The Three-Event Water Skier's Shoulder

The Problem

Ever since 18 year old proficient aquaplaner, Ralph Samuelson, from Minnesota, stepped onto his cleverly invented construct of pine boards, 8 feet long by 9 inches wide, he became known as the first modern day water skier in 1922. The sport of water skiing with its concomitant technology have evolved much since the days of being towed by outboard-powered boats at 20 mph. Today's high tech tournament towboats are specially configured with engine, fuel delivery system, propeller, transmission, ballast, and weight systems to meet the criteria for the ever so popular three-event skiing.

The favorite and most popular, even among those non-three-event skiers, is slalom skiing. Nothing is more exhilarating than experiencing a force greater than

4 g when accomplished skiers round a buoy at 41-off with a centripetal acceleration speed of over 72 mph, more than doubling the boat's speed of regulation maximum of 36 mph. A show of agile brute strength concealed by the tapestry of a ball of spray.

Trick skiing is more technically demanding than slalom and jump. High level trick skiers are not only creative with their movements but possess poise, confidence, and total body agility. A real show pleaser of acrobatic power and control.

Water ski jumps are executed with supreme confidence and timing. Being towed at a maximum boat speed of 36 mph, the jumper takes advantage of knowledge of angular acceleration in the laws of physics by making zigzag turns behind the boat in a series of cuts during the approach, thus generating speeds of over 70 mph when the jumper hits the ramp in order to launch the farthest distance. At speeds of over 70 mph, the load generated on the rope can easily top 1,300 lb - a real stunt show of guts and glory.

The shoulder, being the weakest link in the kinematic chain that lies in line with the body, the hip, and the knee, is, therefore, the most prone to injury. Consequently, the price paid for pushing the envelope for championship performances are that no less than 40% of all high level water skiers have suffered shoulder pain at one time or another, and , not surprisingly, no less than one in five of those injured athletes continue to ski in spite of shoulder pain. It is not uncommon for many athletes to have had shoulder surgery, even multiple times.

Water skiing is a sport of acceleration and deceleration while executing controlled power with lightening reflexes like a cheetah on the hunt.

