trunk while stabilizing the lumbo-pelvic region. This integrated process of movement will promote functional patterning of the scapula in relation to the trunk that is important not only immediately in rehabilitating the patient's shoulder but also in correcting pre-existing faulty movement patterns that may have been a contributing factor in the original injury. This is significant in Molly's case because the patient originally injured her rotator cuff while throwing a ball which requires muscle groups to activate in a kinetic order beginning with the abdomen, then the shoulder, elbow and wrist (Wirhed 1995).

In the initial stages of the rehabilitation process it is advisable to re-educate the neuromuscular system by having the patient perform motions of the shoulder, integrated with trunk control, which are new and unfamiliar to them. Doing this will reduce holding patterns and increase the likelihood of being able to break faulty habitual patterns so as to allow for more functional patterning. This objective can be accomplished using various mediums such as foam rollers, slide boards and structured movement systems. Foam rollers can be used to re-establish functional scapular patterning both independently of the trunk and in relation to the trunk. Slide boards can be adapted to allow for a variety of arm and scapular movements effective in re-educating the neuromuscular system. If access to a structured movement system such as GXS® or a Pilates-based system is available, these systems are extremely conducive to re-educating an individual's neuromuscular system using unfamiliar movement patterns while promoting trunk control.

Using the GXS® system, the first and most basic exercise effective in integrating the entire body is the Arch and Curl (Figs 2A–C). This is the baseline exercise from which many others are built. The basic Arch and Curl exercise focuses on segmental mobility of the spine in flexion/extension while dynamically stabilizing the trunk through activation of the transversus abdominis and the deep pelvic musculature. In addition, the movements of the legs and arms in concert with the Arch and Curl of the spine facilitates articulation and expansion of the hips and shoulder. Throughout the exercise, the movements of the arms and legs are continually and subtlely changing in conjunction with the position of the trunk. Generally, however, during the arch (extension) portion of the movement, abducting the legs to a wide 'V' position while trying to lengthen and externally rotate the femurs will increase space around the hip socket and allow for more freedom through the pelvis. During this phase expansion through the shoulders is facilitated through abduction and external rotation of the humerus while the scapula is depressed and downwardly rotated. As the transition is made between the arch and the curl phases of the movement, the legs will move somewhat into a position of adduction and internal rotation at the femur facilitating a hip position most appropriate with the curling action of the pelvis. The scapula will shift to a position of protraction and upward rotation as the arms internally rotate and horizontally adduct. Through full range of the exercise the shoulder moves through some aspect of internal and external rotation, abduction, adduction and flexion and extension not independently of one another but in sequence with the movement of the spine. For example, with extension of the thoracic spine the natural rhythm of the shoulder complex is for the scapula to depress and downwardly rotate while the arm will externally rotate and extend. The opposite occurs with flexion of the thoracic spine. It is this rhythmic patterning of movement between the trunk and extremities that not only encourages mobilization of the affected joint but also begins the neural re-education process of the entire body.

The Arch and Curl can be modified to the specific needs of any individual allowing for movement in smaller ranges of motion, if necessary, as well as focus on areas of restriction proximal/distal to the sight of the problem. For someone in the initial stages of frozen shoulder it would be impossible to complete this exercise as intended. If

