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Movement Analysis of a Swimmer's Breaststroke

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The correct technique of Breaststroke in swimming is the focus of this paper. I choose this stroke, as I have personally grown up around the pool, have been in competitive swimming competitions and enjoy length swimming and water walking, even now due to a chronic medical diagnosis of osteoarthritis in all four joints, along with lower back issues. I especially enjoy watching the Olympic swimmers compete against their competitors at the world's Olympics.

Swimming is one of the most effective exercises, and can be an excellent form of rehabilitation, by simply going to the pool and performing aquatic therapy. The water helps to ease muscles and take the weight off the weight-bearing joints, due to increased water temperature and buoyancy. It can also improve circulation, respiratory rate, metabolism, strength and flexibly. Swimming is not only fun but also helps with movement, power and speed.

Hypothesis of Individual Joints –

Shoulder:

Swimmer's shoulder, Rotator cuff tears, Rotator cuff tendonitis and Breaststroke knee (caused by the kick motion) are the most common injuries that can occur with improper breaststroke technique. These can be prevented with corrected form and strengthening of the shoulder and muscles prior to jumping into the pool. Neck injuries are also quite common, which can cause significant strain, due to the involvement of keeping the head above the water during breaststroke and/or rotating the neck to breathe in/out of the water.

Elbow and Forearm:

Swimmer's elbow, Tennis elbow, Rotator cuff tears and tendonitis are the most common elbow and forearm injuries that can occur with the improper breaststroke technique. These can be prevented with corrected form and strengthening of, most specifically the shoulder, elbow and

forearms prior to jumping into the pool. Neck injuries are also quite common, which can cause significant strain, due to the involvement of keeping the head above the water during breaststroke and/or rotating the neck to breathe in/out of the water.

Wrist and Hand:

Injuries to the muscles in the hands, wrists, and fingers are quite common. Overstretching the hand, or moving the hand in strange angles, having weak or overworked muscles can all lead to strains and sprains. Delayed onset of muscle soreness, DOMS especially is a common muscle soreness among swimmers. This is delayed muscle soreness which is caused by exercise that typically happens 12-24 hours after a workout. Long swimming routines can increase the risk.

Other injuries which are not muscular, can occur from the pool water. A person can be exposed to a variety of chemicals which can interfere with a person's skin, such as chlorine. An athlete who has sensitive skin, allergies or eczema, their fingers may end up very sore. This soreness usually happens from small scratches from bumping into the bottom of the pool. Hands and fingers tend to get swollen, itchy and red. Other injuries can occur such as having stiff wrists or hands. Having the proper wrist and hand position when doing breaststroke is vitally important to reduce potential injurie developments.

Neck, Head and Trunk:

Neck, Head and Trunk injuries can be prevented with the proper swimming techniques. The head must always be aligned with the spine. Incorrect motions and repetitive use can cause neck injuries. Having the head above water always should be avoided, as this constantly puts pressure on the neck. Other such traumatic injuries can occur which can cause significant and life-threating brain injuries, cervical spine injuries and injuries specific to the spinal cord. These types of serious injuries can even cause paralysis from the neck down.

Spinal cord injuries (SCI) are serious and can be a life-changing event. According to the National Spinal Cord Injury Statistical Center (NSCISC), diving into shallow water is the 5th leading cause of spinal cord injuries. For a breaststroker, preventive methods of not diving in less than 12 feet of water can help prevent such a traumatic event.[18] Preventable measures in use of the corrected swimming form or technique are so important, especially during an athlete performing breaststroke.

Pelvis and Hip:

When an athlete has poor coordination during the breaststroke kick phase, it can potentially lead to hip bursitis or tendonitis which reduces the swimmer's ability to fully extend their hips. This also causes joint pressure with pain, along with pain in the pelvis and lower back areas causing more discomfort. Groin pain has been reported at 43% of the most common injury in breaststroke. Other injuries include Pelvic injuries, Torsional strain, Tight hip flexors and Anterior pelvic tilt. There is also something called Breaststroke Back Syndrome, which is a hyperextension motion of the lumbar spine causing facet joint irritation.

Although these are nasty and, in some case, severe symptoms, they can all be prevented with corrected form and strengthening of, most specifically the hips, spine, pelvis.