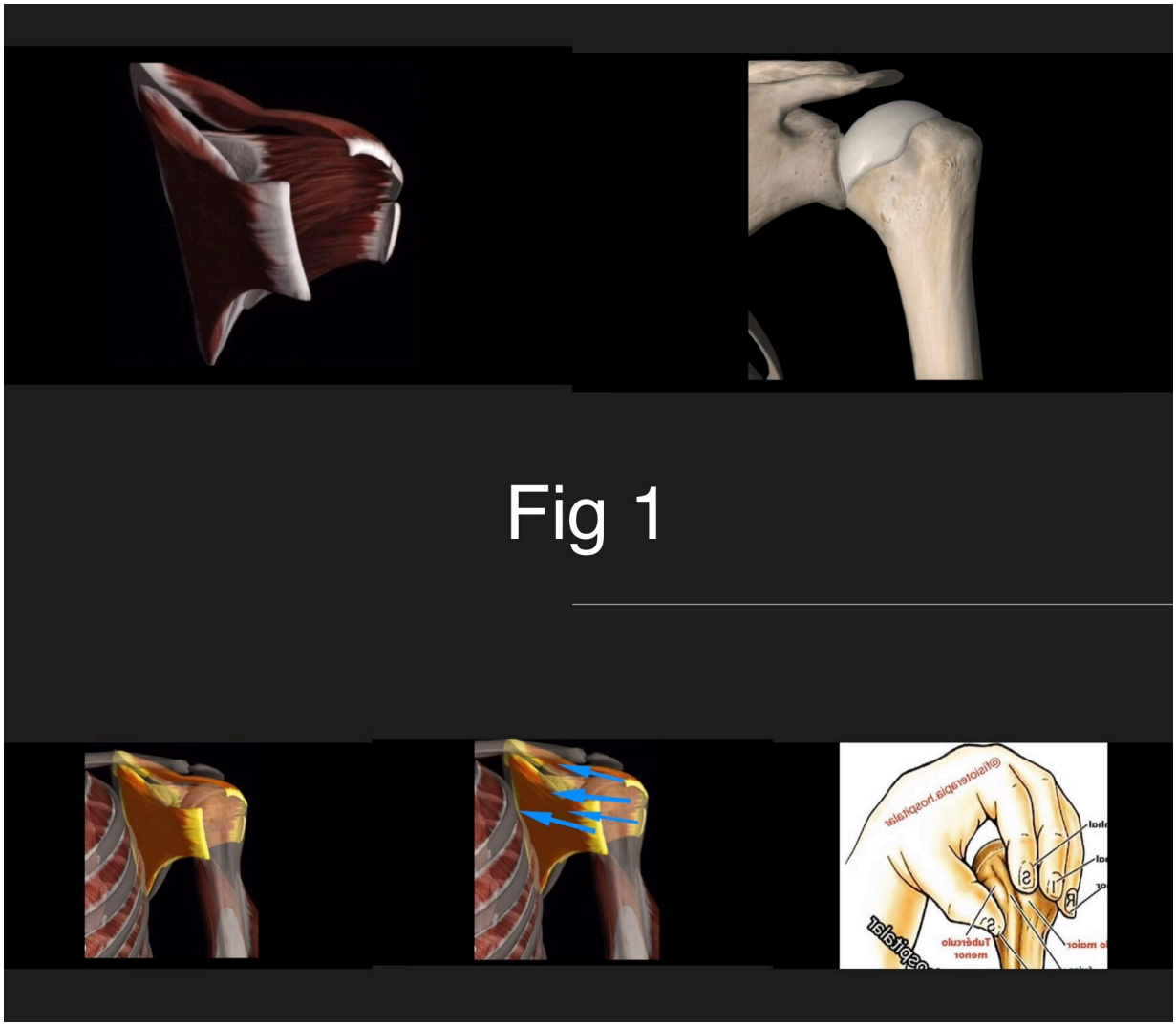
Aside from formidable demands placed on the entire body, the prerequisite for all water skiing is to hold onto the ski handle, unless trick foot holds are involved. Being towed at speeds of up to 36 mph, the shoulder is obligated to react to supra-physiological stresses at moments notice. Diagnoses such as "biceps tendinitis", "shoulder impingement", "bursitis", "rotator cuff tendinitis", "labral tear", "SLAP tear", "hyperlaxity", "instability", and "rotator cuff tear" have become common household terms.

Functional Shoulder Anatomy

The shoulder, being the most mobile joint in the body, endows our ability to place our hands virtually anywhere in space. In exchange for this evolutionary trait of nearly unrestricted arm motion, by default, comes with increased shoulder

instability.

The single most important structure that keeps the shoulder joint stable is the rotator cuff. The rotator cuff is consisted of four separate muscles - one from the front of the shoulder, three from the back of the shoulder. Although these are four muscles, from four locations, they converge together on top of the arm bone (humeral head) and function essentially as "*one" muscle unit acting in unison*. Conventional teaching is that our rotator cuff "rotates" the shoulder in "external" or "internal" rotation, or other "rotational" motions. However, with modern appreciation of "functional" kinematic motions of the shoulder, our rotator cuff muscles perform a much more important role in the health and movements of our shoulders. This is SYNERGISTIC CO-CONTRACTION of all four rotator cuff muscles, simultaneously, at all times. With any shoulder movement, the rotator cuff muscles pull the humeral head against the glenoid , as the outcropping fingers of a hand, hug and compress against the glenoid, to maintain a stable and well aligned shoulder joint. (Fig. 1)



It is this simultaneous contraction of these four muscles that maintain the humeral head *compressed* in the joint against that part of the shoulder blade bone called the glenoid. This is called "glenohumeral joint compression", or "centration" effect — the joint is compressed in a centered position. Any relative weakness in one of the four rotator cuff muscles will result in off-centered movement of the humeral head during shoulder motion. When repeated many times, this will lead to shoulder pain, tendinitis, labral tears, and ultimately even rotator cuff tears.

In order to ensure shoulder stability, all four rotator cuff muscles must contract synergistically in a balanced manner, with just the right amount of tension from each muscle. This keeps the humeral head centered and compressed against the glenoid , while at the same time being flexible and able to yield to directional changes from shoulder motion. Like tentacles on the octopus that are flexible, yet powerful to grab onto a prey.

