Managing Shoulder Pain in the Swimming Athlete – A Sub-Classification Approach: 2016

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Changes in training practices and improved research allow healthcare providers to manage shoulder pain in competitive swimmers better than ever before. In the past, the healthcare providers generally attributed shoulder pain to excessive training or too many repetitive overhead strokes leading to laxity and resultant impingement of the rotator cuff. This often resulted in a cookbook approach when treating the athlete. However, there was no consensus on the precise causes of shoulder pain, which could vary in type from swimmer to swimmer. Today, elite-level swimmers train about 30% less than they did 25 years ago, easing the number of shoulder revolutions and the load on the rotator cuff. At the same time, a new treatment paradigm reveals no single cause for shoulder pain in swimmers, but rather a cluster of contributing factors that can match the clinical presentation to the treatment. Identifying individual causes allows targeted and more effective treatment.

In the 1980's and the early 1990's, it was not unusual for elite level swimmers to train as many and 90,000 to 100,000 yards a week. The excessive training contributed to several misconceptions throughout the medical field, skewing shoulder pain management in competitive swimmers. Health care providers believed swimmers over trained and that repetitive overhead strokes caused pathological glenohumeral joint laxity and injury.[1 2 3 4] Many early publications point to excessive shoulder revolutions as the source of shoulder problems in the sport. This resulted in short sited treatment plans with little variability from one swimmer to the next. Another misconception was that excessive shoulder ROM is necessary to be competitive and as a result swimmers have been stretching the glenohumeral joint for decades with no clinical rationale.

Before today, there was no clear consensus on the underlying cause of shoulder pain in swimmers, although many authors tried to single one out. Some concluded scapular dyskinesis is the main reason for swimmer shoulder pain. [1 5 23] Others suggested anterior instability.[6 7] Finally, some attribute the cause to impingement and tendinopathy.[7 8 9 10 15 11]

The sport is changing. Currently, elite level swimmers are training 30% less than they did 25 years ago. They typically swim 60,000 to 70,000 yards per week, 48-50 weeks per year with one day a week designated for recovery. They tend to complete 8-10 workouts per week with 6,000 to 7,000 yards per workout. This results in approximately 850,000 shoulder revolutions, per shoulder, per year. The current number of shoulder revolutions is about 1/3 to ½ lower than what was documented 25 years ago.

The transformation is refreshing and has allowed healthcare professionals to understand the development of shoulder pain in swimmers better. Despite the lower volume of training, the rate of injury[12 13] has been consistent supporting the need to search for other causes or perhaps a better treatment strategy. Through their research, Borsa[14] and Sein[15] discounted the notion that swimmers acquire glenohumeral joint laxity as a result of long-term participation in the sport. Underwater videography revealed that not one of the four competitive strokes requires unusual glenohumeral joint ROM to be competitive. We can no longer falsely attribute over training as the only source of pathoanatomical changes in the athlete.

Edelman[16] recognizes there is no single cause of shoulder pain in swimmers and offer a sub-classification system identifying a cluster of etiological factors that can guide the selection of homogenous subgroups for more effective treatment strategies. The 4 sub-groups of non-specific shoulder pain (in the absence of trauma) are as follows: 1) Predisposition, 2) Fatigue, 3) Injury Related Mechanics and 4) Tendinopathy.

1) Predisposition

The Predisposition group includes the athlete that has an underlying preexisting condition. This could include a whole array of presentations but in the absence of trauma, oftentimes physical examination of the swimmer identifies a glenohumeral joint laxity or a capsular restriction. If not properly identified and treated, this group may present with faulty stroke mechanics and / or fatigue during a workout. Without appropriate treatments, this group is susceptible to developing a tendinopathy.

Treatment Strategy: For the Predisposition group, identifying the pre-existing condition is critical. Glenohumeral joint capsule mobilizations and a home stretching routine targeting the glenohumeral joint capsule will resolve the ROM deficits found in the swimmer with capsular restrictions within a week or two of concentrated treatment sessions.