Knee:

When an athlete has poor coordination during the breaststroke kick phase, it can potentially lead to breaststroke knee, medial collateral ligament stress syndrome (MCL) and plica syndrome. Other injuries associated with the knee include hip, pelvic pain, muscle strains and sprains. Although these are, in some case, severe symptoms, they can all be prevented with corrected form and strengthening of, most specifically the knees, hips, spine, pelvis and back.

Ankle and Foot:

When an athlete has poor coordination during the breaststroke kick phase, it can potentially lead to many common injuries, such as breaststroke knee, medial collateral ligament stress syndrome (MCL) and muscle strains, sprains, tightness and cramps. Other injuries associated with the ankle and feet include foot and ankle tendonitis = This is a less-common overuse injury that affects the tendons in the front of the foot and ankle due to the frog like kicking motion. These types of injuries can be prevented with corrected form, pre-warm up exercises, and strengthening of, most specifically the knees, hips, pelvis and legs before jumping into the pool.

Introduction –

Swimming is one of the best and most popular sports worldwide and often requires the entire body to move through water as each stroke requires a set of specific techniques. Competitive swimming is one of the most popular Olympic sports.

The goal of a swimming athlete is to try and break a personal time while beating other competitors in the same event. It takes years of practice to build solid techniques and form the work for the stride or stroke. Speed, strength and performance are key elements, and this can be measured both on the pool deck, on dry land doing warm-up exercises and especially for an athlete in the pool, ensuring they follow proper swimming techniques which defines how the athlete performs in and out of the water. A swimmer's stroke is defined as a method of moving the arms and legs to push against the water and propel the swimmer forward. There are five main types of strokes in swimming. Freestyle, Butterfly, Breaststroke, Backstroke and Medley. For the purpose of this paper, Breaststroke is the focus.

Certain techniques are essential as each one depends on the other and can include race distance, and stroke ability. Swimming is a full body sport and requires the coordinated

activation of muscles in legs, core and upper body[2] (neck to the knees, including all of the upper-back and shoulder muscles, the abdominal muscles and the truck and upper-leg muscles). With proper execution of these muscles, it sets an athlete up for a better formed stroke and power in the pool. Proper swimming technique involves stroke, kick and breathing as well as overall form, force and streamline which can greatly improve the ability to swim without injury. Given the unique swimming mechanics, power comes from the shoulder girdle.

The head, neck and trunk work together with the shoulder, and chest, as everything is interlinked. Keeping the head in line with the spine is so important when doing breaststroke to reduce potential injury developments. The most common cause of neck pain in breaststroke is extending the neck too far when coming up for air. Swimming can cause significant strain on the neck, primarily due to the contortion involved in keeping the head above water during the breaststroke or rotating the neck to breathe. It is better to come up and breathe just enough to get the air a person needs. Instead of twisting or rotating the neck, rotate the entire body instead. Ultimately honing the proper technique to eliminate potential damaging neck movements is the best preventative measure, along with performing neck rolls and stretches outside the pool. An athlete should really try to adjust their position, so the neck isn't arched too far for too long. If not done correctly, swimming head-up over long term can cause serious damage due to the extra stress and strain on the neck and back.

> Cokie Lepinski, US Master Swimming Level 4 coach suggests that the head does not move in breaststroke. *"It is important to keep the back of the head and neck lined up with the entire spine. Hinge from the hips, not the neck. Connect the hands, head and hips as you go up to get air, and as you go to streamline or starting position. If the head is out of alignment, even by 1-2 inches – the hips will compensate by riding too low or too high.*

This will loose the body line, ruin the streamline and create resistance instead of minimizing it".

Great Tips:

- Keep head in line with the spine
- Focus the eyes at the bottom of the pool during the glide
- When rising to breathe – use the shoulders and hips, not the head – keep the head lined with the neck, which is lined with the spine
- Hands and head need to hit full streamline at the same time.

Although swimming has many benefits, it can cause a range of injuries to any given individual from repetitive movements and overuse. Injuries such as musculoskeletal, muscle overuse and concussions can happen.