Functionally, the rotator cuff muscles facilitate 3 aspects of shoulder activity — 1) shoulder movement with directional changes, 2) arm acceleration, and 3) arm deceleration.

The Challenge Faced By Three-Event Skiers

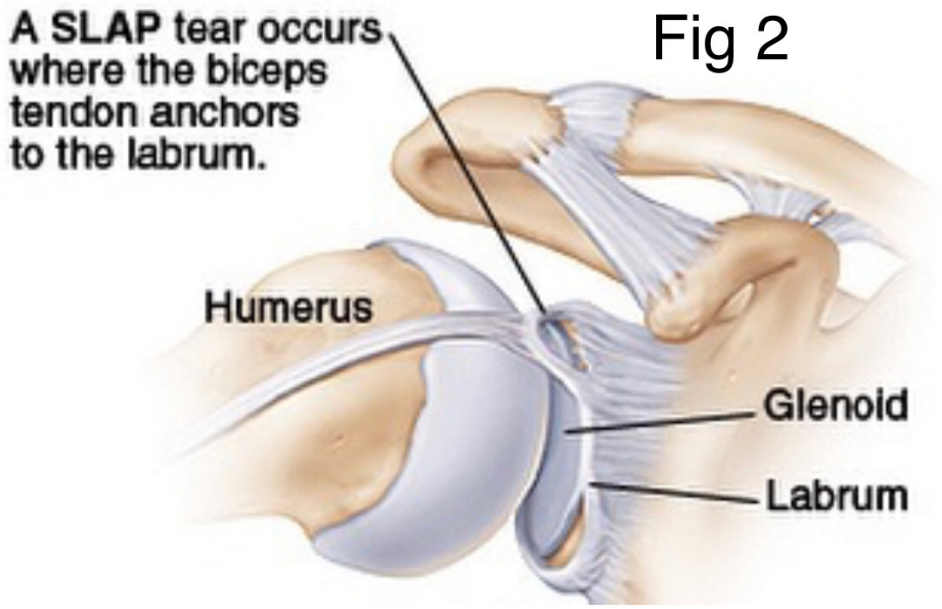
Guts, grits, and grace are key ingredients for slalom, trick, and jump water skiing. These are highly entertaining for spectators but risky for the skiers. Accounting for boat velocity, angular momentum with directional changes in acceleration and deceleration, the rotator cuff is subjected to forces 3 to 6 times body weight in under 1/2 second when rounding buoys. This translates to a power equivalent of greater than 23,000 ft-lb per second reaction time when a 150 lb skier is being pulled at 36 mph!

Shoulder performance is predicated on stable shoulder joints. Like the tires on Formula 1 race cars that keep the cars on the track, your rotator cuff keeps your shoulder centered in the joint.

What makes the rotator cuff exceptionally prone to injury is not just the power required, but the rapid adjustments needed to respond to changes in direction of shoulder movements. Within milliseconds, the rotator cuff muscles must adjust to directional changes and stay engaged while the arm whips across sagittal, coronal, and transverse planes of motion. Ineffective, and, inefficient rotator cuff engagement, are direct causes for shoulder instability, shoulder underperformance, shoulder pain, and shoulder injury.

SLAP Tears - A Unique Proposition

An entity unique to shoulder athletes is the SLAP tear. SLAP stands for *S*uperior *L*abrum *A*nterior and *P*osterior tear. It is a detachment of the top part of the fibrocartilaginous rim from the shoulder socket (glenoid) where the biceps tendon attaches (Fig 2). Tears can occur from 1) a direct fall onto an outstretched arm, 2) repetitive overhead activity with inadequate shoulder stability, or 3) reflexive biceps muscle eccentric contraction creating tensile stress on the biceps anchor in an unstable shoulder. All skiers are at risk due to the repetitive forceful distracting nature of water skiing.



The principal cause for shoulder pain and SLAP tear is a weak rotator cuff. A shoulder during motion, especially at end ranges of motion — such as when the arm is maximally cocked backward in a 180 trick turn, or maximally pulled leaning to the side when rounding a buoy, or stretched forward when setting up for the jump off the ramp. These situations are setups for shoulder slippage of either dislocation or detachment of the labrum, if it were not for the centration effect created by the rotator cuff.