Swimmers with pathological glenohumeral joint laxity can take longer to address. Peter Blanch[17] offers a clinical hypothesis on functional stability of the glenohumeral joint that includes a combination of mechanical restraints and neuromuscular feedback mechanisms (Figure 1). When the two are operating above a threshold of stability, the swimmer is able to train without issue. When the threshold drops below a level of stability, the swimmer is at risk for injury. When the mechanical restraints are pathologically loose, healthcare providers can positively influence neuromuscular feedback mechanisms and improve the level of glenohumeral joint stability. For this group, incorporating a host of neuromuscular re-education exercises for the shoulder complex is beneficial. As the swimmer progresses through the rehabilitation program, it is important to challenge the more vulnerable phases of the stroke.

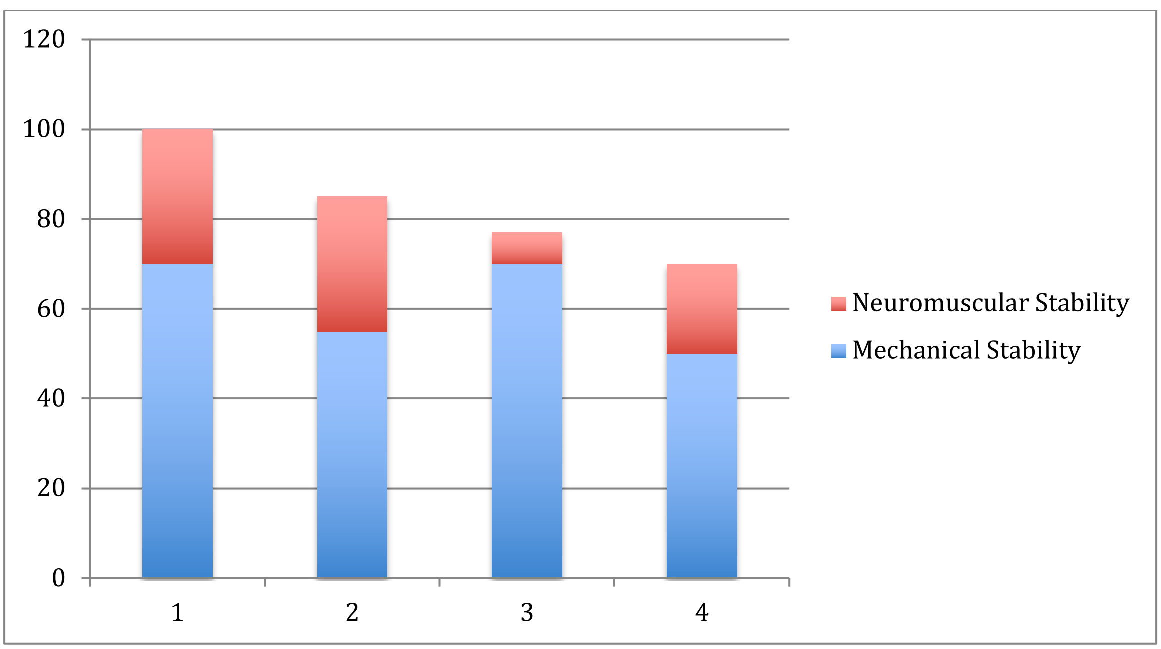


Figure 1: Blanch's Model of Functional Stability

2) Fatigue

It is well documented that fatigue can lead to pathoanatomical changes in the shoulder girdle.[18 19 20 21 23 27 28] Data collected from the initial history will help to identify the Fatigue group. The swimmer will point out recent changes that may have occurred in training prior to the development of shoulder pain. Usually the changes include a graduation to a more senior group within a swim club or moving to a college program resulting in more workouts and more swim volume per week. Wolf[22] found a strong relationship of injury to the year of eligibility in Division I college swimmers. He found a high prevalence of injury in freshmen and attributed it to the increase in swim volume associated with the transition from high school to college. The swimmer may also describe pain that develops in the second half of a swimming workout often associated with fatigue. Some of the typical changes leading to fatigue are as follows:

- Return to Swim after a Period of no Swim Training
- Ramp Up in Volume / Intensity
- Increase in Competitive Level
- Coaching Philosophy
- Training Errors
- Strength Deficits

Strength deficits can play an important roll in fatigue development. Madsen[23] and colleagues found that 82% of swimmers demonstrated signs of scapular dyskinesis in the course of a 100-minute swimming session. Through EMG analysis of the painful shoulder, Scovazzo et al.[24] discovered muscle activity of the Serratus Anterior is significantly depressed through the important pull-through phase in swimmers with shoulder pain. Batahla[25 26] revealed in the course of a swim season the internal rotators of competitive swimmers become proportionally stronger when compared to their antagonists, increasing muscle imbalance and the risk of an injury process. McCreesh[27] and Chopp[28] demonstrated that fatigue leads to a short-term decrease in acromiohumeral distance.

Treatment Strategy: The Fatigue group generally needs to focus on strength training of the entire shoulder girdle and core musculature. Knowing that a muscle imbalance can occur in the course of a season and that internal rotators of competitive swimmers become proportionally stronger when compared to their antagonists,[25 26] a program focusing on the external rotators is encouraged. In addition, addressing the Serratus Anterior and other peri-scapular muscles is indicated. Healthcare providers are encouraged to focus the strength training on endurance to help the swimmer complete a 2-hour workout. Instead of sets of repetitions, sets-for-time is warranted. Adding strengthening exercises for the entire core is also recommended.

3) Faulty Mechanics

There can be some crossover between sub-groups. For example, the predisposition of an unstable glenohumeral joint could lead to fatigue and then to faulty mechanics or it could lead directly to faulty mechanics. Fatigue alone, could lead to faulty mechanics. The Faulty Mechanics group can also be mutually exclusive and purely related to poor stroke mechanics that lead to anatomical damage. In this case, the athlete will describe shoulder pain within the 1st half of a swimming workout. When shoulder pain is described towards the end of a workout, it is usually fatigue causing injury-related mechanics. Fatigue often leads to longer breaths, bigger rotations and possibly a dropped elbow during the catch phase of the stroke, placing a greater demand on the shoulder. In addition, when fatigued, the swimmer may begin to compensate with secondary muscles to get through a difficult workout, leading to faulty stroke mechanics.

Treatment Strategy: When faulty stroke mechanics are identified and not associated to fatigue or an underlying predisposition, coaches and sports performance specialists can resolve the shoulder pain by correcting the mechanics. When fatigue and / or the predisposition is the cause of the faulty mechanics, it is important to contact the coach to correct the mechanics while addressing the fatigue and / or predisposition in the clinic.

4) Tendinopathy

Rotator cuff tendinopathy is defined as pain and weakness with movements of the shoulder and most commonly with shoulder external rotation and elevation as a result of excessive load on rotator cuff tissues.[29] External mechanisms of rotator cuff tendinopathy include the contact of the humeral head on the corocoacromial arch. Internal mechanisms of rotator cuff tendinopathy include: genetics, age, vascular changes and increased loading of the rotator cuff tendon. Sein[15] found that elite-level swimmers training more than 15 hours a week or more than 38,000 yards a week are 4 times more likely to develop tendinopathy. He is essentially describing the internal mechanism of increased load of the rotator cuff.

Edelman's Pathway to Injury[16] (Figure 2), describes the typical injury process for shoulder pain in the competitive swimmer. The four sub-groups are intertwined and the focus is to break the swimmer from the pathway before developing a tendinopathy. For example, in separate studies, McCreesh[27] and Chopp[28] demonstrated that fatigue leads to a short-term decrease in acromiohumeral distance. The reduced distance could contribute to the external mechanisms of tendinopathy as described above. Moreover, as described previously, a predisposition could lead to fatigue and faulty mechanics.

