Biceps Brachii Tendon Rupture

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The following case study will discuss the processes involved in the event of a rupture of the biceps brachii tendon on both a macro and micro scale. That is, both the physiological and functional factors involved in the pathology will be discussed from a kinesiological perspective.

Biceps brachii musculo-tendinous complex

***Proximal attachment*: *Long head* - Supra-glenoid tubercle. *Short head* - Coracoid process of the scapular.
***Distal attachment*:** Radial tuberosity and bicipital aponeurosis.
***Actions*:** Flex forearm when supinated, assist shoulder in flexion, supinates forearm and long head tendon helps maintain the positioning of humeral head in the glenoid cavity.
***Innervation*:** Musculocutaneous nerve C5, C6

Case presented

A 35 year-old male baseball pitcher, who competes socially and trains once a week, presented with excruciating pain in the left brachium. This was associated with a bulging lump located in the upper arm (distal to the site usually occupied by the belly of biceps brachii muscle) becoming accentuated upon resisted elbow flexion. The patient was also apprehensive about fast movements with the arm suggesting shoulder instability and/or weakness.

The patient also complains of ongoing aching pain radiating from the shoulder distally to the anterior surface of the elbow. The patient's shoulder range of motion was somewhat reduced, probably due to associated inflammatory processes. Strength during elbow flexion in an isometric fashion (muscle contraction without movement of the associated joint/s), was only marginally reduced when compared bi-laterally. Due most likely to the brachialis, brachioradialis and forearm flexor muscles compensating for the torn biceps brachii tendon.

Comparatively, if pain allowed elbow flexion strength to be measured during fast moving muscular contractions one would expect a greater dilution in strength. This could be due to the partial inhibition of the damaged bicep muscle, which usually is the greatest producer of peak force during fast elbow flexion. Forearm supination strength was also affected. Again, a result of the reduction of long head of biceps function and its mechanically advantaged line of pull, leaving only the remaining short head of biceps to control all bicep supination.

His pain has subsided dramatically since the injury. The assessment is a full rupture of the tendon of long head of biceps brachii muscle where it enters the intertubercular groove of the humerus. Upon this finding, the patient was then referred immediately to a medical doctor and was consequently prioritized for surgery.

History of pathology

The patient first noticed niggling pain in the upper shoulder (anterior humeral head) during throwing exercises approximately three months prior to the full rupture. Pain gradually increased as training progressed, as did the subjects feeling of shoulder "looseness" and apprehension. Patient also remembered a clicking in his shoulder during the cocking the phase of the throwing action.

Upon visiting a physician previously, he was advised that his transverse humeral ligament may have become lax due to a compromised throwing technique. He failed to correct his technique and subsequently suffered further increases in pain and post activity inflammation. This was possibly a result of biceps tendon/synovial membrane irritation related to increased tendon movement within the bicipital groove.

Shortly before the rupture occurred he had difficulty sleeping on the affected arm and was often woken during the night because of shoulder discomfort. It was likely that this was also an inflammatory related complication.

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In his frustration he accepted numerous cortisone steroid injections, administered by a medical doctor. This produced a reduction in the inflammation and pain. As a result he maintained his training and competition intensity throughout the following months until the full rupture occurred. He remembers the injury occurring just prior to the release of the baseball from his hand, marked by a loud snapping sound. Immediately afterwards he reported immense pain in the injured limb and the inability to move his arm from shoulder level down. Local swelling and bruising became apparent several hours afterwards.

Assessment of pathology

By obtaining a detailed patient history the pathology could be somewhat established before physical examination.

Chronic phase of injury

In the chronic stage there may have been:

1. Interstitial injury or tissue microtrauma (very small and often numerous tissue injuries)
2. Central tendon necrosis/death
3. Frank partial rupture or tear
4. Acute complete rupture

The origin of the problem presenting most likely began with the overuse of the throwing arm. That is, without the continual use/aggravation of the tendon, a complete rupture probably would not have occurred. In normal circumstances one would not expect the continual use of a limb to have this undesirable effect. However, it seems in this case that the transverse humeral ligament that holds long head tendon of biceps brachii in the inter-tubercular groove had become laxed.