Research proves there is more strain put on the legs and knees than in any other swimming stroke. A screw-kick is incorrect form when two legs are doing different things simultaneously, a common mistake.

The most common injuries in swimming are the breaststroke knee where over 86% of breaststrokers report having experienced knee pain at some point during their swimming career, whereas 47% of breaststrokers have knee pain at least once a week. The foot and ankle are also prone to injuries, caused by over-usage of the muscles, previous injuries not healed correctly, and different or awkward movements in the pool. Foot and ankle tendonitis is a less-common overuse injury that affects the tendons in the front of the foot and ankle due to the frog like kicking motion.

Planning and training for swimmers includes getting the athletes in top performance so they

can do their best. An athlete often has tremendous passion and determination to do everything for the sport, and it has become a sport that is both mentally and physically exhausting. Swimming has many positive psychological benefits, such as reducing stress, ease muscles, and increase positiveness to make a person feel good, and helps a person feel energized. If an athlete is competitively swimming, or for any type of swimming group, it is still important to get the individual 'ready' for the pool. One advantage is a tall person, and someone who is fairly lean. This type of body composition may have a better advantage to say someone who is overweight. Being tall is an excellent advantage. On a personal level, I know someone who is 6.3' and like me, has done a lot of competitive swimming, unfortunately through many years of swimming he now has a shoulder injury, which is very common in this type of sport. Years ago, he reached a goal of being 8th in all of Canada.

Now enjoying watching Olympic swimmer Adam Peaty, a tall 6'3 British swimmer who has won breaststroke gold medals. According to Fédération Internationale de Natation (FINA) Peaty is widely regarded as the dominant breaststroke swimmer of his era, and the most dominant sprint breaststroke swimmer of all time.

A breaststroke swimmer can experience any one of these types of injuries (as listed below), often caused by incorrect techniques.

In competitive swimming the proper techniques, proper physical activity, and exercises ahead of the game can try to prevent or dimmish injuries. No one knows when an injury would strike, but what can be done is to try and prevent the injuries from happening. If an injury does strike, depending on what it is, an athlete must try and get back into the activity slowly. Slow and Steady WINS the race. Don't rush things. Take baby steps and build back up.

Speed, distance and performance all have relative impact as to how an athlete does in the water.

Physical and physiological requirements are also important factors. Being ready ahead of the game (before jumping in the pool) means doing various physical activities and warm-up exercises on the pool deck or weight room/gym on dry land before hand and getting tested to see the level of performance and endurance an athlete has.

Strength training, cardio, weights, and other athletic exercises are especially important to strengthen certain muscles and these types of exercises can all prevent injuries. If these are done correctly, these physical exercises prior to the competitive swim can in fact prevent injuries in the pool. Competitive swimmers try and gain power and control in the pool, to swim faster. Although swimming faster and reaching a goal is not the only focus. The other focus is, of course, the scope of the swim, the technique, movement and how the athlete performs in the water - do they have the right physical form?

For overuse training. it just depends on how much the athlete does, as everyone is different. So athletic exercises can be too much for one person (perhaps they suffer from under-training) and then training, and the amount of training can be perfect for someone else. Research shows that team sport athletes who performed more than 18 weeks of training before sustaining their initial injuries were at reduced risk of sustaining a subsequent injury, while high chronic workloads have been shown to decrease the risk of injury.

The appropriate amount of planning ahead of time and high intense training should improve a person's fitness, which in turn may protect against injury, ultimately leading to greater physical outputs and resilience in competition, and a greater proportion of the athlete available for selection to perform competitively.

There are distinct phases of the Breaststroke technique, which consists of out sweep, in sweep, breathing phase, lunge, extension and recovery phase. In other terms – pull (out sweep), breath

(in sweep), kick, recovery and glide, as shown by the diagram below.

Description / Joint Analysis / Phases / Procedures –

Breaststroke requires a level of skill and coordination that for some is challenging to master. To swim fast, an athlete must balance power with ease, gliding through the water in the most streamlined and efficient way possible. Competitive breaststroke requires a high degree of power, strength, endurance, speed and coordination to generate the required speed for each set of strokes.