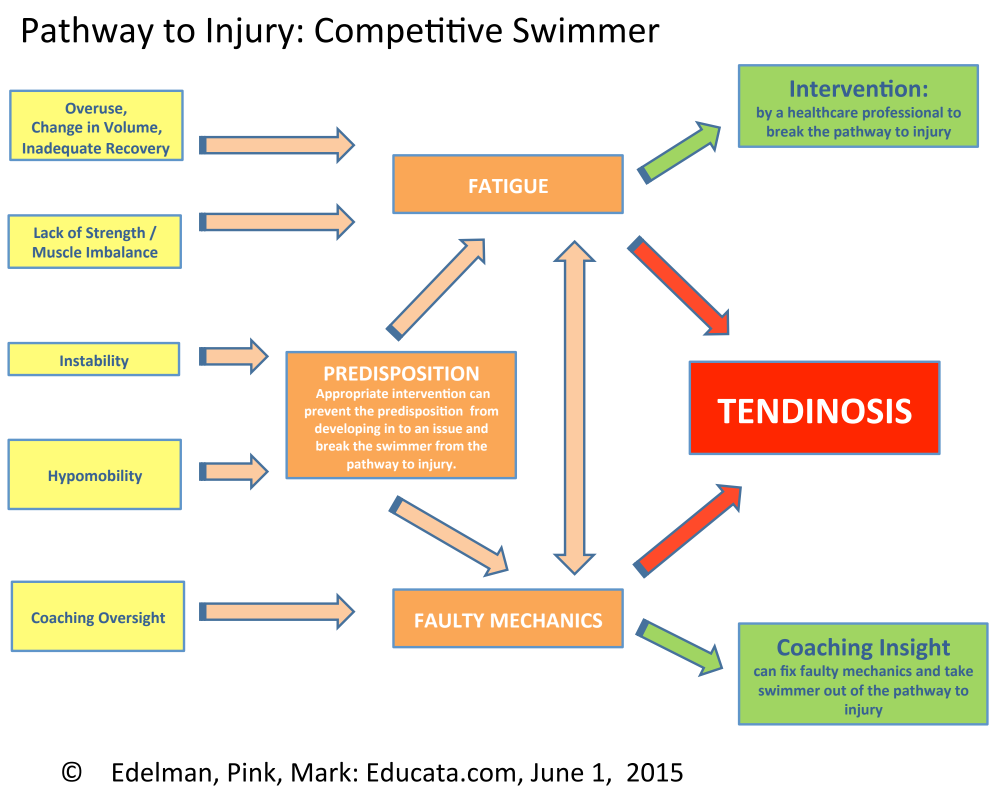


Figure 2: Pathway to Injury

Edelman et al.[16] point out that non-specific shoulder pain (shoulder pain in the absence of trauma) in swimmers can have multiple etiologies and it is up to the healthcare provider to identify the subtle signs of injury before symptoms develop into a rotator cuff tendinopathy that is difficult to manage. Many coaches can be adverse to rest. When identified early, the symptoms are managed without removing the swimmer from the pool.

Treatment Strategy: As a general rule, the treatment strategy for a rotator cuff tendinopathy is: relative rest, modification of painful activities, an exercise strategy that does not exacerbate pain over time, controlled reloading of the tendon, and gradual progression from simple to complex shoulder movements.[29] In addition, research has found that eccentric training can be helpful when managing a tendinopathy. Most of the current research has focused on Lateral Epicondylitis and Achilles Tendonitis. However, Camargo[30] suggests eccentric training can be helpful for a rotator cuff tendinopathy. Anti-inflammatory modalities to help modulate the pain is recommended with this group. In addition, consultation with the coach to review the entire training regimen is indicated. Encouraging the swimmer to use fins to help unweigh the shoulders during a workout can be helpful. Reducing the swim volume and / or taking 3-4 days rest from training may be warranted.

Return To Swimming After Injury

If the treatment program results in removing the swimmer from the water then a careful reintegration back to swim training is essential. Benchmarks have been developed[31] to help the health care professional and coach with this process. Benchmark 1: During the rehabilitation process, when the swimmer is able to reach above shoulder height without pain and demonstrate resisted motions from 0-90 degrees without pain, then the swimmer is encouraged to return to the pool and swim 1000-2000 yards slowly and comfortably while avoiding antagonizing strokes and sprint sets. Benchmark 2: When the swimmer is without pain during resisted motions in all planes, and during most activities of daily living and swimming 2000 yards, then add 500 yards every 3 workouts. During benchmark 2, it is indicated to avoid double workouts and sprint sets. Benchmark 3: When swimming 4000-5000 yards without pain, then integrate all four competitive strokes and add short sprint sets.