Two possibilities of how this ligament had originally become laxed are:

1. the patient either suffers from decreased ligament strength in one or all areas of his body, and/or
2. a direct result of his previously identified technically flawed throwing technique.

The weakening of the Transverse Humeral Ligament (THL) its bony insertions and/or the tendon of biceps brachii, may have been a direct side effect of the steroid injections in the form of cortisol. Gradual softening of these structures can occur through either incorrect placement of the steroid and/or inappropriate or over-repetition of dosages.

The later hypotheses cannot be proved nor disproved because of the patient's inability to re-enact his action. Even if he where to act out the pitch with his non-affected arm, the neural patterns and muscle involvement would most likely fail to mirror his dominant arm. Unfortunately no appropriate video footage is available either of his technique prior to the injury. Therefore no definitive assessment can be made.

However, the patient's social approach to the pitching activity, poor technique and inadequate pre- and post-match preparations are a cause for concern. It is in the absence of proper warm ups and cool downs that niggling injuries can manifest and become more serious.

One technical flaw that may have been present in his action, and a possible a causal factor, is the presence of excessive internal rotation of the pitching/throwing arm. This is a common associated problem in those possessing a shoulder throw type action. That is, the starting position of the throwing arm could have been - 90 degree abduction, 0 degree extension and cocked in a fully externally rotated position.

This notable lack of extension of the humerus inevitably results in a lack of power. Throwing power should ideally originate from the mid-torso/core of the body and then be transferred into the throwing arm/ball. Instead the humerus is now required to undergo excessive internal rotation in order to substitute for this reduced mid torso rotation.

Biomechanically imperfect movements not only reduce overall efficiency levels but can also expose related body structures to unfamiliar forces. This may occur during a "shoulder throw", when the rotator cuff muscles can be forced into the unfamiliar role of initiating humeral rotation and power production. These relatively small muscles are merely designed to stabilise humeral movement, not initiate it. This compensatory technique raises obvious injury concerns.

Excessive humeral rotation also places increased tension on the THL as it tries to maintain the positioning of the long head of biceps brachii tendon (LHBBT) in the intertubercular groove.

The medial collateral ligament of the elbow would also have been exposed to excessive valgus stresses associated with a "shoulder throw". This is due to the increased exposure of the ulna to sudden and forceful medial rotating forces transferred from the humerus. The weight of the ball at the end of the forearm only adds increased force to what now has effectively become a distraction lever.

Combined with "lanky" ectomorphic characteristics, typically present in baseball pitchers, and associated bone leverage stress can be substantial. In repetitive sporting environments this phenomenon can have destructive consequences.

If the THL were to develop a degree of laxity as a result of increased stresses, then it could allow the LHBBT excessive movement within the intertubercular groove. Eventually, if enough laxity occurs, the LHBBT may begin to flick across the tubercules that make up the inter-tubercular groove during arm movement. This could account for the clicking sensation and the destabilization of the glenohumeral joint felt by the patient prior to the full rupture of the tendon.

Excessive movement of LHBBT would have mainly presented on either strong internal or external rotation of the humerus. This is when the greatest transverse or dislocating forces are exerted on LHBBT and when the integrity of the THL is most tested.

The clinical importance of the LHBBT moving excessively within the intertubercular groove is substantial. As the LHBBT flicks across its positioning tubercules either side of the bicipital groove, micro-trauma of the tendon can result. This trauma is problematic for mainly two reasons; it creates an inflammatory response to the wounding of the tendon and also begins to degrade the tendons structural integrity and strength.

Inflammation will not only cause pain in the affected site, as displayed in the subject's sleepless nights, but will also lead to the local swelling of the area. A reduction in blood flow will most likely follow due to the exudates of the vasodilated blood vessels surrounding the site of injury. It is well understood that the blood supply to tendons is already inherently poor relative to muscle tissue. Any further reduction in local blood flow will have a marked effect on tissue repair and function.