How To Prevent Water Ski Shoulder Injuries

The cornerstone for all shoulder injury prevention program is to strengthen the rotator cuff. Traditionally these have involved pulling elastic bands or lifting dumbbells. However, more important than to “strengthen” the four rotator cuff

muscles, is to “train” how the four muscles *function in unison* to *react* to directional changes. Therein lies the difference between “strengthening” and “training”. Strengthening gets the muscle strong; training gets the muscle functional for a specific activity. Shoulder injuries among three-event water skiers are secondary to poor “motor control”, not “motor weakness”. Universally all water skiers are *strong,* it is the lack of *control* that causes injury. Elastic bands and weights do “strengthen” the rotator cuff muscles; however they do not “train” for control for the function of the activity across multiple planes of motion. When the shoulder moves through multiple planes of motion, each rotator cuff tendon must be responsive to changes in shoulder direction, shoulder acceleration, and shoulder deceleration. Shoulder joint stability throughout all directions of shoulder motion can only be achieved by coordinated synergistic activation of all four rotator cuff muscles, just like a well orchestrated symphony, working together as *one functional muscle unit*. This “one” functional equivalent muscle unit exerts a constant and well balanced glenohumeral joint compression force throughout all planes of motions in order to ensure shoulder joint stability and to avoid shoulder injury.

The ShoulderSphere Technique

Rather than pulling rubber bands or lifting dumbbells in a “linearly” directed fashion in one of four “directionally” based movements - the push, pull, lift, or the press; ShoulderSphere (Fig 3) is the only rotator cuff exercise device in the world that strengthens and trains ALL four of the rotator cuff muscles simultaneously in a rotational manner. Linear movements only work on one muscle, one plane, and one direction at a time. These are nonfunctional and may result in imbalanced strengthening.

Fig 3

ShoulderSphere **A7**

ShoulderSphere **F2**

The use of ShoulderSphere involves active rotation of the ball inside the globe of the ShoulderSphere. When rotating the ball inside the globe in a circular motion, all four rotator cuff muscles are immediately activated simultaneously in a synchronized and balanced fashion in unison. Any rotator cuff shut down or imbalance will cause the ball inside the globe to drop and bounce rather than to rotate. This bouncing, or dropping the ball, gives an immediate valuable feedback to the user's rotator cuff engagement. Additionally, when using the ShoulderSphere, the user's wrist is locked in the splint by the strap, all the work needed to rotate the ball must all come from the four rotator cuff muscles. The elbow only goes up and down, which will not rotate the ball. The wrist, being locked, cannot compensate to rotate the ball. Therefore, all the rotation must

come from the rotator cuff.... the rotator cuff *rotates*. These features make ShoulderSphere a most unique rotator cuff exercise device being the most selectively isolated rotator cuff workout of any technique available.

The Smart Rotator Cuff Power Performance Tracker

A special feature of ShoulderSphere is the attached Smart Rotator Cuff Power Performance Tracker (the blue box in Figure 3). This Smart Power Performance Tracker gives real-time display of the power of rotator cuff muscles during workouts. Power is velocity. The greater the velocity, the greater the power. The tracker lights up either in green or red light. Green light equates to low power for endurance workout, red light equates to high power workout for high intensity interval training style exercises (HIIT). Translational function equivalents, one can equate a 3 second maintenance in red light as roughly equivalent to 38-off while using the larger A7 model; and 32-off when the A7 is in green for 3 seconds. While using the smaller F2 model, red light for 3 seconds is roughly equivalent to 28-off; and in green for 3 seconds is roughly equivalent to 22-off.

The Smart Power Tracker is activated by active spinning of the ball inside the ShoulderSphere. The DIRECTION of spin does not matter. Since this is "circular" training. As long as the ball spins, ALL rotator cuff muscles are engaged. The principle of ShoulderSphere workout is to maintain a continuous smooth spin of the ball inside the ShoulderSphere throughout the entire training session. Avoid allowing the ball to bounce, which signifies one or more of the rotator cuff muscles has been shut down, thus the chain of the circle has been broken.