Stretching and Dynamic Warm-Up

Athletes often stretch with the misconception that they will increase muscle flexibility, reduce the risk of skeletal muscle injury, and improve performance. Stretching has been well accepted among the swimming community. It is advocated in literature by its governing body[32] [33] and in books considered to be the authority on swimming.[34] Accordingly, swimmers and their coaches tend to devote a considerable time to stretching. However, there is little evidence to support the relationship between muscle stretching and a reduction in injury.[35] [36] [37] [38] [39] In addition, pre-exercise stretching has been found to decrease muscle strength, power output and balance performance.[40] [41] [42] [43] [44] [45]

The shoulder is made up of four joints: the glenohumeral joint, the acromioclavicular joint, the sternoclavicular joint and the scapulothoracic joint. As compared to other joints in the body, the shoulder in unique in the fact that it allows for multiple planes of motion and as a result it is inherently unstable. Stability is predominantly provided by dynamic and static stabilizers. The dynamic stabilizers include the rotator cuff musculature and the surrounding periscapular muscles. The static stabilizers of the shoulder are composed of the articular, capsular and ligamentous structures. Instability describes a pathological environment in the joint representing excessive motion as a result of insult to the stabilizing components, which could lead to shoulder pain in the competitive swimmer. [1] [5] [46] [47] [48]

The shoulder is the most frequently stretched joint among the swimming community. To date, swimmers have adopted stretches that target the static stabilizers of the glenohumeral joint. From the grass roots level to the elite National Team, the stretches shown in Figure A are routinely identified on the pool deck before practice and before a race. In addition to these stretches, some swimmers will incorporate a pre-race ritual that is similar to a ballistic windmill motion with their arms in which one arm is going in the direction of the clock and the other arm is going counter-clockwise. Other pre-race rituals include clapping the hands in front of the trunk similar to horizontal adduction and then clapping the hands behind the back in a horizontal abduction motion. Many of these traditional stretches and pre-race rituals tend to emphasize increasing tissue extensibility of the static stabilizing components of the shoulder and may contribute to instability if routinely completed on a daily basis.

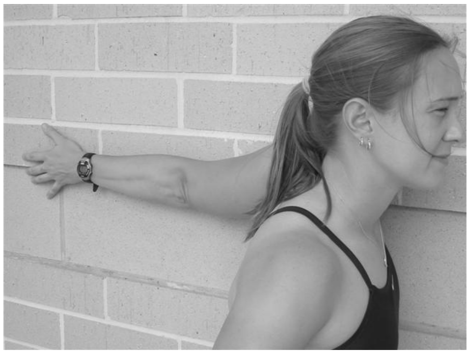
Recent research on swimmer's flexibility[14 15 49 50] suggests there is no indication that extraordinary shoulder joint motion or flexibility is necessary to achieve a fast, efficient stroke. Elite level competitive swimmers are naturally selected to their sport.[3 51 52] They are generally flexible and possess loose connective tissue (general joint laxity).[53 54] Because of their inherent laxity, swimmers should emphasize preserving the overall stability of the shoulder, and the stretches targeting the static stabilizers as pictured in Figure A are strongly discouraged.

Despite the overwhelming evidence that stretching does not reduce injury and that pre-exercise stretching negatively impacts muscle performance, there remains a role for stretching in the sport of swimming. When compared to age-matched controls, competitive swimmers present with limited shoulder rotation range of motion.[54] Stretching is athlete specific. When selecting stretches as part of a routine, it is important that the stretches target the muscle tissue and do not jeopardize the integrity of the static stabilizing components of the joint. Observationally, there are four muscle groups that tend to shorten during the course of a swim season for many swimmers. In an effort to maintain normal rotation range of motion, offset the development of a muscle imbalance, and prevent dysfunctional shoulder mechanics, it is recommended to stretch the following muscles: 1) Upper Trapezius, 2) Levator Scapulae, 3) Pectoralis Major and Minor and 4) the Latissimus Dorsi. The recommended stretches are described below in Figures B-D.