This engages a positive feedback response common to most chronic based injuries. That is, when a tissue is injured - inflammation occurs reducing local blood flow to the area - pain is then often increased - subject reacts by reducing movements of the effected area - this results in a further reduction in blood flow to the site most in need of adequate circulation - which further limits the effectiveness of the tissue repair process - and poorly healed tissue is now pre-disposed to re-injury.

Added to this undesirable process is the failure of many to undertake and maintain an adequate rehabilitation program. It is little wonder why those that experience injuries often re-injure the same structures at a later date.

Research by Huijbregts, Scott and Smith (1999), indicates that because the LHBBT is stretched over the head of the humerus in a tight arc, its outer synovial sheath is inherently exposed to both high levels of friction, force and hypovascularity. The related mechanical disadvantaged of the tendon further pre-disposes it to injury with or without pre-existing tissue faults.

Importantly, hypovascularity exposes the tendon to number of possible adverse reactions. Calcification can occur in the presence of hypoxia (poorly oxygenated tissues) as newly formed cells can cause a deposition of calcium throughout the tendon (Huijbregts, Scott and Smith, 1999). Also areas subjected to transient ischemia can also develop highly reactive oxygen-derived free radicals capable of tissue destruction, which in turn leads to degenerative changes in the tendon (Huijbregts, Scott and Smith, 1999). It is also important to note that in hypovascularized regions of the tendon blood flow is compromised. With reduced blood circulation though the area, the cooling capabilities of the tissue is also impaired. This has implications for the 5-10% of elastic energy released as heat during exercise. As a result, research shows that the tendon temperature can rise to levels sufficient to cause heat related damage to tendon cells. However, it is also interesting to note as Huijbregts and Scott 1999 report, that chronic tendon injuries are not simply recurrent acute tendon injuries. They quote "degenerative changes in spontaneously ruptured tendons were obviously not consistent with the normal inflammatory process. The inflammatory cells and the orderly phased repair process seem either absent or cut short."

By treating overuse injuries in their early/acute phase, there is an increased chance of preventing a chronic based injury. In this soft tissue injury case, early detection of tendon degradation by the therapist combined with proper counselling could possibly have prevented the resulting rupture from occurring.

Acute phase of injury

The subjects recalls a "snapping" sound and immense pain during what can be described as the power phase of his throwing action. This immediately suggested at least a potentially ruptured tendon or ligament. The bulge at the distal end of the upper arm also suggested completely torn muscle attachment, commonly referred to as "pop-eye syndrome" when located in the brachium. There was minimal pain present upon elbow flexion and the bulge in the upper arm was accentuated during contraction of biceps brachii muscle. These symptoms strongly suggested a complete rupture opposed to a partial tear where strong pain and no bulging would be expected upon muscle contraction. Also through palpating the area a taught musculotendinous unit could not be located.

The short-head tendon of biceps brachii was asymptomatic and was cleared of a complete rupture. Its tendon could still be felt in a taut position travelling to its attachment, and no pain or structural deformity was present. However, only by referring the patient for an ultra-sound could this hypothesis be confirmed.

The finale of tendon rupture could be described as a result of constant tendon micro-trauma. An ongoing degenerative process that continually reduced the structural integrity of the tendon, until the one off peak force applied to the tendon (during a pitch of a baseball) out-weighed the remaining tendon strength. The tendon finally snapped at the point of greatest stress - where it enters the bicipital groove and crosses the humeral head.

Treatment and rehabilitation from a kinesiological perspective

When advising a patient on their best course of action post-injury, it is important to take into account the subjects age, occupation and daily requirements for the use of their body.
For example, an 80 year-old patient that cares little more than to undertake simple daily chores, the level of limb function required post-rehabilitation would be less than that of an active eighteen year-old sports person.