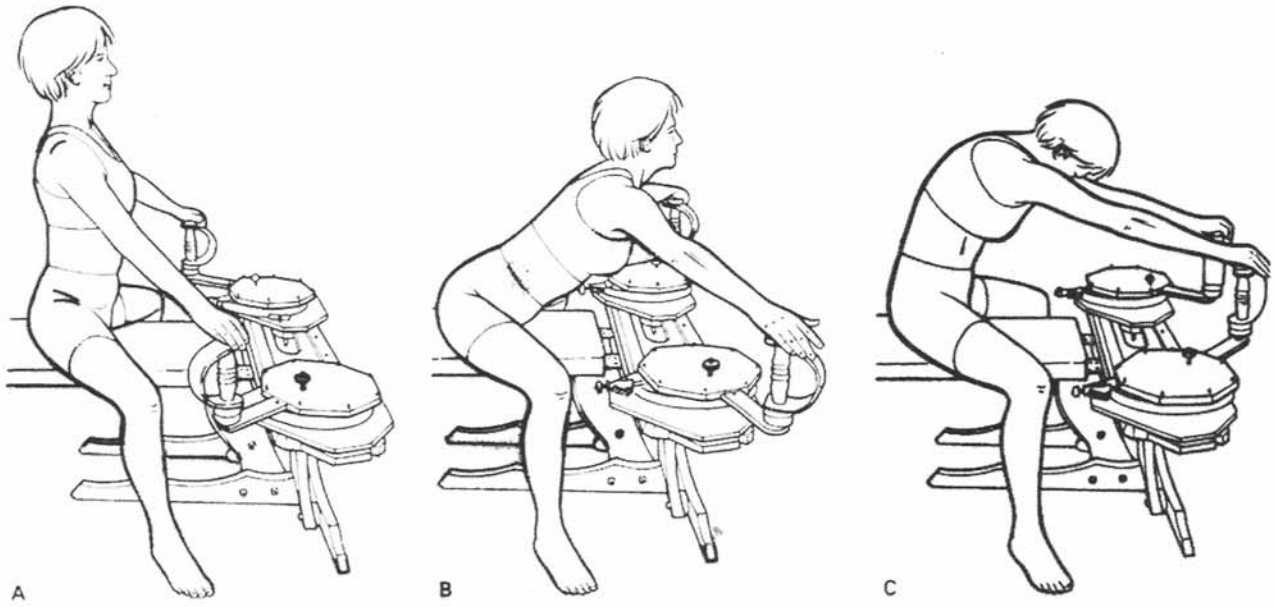

Fig. 2 (A–C) Arch and Curl exercise performed on the GXS handle unit.

Fig. 3 Figure eight exercise performed on GXS handle unit. It is the next exercise in the GXS exercise progression after the Arch and Curl and focuses on the rotational component of the spine.

the patient with frozen shoulder is initially unable to produce significant gleno-humeral and/or scapulo-thoracic movement in the early stages of rehabilitation the patient can still make progress by concentrating on achieving functional mobility throughout the spine. Specific attention to the thoracic region is often helpful due to the postural influences the thoracic spine has on the position of the arm and scapula as mentioned above.

As the patient begins to gain more functional mobility and stabilization of the trunk, the Arch and Curl can be progressed to incorporate more arm activity. Later rotational components of the spine may be added (Fig. 3) and then progressed to rotational movements in conjunction with flexion/extension to increase the neural challenges of the body. For those who do not have access to this equipment, the Arch and Curl can be modified without equipment. One way of doing this is to have the patient seated on a stable surface with a Swiss Ball in front of them. The patient should be seated in a tall upright posture with a comfortable amount of extension evenly throughout the spine. Legs should be in a wide, open stance increasing the stability of the lumbar spine and facilitating mobilization of the hips. Have the person rest the affected limb on the ball and move between extension (as they move forward) and flexion (as they move backwards) of the spine, always initiating the movement from the pelvis so as to activate the deep transversus abdominis first (Figs 4A and B). To include mobilization of the shoulder, the arm can participate in the movement pattern by moving back and forth on the ball in conjunction with flexion/extension of the spine. In the early stages, if this is not possible simply have the patient rest the arm on the ball in a comfortable position and focus on spinal mobilization. Again, as the patient progresses, the exercise can be enhanced to include rotation of the spine and circular motions of the arm (Figs 5A–C).

There are many leg exercises that can be performed without participation of the shoulder and are still very effective to the overall rehabilitation process of someone suffering from a shoulder problem. These exercises focus on increasing the mobility of the hip joints while stimulating the movement of energy through the entire body. Although these exercises focus on hip mobilization they will still have a direct impact on the shoulder.