It is recommended that swimmers stretch at a time unrelated to working out and competition, stretching at least several hours prior to getting in the water. For coaches interested in crafting recovery programs for their teams, post-exercise stretching is not encouraged. Stretching fatigued muscles tends to facilitate muscle spindle and inhibit GTO firing[55 56] which does not allow for the muscle to relax and effectively elongate. Stretching that is incorporated into a recovery program should take place several hours after practice or on lighter training days when the muscles are not fatigued. General guidelines for stretching include completing a specific static stretch that targets muscle tissue 1-3 times for 15-30 seconds each, approximately 5 days a week.[57 58 59 60]

A sport-specific warm-up is essential to prepare the body for exercise and competition. Contrary to the deleterious effects of static stretching prior to workout, a dynamic warm-up has been found to produce short term and long term performance enhancements in power, agility, strength, muscle endurance, and anaerobic capacity.[61 62 63] Because of these documented benefits, an active on-deck shoulder warm-up (Figure E) has been developed for swimmers to implement before workout and competition. Five activities are offered with pictures indicating the beginning and ending positions. The swimmer is instructed to complete 15 repetitions of each activity and then complete the entire group twice. The swimmer should employ a steady pace with each activity and avoid ballistic type motions. The order of the activities is purposely designed to sequentially warm-up the tissues in increasingly elevated positions.

Figure A: The five stretches pictured below are no longer advocated for the swimming community.



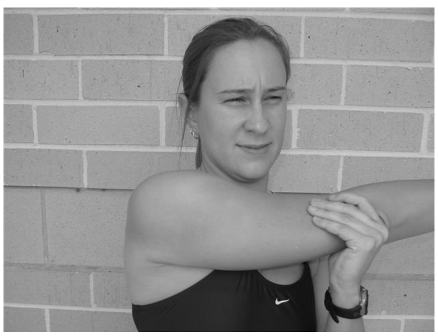


Figure B: **Recommended Stretch #1 - Door Frame Stretch for the Pectoral Group**

Stand at doorway with forearm on doorframe. Elbow bent to 60-90 degrees. Step through the door. A good stretch should be felt along the anterior chest, not the shoulder joint. If you are stretching the right shoulder, step through with the right leg. Complete 3 x 30 seconds each side. The angle of the arm can vary depending on which fibers of the pectoral group you wish to stretch. A combination of angles can be added to the stretching routine to incorporate the different fibers.

Figure C: Recommended Stretch #2 - Two Part Latissimus Dorsi Stretch

Arch your back up like an angry cat to round out your back. Keep your back rounded and drop your rear to your heels. Reach out with your hands and then reach to a side to specify the stretch and address each of the Latissimus Dorsi. Hold each stretch 30 seconds and repeat three times, alternating sides.