With a complete rupture of the long head of biceps brachii tendon there is often a minimal reduction in strength during elbow flexion. This is often due to the compensation/hypertrophy affect of brachialis muscle and the remaining short head of biceps brachii muscle. However, in the absence LHBBT shoulder stability is often compromised, due mainly to reduced tendon support across the humeral head. With glenohumeral joint stability now reduced, forceful or fast elbow flexion would most likely stimulate an inhibitory neural feedback response to the brain. That is, the joint receptors will inform the brain of a decrease in glenohumeral joint stability, in turn the brain responds by inhibiting the muscles effecting the movement in order to protect the joint from further damage. Furthermore, an elderly person may not notice any reduction in strength due to their infrequent demands for maximal effort during elbow/shoulder flexion.

In the case of a 35-year-old baseballer, the functional requirements of the injured limb post-rehabilitation would need to be high. That is, at a level equal to or better than it was pre-injury.

An injury specific rehabilitation program for this case will be suggested shortly. However, if adequate rehabilitation is not undertaken routinely from day one the long-term success of the program is jeopardised. Its net result/effect can present in various forms:

1. Decreased strength of muscle, tendon, joint complex
2. Decreased ranges of motion
3. Chronic pain
4. Re-occurrence of injury or associated problems
5. Reduced over all function and performance of structures involved
6. Direct and indirect effects on body posture and biomechanics

The treatment process one could suggest in respect to the case presenting would be as follows:

1. Immediately upon injury support the limb in the least painful position and come off the field of play. Apply the principles of CERI (Compression, Elevation, Rest and Ice).
2. Obtain appropriate injury assessment

Assuming the assessment was a complete rupture of the LHBBT, I would advise the patient get the injury repaired by an experienced and reputable surgeon as soon as possible. As discussed previously a return to full function of the shoulder/limb complex is required if the subject is to pick up where he left off, in his sport at least.

Once post-operative, it is important to not only give the patient correct advice, but also to ensure that the patient is psychologically ready to accept and/or implement instructions. Patient state of mind can greatly enhance or indeed impair healing processes. Thus, much care needs to be taken to ensure advice given is both encouraging and suited to the individual's personality.

Another psychological hurdle in those recovering from injuries is the patient's fear of re-injuring the area. This can result in the patient's sub-conscious development of a compromised throwing action i.e. guarding the structure that is still perceived by the patient as being weak.

Examples of where this can directly affect the rehabilitation process is during the stretch shorten cycle of the tendon, which occurs momentarily during a forceful throw and is when the greatest loads are experienced. The patient also may feel uncomfortable with the shoulder travelling through hyper ranges of motion associated with this action, and may sub-consciously prevent this from occurring. If the tendon is not allowed to heal in the presence of these forces then its finite strength will most likely exist at a level below that of the body's maximal requirements.

Post-operative rehabilitation process

The extended rehabilitation process could take the following course:

Phase 1. Specific muscle isolation stimulation effected by a TENS machine (Transcutaneous Electrical Nerve Stimulator)

Phase 2. Specific muscle isolation strengthening i.e. bicep curls

Phase 3. Muscle stimulation with a functional emphasis. That is, taking the shoulder complex thorough a wide range of complex movements ensuring correct muscle timing, functioning and balance. An electromyogram or E.M.G. may be required to assess these electrical/ neuromuscular patterns, preceded by the use of a TENS machine to stimulate or "re-educate" muscle contraction.

Phase 4. Muscle strengthening in a functional environment, such as throwing a tennis ball at low but increasing intensities.

Phase 5. Returning the muscle/s to a functional unit to a level capable of withstanding stressors encountered during the individuals chosen pursuits i.e. throwing objects of varying shapes, sizes and weights (slightly heavier than a baseball) at maximal effort.