THE SMART POWER TRACKING LIGHT—

Fast spinning makes the power light turn on in red, lower power velocity spin changes it to green. A test, and means of tracking one's progress with strength improvement, is one's ability to maintain the tracker lit in red for 30-60 seconds continuously. This is high intensity interval training and a fun challenging gauge regarding one's own progress. GREEN light can be thought of as endurance training; RED light as power training. Activity translational equivalents can be thought of as that when the power tracker light is maintained in red for 3 second while using the larger ShoulderSphere (A7 model), it is equivalent to the rotator cuff engagement required for a pitch of 90 mph if you were a pitcher, or 38-off for slalom water skiers. When the light is lit in green, it is equivalent to the rotator cuff engagement for a 60 mph pitch for throwers or 32-off for skiers.

Strengthening vs Training

ShoulderSphere can be used either as a pure rotator cuff strengthening device (in "static mode"), or as a training device (in "dynamic mode"). "Static mode" technique to strengthen the rotator cuff is performed by active rotation of the ball inside the globe *without* concurrent arm motion. "Dynamic mode" training technique is performed by moving the arm through various planes of motion while at the same time rotating the ball inside the globe (which also strengthens the rotator cuff muscles at the same time). Dynamic mode specifically trains the responsiveness of the rotator cuff muscles to adjust to directional changes for multiplanar shoulder movements. All four rotator cuff muscles are trained to function as *one muscle unit*, not separately as four, to maintain glenohumeral joint compression at all times. This trains motor control and constant rotator cuff engagement for those ranges of motion.

The following video depict "Static mode" training - https://youtu.be/eT8s1yrWedg

"Dynamic mode" training - for motor pattern simulation training as in water skiing moves by Chet Raley —
https://youtu.be/6-nBMRbhxvE

Training the Rotator Cuff For Three-Event Water Ski Shoulder Movements

Shoulder injuries in water skiing occur when the shoulder is not able to react to sudden changes in direction and speed. Strength is how strong you are in one plane; control is how you well can move your arm through multiple planes. To be truly functional is the ability to adjust and maintain stability of the shoulder in a multidirectional manner when the arm is rapidly moving through different planes of motion.

The ShoulderSphere sports specific strength training technique specifically trains rotator cuff power with control. This is performed by mimicking event-specific movements of the arm that mirror the water ski motor patterns involved. This "dynamic" motor control workout calls for active rotation of the ball inside the ShoulderSphere globe while the arm mimicks the ski pattern intended. The closer the mimicked motion that mirrors the activity intended, the more powerful will be the motor control training for rotator cuff responsiveness to stabilize the shoulder for that intend activity. Practice the lean to the side for slalom, outstretch forward for the jump and behind the back for tricks. The following video links demonstrate motor control training of rotator cuff responsiveness for waterskiing or wakeboarding specific movements —

1) for the water skier - I am using optional one ShoulderSphere in each arm in conjunction with 2 Power Coaching Rings for higher intensity training. The concept being motor pattern event specific simulation moves -

https://youtu.be/JDf1C6ENSsI

2) for the wakeboarder -

https://youtu.be/20op9vUcrXw

ShoulderSphere is the most efficient and effective rotator cuff training device you will ever need. It is also hands down the toughest rotator cuff exercise you will love.

Here is the link to the website for a 10-week progressive rotator cuff strengthening program for water skiers -

https://www.shouldersphere.com/wp-content/uploads/2018/02/Waterski-ShoulderSphere-Workout-Program.pdf

To learn more about ShoulderSphere and how you can integrate various strengthening and training techniques to suit your needs, please visit www.ShoulderSphere.com and follow us on Instagram or Twitter @ShoulderSphere.

Testimonials -

https://youtu.be/v3kGs0QXAME

https://youtu.be/TvX0x1f_Ys8

Dr. Chang is available for any questions or suggestions at Win@ShoulderSphere.com.

Win Chang, M.D.

Fellow of American Academy of Orthopaedic Surgeons

Dr. Chang is a Board Certified Orthopaedic Surgeon with specialty in shoulder reconstruction and sports medicine. A graduate of the University of Rochester School of Medicine and Dentistry with Distinction in Research, he received further trainings at UCLA, NYU, and the Mayo Clinic. His patented invention of the unique rotator cuff exercise device, ShoulderSphere, was awarded the Gold Medal in Health and Fitness at the 2016 INPEX International Inventors Convention. Dr. Chang has given numerous lectures and seminars to physical therapists, athletic trainers, coaches, and athletes on rotator cuff management both nationally and internationally.