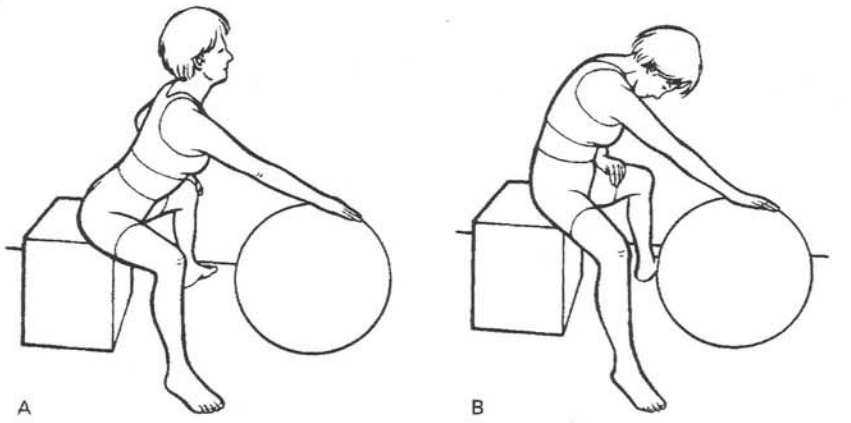

Fig. 4 (A&B) Extension/flexion of the spine with arm mobilization on the Swiss Ball. This exercise simulates the Arch and Curl off equipment.

Increasing mobility of the hip joints will ease tension of the hip flexors which will create ease in the pelvic/lumbar region allowing for increased ability to activate deep pelvic musculature and create dynamic trunk stability. This increase in dynamic trunk stability will in turn effect the shoulder through more efficient use of the musculature.

Prognosis

Just as the cause of frozen shoulder is under constant debate so is the prognosis for recovery. The condition is unique to every individual and no form of treatment is guaranteed to eliminate the problem immediately. Many medical professionals believe it is a self-limiting condition with a recovery period lasting anywhere from 6–9 months up to several years. It is difficult to determine exactly how each individual will respond to a specific treatment protocol due to the large number of variables that can influence the recovery process. Such variables might include how advanced the condition was before the patient sought out treatment, the underlying problem that precipitated the onset of the frozen shoulder, the type of daily activities the patient is involved in (i.e. work, household chores, carrying children) and the emotional stresses in the individual's life. Although it is difficult to determine what the recovery period will be for each individual it is important to encourage continual movement at the shoulder to stimulate healing and prevent worsening of the condition that could lead to permanent loss of motion.

In Molly's case, it has been 6 weeks since the initial onset of pain in her shoulder. She is presently complaining of pain, discomfort and decreased ROM in her shoulder which is limiting her ability to perform daily activities requiring movement of her arm above her shoulder and prohibiting her from playing softball which is important part of her social life. As a result of the increased pain Molly is experiencing she is now protecting the shoulder by further limiting movement. Because it has been 6 weeks since Molly's injury and the shoulder has begun to seize up, getting significant ROM back at this stage may be difficult. In treating Molly my first concern would be to reduce the muscle guarding at the shoulder through increased awareness of how she is holding and moving her shoulder. This can be accomplished manually or through using a structured movement system that promotes assisted movement of

Fig. 5 (A–C) Stirring exercise on the Swiss Ball which incorporates extension/flexion and rotation of the spine while integrating arm movement.

the joint with stabilization. Stabilization of a joint is often a problem when a person is experiencing pain and in many cases a contributing factor as to why the person is experiencing pain. Reducing the amount of muscle guarding will help to decrease the pain and increase the desire to move the joint, thereby preventing further irritation to the shoulder joint.

Continuing Molly's rehabilitation using a structured movement system we can expect a continued increase in ROM at the shoulder while increasing the mobility and stabilization of Molly's trunk and spine. Increasing the overall strength and mobility of the trunk will allow for greater ease in overall movement and decrease postural stresses that are contributing to the problem at the shoulder. Although Molly does not complain of pain in her shoulder while working at the computer it is important to address the postural influences of this type of work. Sitting at the computer for long periods of time keeps the trunk and shoulder in a static position and can create further holding at the joint. This type of work also encourages a rounded forward posture in the thoracic spine and shoulders increasing stress to the upper extremity. Therefore, decreasing the postural stresses in the trunk and spine can help reduce the muscle guarding occurring at the shoulder. As muscle guarding decreases, pain will diminish and achieving desired ROM will be easier. Treatment will be continued until sufficient ROM has been achieved and the individual can return to desired activities.

Conclusion

In conclusion, structured movement systems are very beneficial in the rehabilitation process of frozen shoulder. Versatility allows for mobilization at the site of dysfunction while integrating the entire body. This integrated movement structure increases kinesthetic awareness leading to more effective rehabilitation of injury and improved functional movement and thereby decreasing the likelihood of future injury.

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