New and logical thinking suggests that rehabilitating muscles in isolation does not necessarily transfer into functional improvements i.e. bicep curls may not transfer into greater throwing speeds. Instead one must consider the intermuscular co-ordination factor. That is, how efficiently the whole body can integrate its movements together to produce the most effective result. This can only be adequately trained by performing exercises that mirror these functional actions, i.e., throwing exercises.

It is a questionable activity attempting to provide definitive or "cookbook rehabilitation" time frames when progress varies from person to person and is case specific. Rather the practitioner should be guided by patient pain, progress and response, if not, rehabilitation success can suffer.

Moreover, it is necessary to provide patients with possible timeframes for their rehabilitation. This may ensure one does not develop unrealistic expectations or become disheartened with any exercise program implementation. It is the patient's right to be provided with as much information possible regarding their condition. This assists patients in doing all they can to speed up the recovery process.

Post-operative rehabilitation time frames and guidelines

Week 1: Keep the shoulder relatively still for the first few days until tendon can develop regrowth tissue. Towards the end of the week apply heat and ice intermittently to speed up the healing process.

Week 2: Begin to apply gentle massage to the area. Take the arm through gentle pain free passive and then active movements.

Week 3-5: Weight bearing exercise with progressively faster movements. Deep tissue friction to help align healing tendon fibres.

Week 4-8: Most of the tendon fibres would have aligned permanently therefore tendon strengthening exercises should predominate i.e. bicep curls. Proprioceptive training should begin.

Week 8-12: Functional training and rotator cuff muscle strengthening - both concentrically and eccentrically.

Week 12 – 6 months: Continued pain free functional training with progressing force. Functional throwing activities with varying loads should continue daily until a sustained maximal throwing activity does not bring on a painful response. Patient should always thoroughly warm up and down when competing in any sport.

As mentioned above, once patient can move the shoulder/limb complex, movements that are pain free should be undertaken regularly. It should be clearly explained to the patient that movement will increase range of motion and blood flow to the area, and would therefore be in their interest maintain prescribed exercises. All exercises should be pain free, however some discomfort may be preside afterwards but should be of little concern.

Along with careful loading of healing tendons deep tissue manipulation should also be utilised to align healing collagen fibres. Although, much consideration is required regarding the stage of the healing process, to ensure collagen fibres have established adequate cross-linking, and will not be adversely affected by the pressures associated with manual manipulation (Huijbregts, Scott and Smith, 1999).

The disorganised deposition of collagen fibres is detrimental from a both a strength and re-injury point of view. This can and should be avoided through early light exercises and manipulation, and the stressing tissues in the direction and manner that will normally occur during future post-rehabilitation activity.

Once active movements can achieve full ROM increasing resistance should begin to be applied to the movement's i.e. light dumb-bell bicep curls. Importantly, the bicep brachii muscle requires specific rehabilitation exercises in order return its tendon attachment and motor control to pre-injury strength and function.

One exercise that can help return ROM and strength to the biceps brachii muscle is dumbbell curls. They can be best achieved with the patient sitting on an incline bench set at approximately a 30^0 angle. The arm should drop down under eccentric control to approximately 60^0 extension before the concentric phase of the 'bicep curl' begins.

Resistance levels should be increased by small increments as bicep muscle strength improves. In order to maintain muscular balance in the body, the weights lifted by the left/recovering arm should dictate that lifted by the right.

No emphasis has yet been given to the sports specific training, but simply guiding the affected muscle through all ROM's, circulating blood through the area and slowly increasing strength. Atrophy of the muscle would be significant at this stage of rehabilitation, therefore direct neural stimulation and proprioceptive training may be indicated.

The biceps brachii muscle has a fusiform fibre arrangement, developed mainly for fast contractions. As a result it develops the greatest peak force of all the elbow flexors when the arm is engaged in fast elbow flexion and throwing activities. In order to return the biceps brachii muscle back into a fully functioning unit, it must be trained in accordance with its functional characteristics.

The simultaneous action of the biceps brachii muscle at the shoulder and the elbow joint is also an important functional characteristic. It is a frequent occurrence in all muscles in our body that cross two joints, to simultaneously shorten at one end whilst lengthening at the other. This must occur in order for the body to undertake smooth and controlled movements.