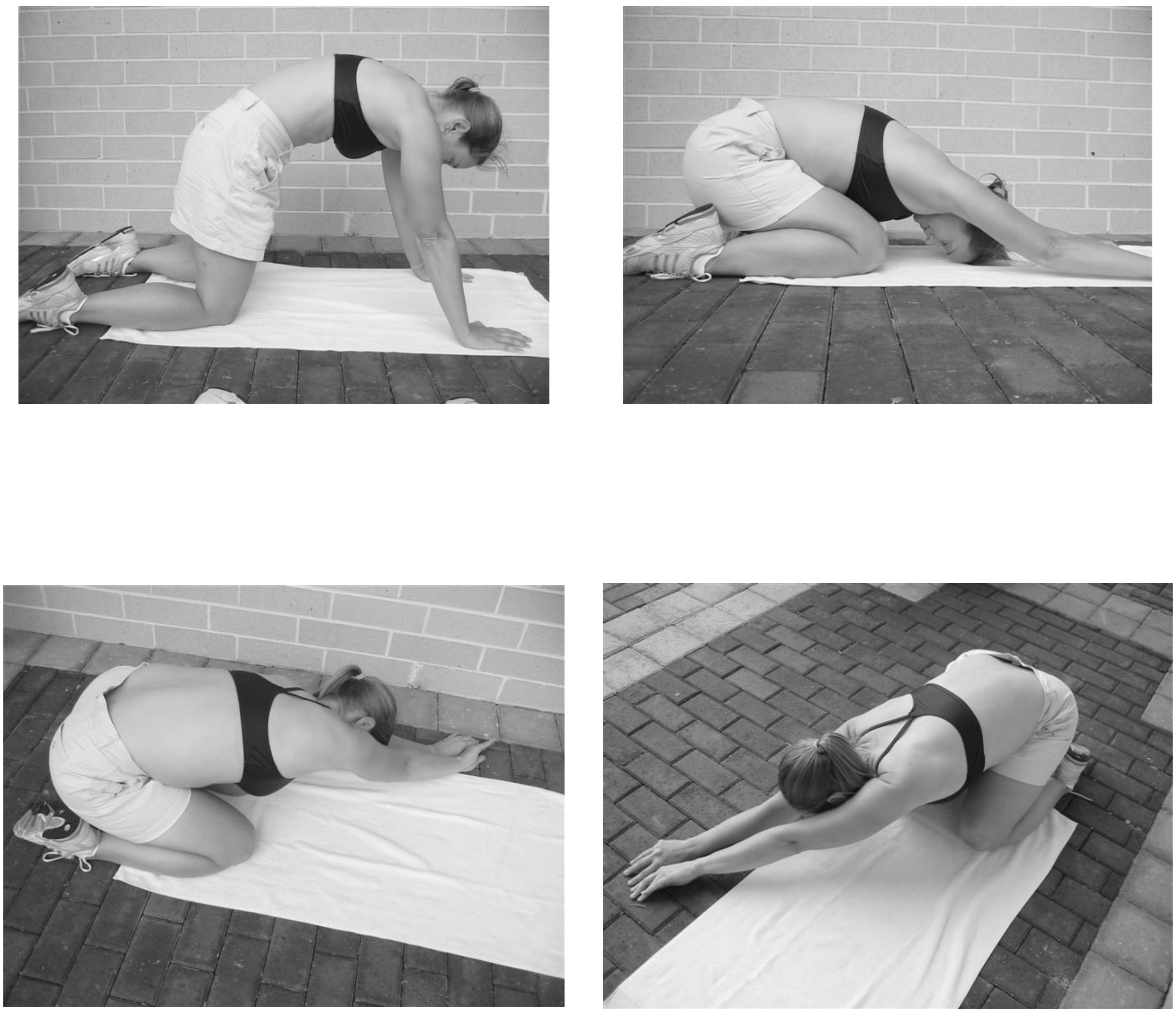


Figure D: Recommended Stretch #3 - Upper Trapezius / Levator Scapulae Stretch

Sit on a chair and grasp the seat with the hand on the side of the tightness. Place your other hand on your head as outlined below and gently pull down and diagonally to the other side. Two versions of this stretch are shown below. The first version is to turn your nose towards your armpit and gently pull down. The second version is to look straight ahead and gently pull down. Hold for 30 seconds and repeat three times, alternating sides.

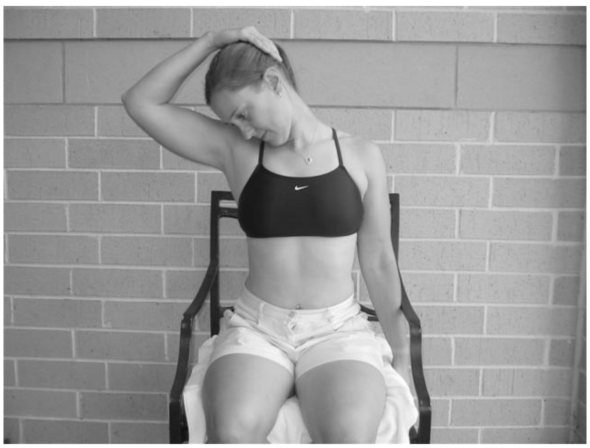
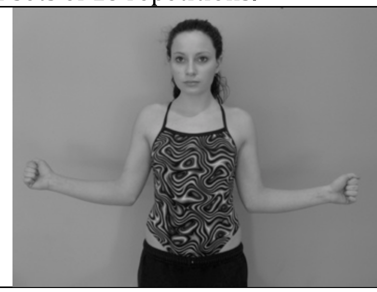