These combined contractions can be seen occurring in the bicep muscle during a forceful throw. At the distal attachment into the radius the biceps muscles (more so the long-head) is contracting eccentrically whilst the arm is moving back into the cocked position. It is required to function in this eccentric manner for two reasons:

1. to store elastic energy in the tendons to be later released increasing the power of the movement.
2. to protect the joint by stabilizing the humeral head from being displaced as the arm is quickly extended into a cocked throwing position. In effect slowing the movement initiated by the extensor muscles on the arm i.e. triceps brachii and posterior shoulder muscles.

This storing or creating of elastic energy during eccentric contraction of the biceps muscle also increases the loading of its tendon attachments greatly. Added to this is the simultaneous action of distal part of the bicep muscle undergoing concentric contractions. This phenomenon occurs momentarily as the biceps muscle is suddenly required to stop the extension of the forearm and initiate a small degree of elbow flexion.

During this period, the moment force exerted on the muscle-tendon unit is of a level only marginally within its own tendon strength limits, hence it is naturally when ruptures are most likely to occur. Further implications arise if the structures designed to support the tendon during in these critical moments are weak or loose. For example, a laxed transverse humeral ligament will most likely allow excessive bicep tendon movement within the bicipital groove, in turn exposing it to friction related degradation.

The functional interaction of biceps brachii and brachialis muscles requires further consideration by the therapist. This muscular interplay is referred to as a spurt shunt relationship. It is based on the spurt muscle being used predominately for speed and the shunt most often for power or postural effort. For example, when the distal end of the arm is not fixed (open kinetic chain) the biceps brachii muscle acts as the spurt muscle and the brachioradialis muscle the shunt. This interplay reverses when the kinetic chain is closed, i.e., when most movement occurs at the shoulder.

The first open chain scenario is most common during throwing activities and this therefore must dictate specificity of exercises. The therapist also will need to expose the tendon, during the later stages of rehabilitation, to these peak forces commonly encountered in an open chain throwing activity, i.e, fast high loading forces.

Prolonged inactivity of the injured area before and after the operation will adversely affect associated soft tissue. These structures can under go a host of changes including atrophy, contracture and neural inactivity. Any one of these changes can seriously affect the functioning of the shoulder complex.

Therefore, all associated muscles need to be thoroughly integrated in the rehabilitation process, through appropriate assessment and treatment. In this particular case, one needs to consider the muscles attaching to the spine, thorax and pelvis. These muscles are important for the following reasons:

1. To control the core/trunk during highly destabilising dynamic movements.
2. Allowing maximal transfers of energy from the pelvis/gluteal region into the selected limb i.e. the arm.
3. To develop the desired trunk rotation speeds.

Aside from the larger muscles attaching to the shoulder, the smaller intrinsic or rotator cuff muscles play an important role in the correct functioning/stabilization of the gleno-humeral joint. These rotator cuff muscles are: Supraspinatus which prevents inferior displacement of humeral head, Sub-scapularis preventing posterior displacement, and Infraspinatus and Teres minor which help prevent anterior displacement.

After injury to an area such as the shoulder, immobility often occurs subjecting these rotator cuff muscles to atrophy. This is problematic as it can lead to decreases in shoulder stability. Weaknesses may only become apparent when these relatively small postural muscles are required to eccentrically slow the throwing arm within a split second.

Considering this, the progressing rehabilitation program must now become specific to these forces experienced by the subject during pitching activities. If not, loads placed on these muscles in a functional setting could easily outweigh the strength of inappropriately trained tissue.

Although, as with all muscles being re-trained, to begin with, exercises should be conducted in slow controlled movements and be simple in nature (i.e. single plane). This will allow the muscles to first neurally and then functionally adapt to re-education without re-injury.

Furthermore, it is important to note that muscles will rarely be used in or injured whilst performing single plane movements with constant resistance levels. Sudden loading variations are more often the cause of injury, i.e., when there is either a sudden change in a plane of movement or in the level of resistance. Therefore, once normal strength levels are regained in the basic planes of movement, sports specific training should begin. These will include loading variations throughout the throwing action, eccentric training, proprioceptive work, neuromuscular loading, co-ordination and motor recruitment training.

One can begin to incorporate some or all of these skills with the use of balls. By directing the patient to control the movement of spherical objects with an outstretched arm, the rotator cuff is called upon to stabilize and control humeral movement in a functional manner.

These activities place ‘higher levels’ of neurological demands on the neuromuscular system and require greater muscle co-ordination. Correct muscle function is vital for repetitive injury free activity to occur over an extended period.

As the rehabilitation phase progresses, so must intensity and speed. This is due to the fact that speed and intensity alters muscle fibre recruitment. For example, a single throw at 10% of maximal effort may have a completely different neurological pattern and fibre selection to a throw at 100% of maximal effort. Hence, limb control will suffer in if motor skills remain untrained at these intensities.

Failing to recognize the importance of the “open v’s closed chain” phenomenon is an easy oversight to make when administering rehabilitation exercises. As mentioned previously, muscle function changes depending on the type of movement undertaken. For example, closed chain exercises such as chin-ups and push-ups, will force the rotator cuff muscle to function in a shunt type manner. However the function of rotator cuff muscles during a throwing action is primarily spurt based. Considering this, any rotator cuff strength gains obtained during closed chain exercises, will be unlikely to have a direct transfer (ie, motor skill transference) into shoulder stability during spurt based throwing activities.

It is also important to develop an adequate degree of body awareness in any rehabilitation program. Proprioceptive and kinaesthetic awareness works by utilizing small stretch receptors in joints and musculature. These receptors supply vital neurological feedback to the bodies higher control centres ie, brain, regarding the positioning of body. Following trauma to joints and/or soft tissue these receptors are often damaged or become less functional, resulting in reduced co-ordination/ balance. Re-training receptor function is paramount in order to reduce the likelihood of re-injuring the area post rehabilitation. This can be achieved by increasing muscle mass and by training the body to adapt to unstable or unfamiliar environments.

In order to prevent premature muscle/tendon overload, to begin with, gentle eccentric and concentric strengthening should be undertaken at similar intensities. Maximal eccentric strengthening should only be undertaken towards the later phases of rehabilitation, as it is more demanding from both a physical and neurological aspect.

Considerations

The final stage towards the rehabilitation of the throwing arm/shoulder complex is safely re-enacting forces at least equal to those normally experienced during a game of baseball. A thorough assessment and ideally a re-education of the patients throwing action would be indicated.

Any re-education of his throwing style would most likely be a continuos, long term, and possibly, an unsuccessful venture. This is due mainly to the fact that the patient has shown previous disenchantment towards injury prevention advice, and the fact that his social involvement in sport does not lend itself to long-term treatment programs. This notion could be proven incorrect provided the therapist adopts a sensible rehabilitation approach.

Successful implementation and completion of rehabilitation programs is synonymous with patient acceptance. The key is realism and simplicity, which often proves harder than it sounds. The level of patient participation in a rehabilitation program, for one reason or another, often exists at a level below both physiological ideals and practitioner's expectations. This is often due to the failure of a practitioner to create a program sensitive to the patient's level of interest and/or understanding.

Sensitivity and insight is required by the practitioner to gauge patient responses and preferences towards a program. A host of different techniques are available to the practitioner in order to stimulate patient participation and any failure to do so can reflect poorly on the practitioner. The least desirable result is the total loss of patient participation in the program.

When rehabilitating a patient's throwing style, there are as many considerations as there are potential problems. One consideration is the effect/trainability of bi-directional fascial slings that exist in the body and aid in the powerful thoracic rotation. The training of these types of structures could possibly increase throwing efficiency. This in turn could reduce the stress compromised throwing actions place on associated joints.