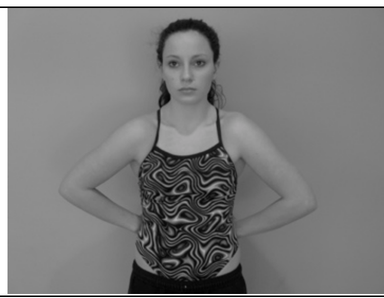
Figure E: On-Deck Active Warm-Up

Complete 2 sets of 15 for each activity

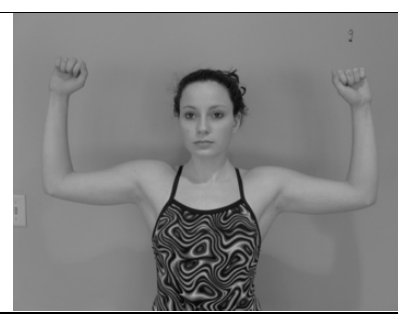
Active Warm-Up #1 – Place your arms by your side, bend your elbows to 90˚ to assume the start position. Externally rotate your arms to the end range at a comfortable pace and then return to the starting position. As you externally rotate, pinch your shoulder blades together. Do not force the end range. Complete 2 sets of 15 repetitions.

#1		
	Start	Finish

Active Warm-Up #2 – Place the back of your hands on your back at the belt line and bring your elbows forward to assume the start position. Squeeze your elbows and shoulder blades together and then return to the start position. Complete 2 sets of 15 repetitions.

#2		
	Start	Finish

Active Warm-up #3 – Forward elevate your arms to 90˚ and then bend your elbows to 90˚ to assume the starting position. Horizontally abduct your arms to a “goal post” position, squeezing your shoulder blades together at the same time. Then return to the starting position. Complete 2 sets of 15 repetitions.

#3		
	Start	Finish

On-Deck Active Warm-Up – Con't

Active Warm-up #4 – Abduct your arms to 90˚ and bend your elbows to 90˚ to assume the starting position. Then externally rotate your shoulders to achieve the "goal post" position. Return to the starting position. Complete 2 sets of 15 repetitions.

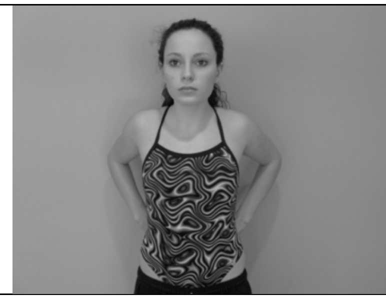
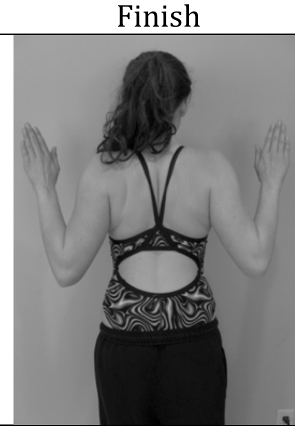
#4		
	Start	Finish

Active Warm-up #5 – Assume a tight streamline for the start position. Drop your elbows into your "back pockets", while squeezing your shoulder blades together and keeping your hands up. Return to the streamline position and complete 2 sets of 15 repetitions.

#5		
	Start	Finish

On-Deck Active Warm-Up

Complete 2 sets of 15 for each activity

#1		
	Start	Finish
#2		
	Start	Finish
#3		
	Start	Finish
#4		
	Start	Finish
#5		
	Start	Finish

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