Again muscle co-ordination throughout the entire body is the most effective means to achieving this outcome.

Past attitudes implied that simple gains in muscle strength and or/or size alone would provide a satisfactory rehabilitation outcome. However, current thought in post-injury rehabilitation does not support this methodology. Rather it suggests that more functional based strengthening programs are advantageous, enabling the body too co-ordinate its own physical development to specific activity demands.

It is now also hypothesized that sports specific strengthening for highly defined activities can actually create long-term injury problems i.e. the heavy gym program of football clubs. That is, when one attempts to dramatically change the structure of the human body invariably an imbalance will result. This imbalance will eventually outweigh the bodies' ability to absorb or adapt to the altered stresses associated with these changes.

Evolution appears to have created a highly refined and balanced being, homeostatically maintaining its balance through various inter-related and complex processes. Western society, and its lifestyles, seems to disrupt many of these delicate inter-relationships, whether through the quest for the fastest man, or our poorly designed working environments. The body's natural soft tissue functional complexity, alone, far outweighs all our current understandings. Only now is western society, against all resistance, beginning to accept the problems associated with our over simplification and crass attempts at altering body form/function.

Modern, western science's attitudes regarding the "best practice" has seldom changed in the absence of scientifically based research. As a result we are only now beginning to learn the lessons that have been part of eastern medicine for thousands of years.

Growing financial costs associated with professional sports and work environments, have forced us to look at how our current methodology actually impacts mind and body.

Body awareness and balance is slowly becoming accepted as the key to injury prevention and increased athletic performances. This phenomenon has existed under our noses in the form of native Australians for years without proper recognition. Despite Australian Aborigine's lack of participation in intense gym programs or training schedules, they have smoother and more efficient movement patterns relative to Anglo-Saxons. This disparity can partially be attributed to the active lifestyles common to aboriginal/native cultures. It also gives testament to the theory that 'modern lifestyle' ensures Anglo-Saxon's exist at a level well below their physical potential.

It is important to further note the steady increase in injuries when athletes reach their mid- twenties. One theory behind this occurrence is that our bodies have only a finite ability to absorb destructive forces applied to it. Once these absorption capabilities become fully exhausted ie. mid-twenties, one may observe injuries surfacing more readily.

Considerations for 5-10 years down the track

At what cost do we say no? At what price do we say yes?

The long term costs verses the short-term gains of injury treatment is a constant balancing act. This never-ending problem in this case presents in the form of cortisone injections, accepted by the patient to provide an effective short-term solution to the pain and inflammatory related problems. However, the long-term complications associated with the bone, ligament and muscle-weakening steroid often exist with the recipient for remainder of their life.

Surgery indicated for this bicep tendon rupture is certainly not without associated costs. As with any invasive surgical procedure scaring of some degree has to result. The very best scenario will ensure the scar tissue exists as little more than an aesthetic blemish. However, it only takes a small amount of ill-placed scar tissue to affect the complex workings within the shoulder joint. Any decrease in shoulder functionability will affect the patient's lifestyle to some degree, the level to which its does so is the only variant.

Osteoarthritis is another surgery related issue. If any area of the joint structure is damaged during the process of rejoining of the tendon then it may very well initiate the onset of arthritis. The affects of degenerative based arthritis may not be felt immediately due to its insidious onset, however its debilitating effects will often be experienced at the later stages of ones existence.

Long term affects of treatments must be thoroughly examined by the practitioner and be clearly explained and discussed in detail with the patient. It would also be responsible of the practitioner not to administer treatments, such as cortisol injections, during highly emotional periods of the patient's life i.e. during a football game. It is the patients absolute right to be counselled in detail regarding treatment processes that could quite easily adversely affect their long-term health and wellbeing.

References

Peter A. Huijbregts, Scott E. Smith. (1999). ***The Journal of MANUAL & MANIPULATIVE THERAPY***, Volume 7, (number 2).