Movements such as the wide breaststroke kick places a high level of stress on the knees, hips and feet and can easily lead to damaging the tendons and ligaments. Breaststroke knee occurs from a variety of reasons such as over-training, poor technique, and insufficient warm-ups.

Alternating swimming strokes can help individuals avoid damaging their legs (feet and ankles), along with doing the correct stretching exercises before entering the pool.

To avoid further pain, it is important to avoid causing further strain to the area by staying away from breaststroke training until the injury has been given a chance to heal and the pain has gone away.

As mentioned, before any competitive event, an athlete should effectively and regularly undertake a strength and dry land training program. This will help gain additional benefits for the body and make a person much more flexible in the water for an increased range of movement. It can also help correct any muscle imbalance caused by poor stroke techniques or overuse of the muscles. The combination of strength training before jumping into the pool will benefit an athlete through increased flexibility, and stronger more balanced muscles and can lower the risk of injuries.

A full report of good strength training and warm-up land exercises for any swimmer has

previously been created, as a separate document. These types of exercises both in and out of the pool, for an athlete, will help engage in top performance which should be incorporated into their training program. (Separate report).

Breaststroke is a stroke where the head gets submerged in the water and then raise the head to breathe. This allows the head to be above water, therefore a person can breathe freely while keeping their eyes open. However, more experienced elite athletes and well-competitive swimmers dip their heads underwater during the glide phase. This position improves the person's form or technique as it reduces drag and enables the swimmer to swim with performance and speed.

Breaststroke has 6 Elements of a "Good Breaststroke form":

1. Body Position

Body position should be with the face facing forward in line with the body, while the shoulders, hips and knees and legs remain as horizontal as possible but slope the body slightly to allow the leg kick to stay beneath the water. Each stroke starts and ends in a streamlined position. For an athlete, the more quickly a person can get into the streamlined position; the more efficient the stroke will be.

A good form to start the breaststroke consists of a proper head position (looking straight down with head in the water) and having the proper leg, feet, ankle

and high hip position. Hips should be kept up at all times to reduce drag, especially when a person lifts their head up to breathe.

In breaststroke the arms perform synchronous semicircular movements. When the arms begin to pull, they move outwards, backwards and downwards until the arms are bent 90 degrees. The elbows are at shoulder level, and the upper arm and hands are in line and pointing downward. Along with providing additional propulsion, the hands and arms lead the body during breaststroke, break the water and create an opening for the head and shoulders to pass through, contributing significantly to the proper streamline.

The shoulders shrug to narrow the upper body width during the in-sweep. The hands, arms and shoulders work with the hips to create a pocket of air in which to catch your breath. Next the arms move further back, the upper arms move to the sides of the body, while the hands move towards each other under the chest. This is when the upper body rises out the water until it is included at 45 degrees. When hands meet under the chest, the arms are extended forward in a line to return to the starting position. At the same time, the body is then positions in a horizonal position.

Breaststroke requires a high degree of flexibility, especially plantar flexion of the ankle and in using the core and abdomen muscles. This helps in pulling motion and recovery and helps in kicking speed.

The feet should be faced outwards as they sweep out and backwards in circular motion, while the feet remain flexed rather than loose. The legs then come together, long and in a streamlined position with the feet intoed.

The legs recover to bring the ankles and heels towards the seat with the soles of the feet facing outwards. A good athlete keeps the feet and ankles high towards the bum rather than the

knees to the chest.

The legs and feet are the main source of power in breaststroke nearly at 80%, more so than the arms. The feet should be turned outwards and are kicked in a frog-like motion. Ankles and feet need to be relaxed as much as possible. The feet should come up towards the back side so the athlete can drive the feet back and outwards into extension. When the knees and legs are straight, push the feet back together, which will allow forward gliding in a streamlined position.

When the athlete turns at the wall, the feet can be placed against the wall sideways, where the head comes out of the water (to breathe) during a turn. The face will then go back into the water, push off in a streamlined position and pull back, kick and extend into the stroke.

2. Pull (Out Sweep) – Catch Phase

A person must initiate the pull from the streamlined (starting position). Pulling hands apart and creating a large triangle of space, driving the hands forward and back to the starting or streamlined position, catching the water.

The "catch" is when the hand enters the water. A person is essentially "catching" the water, with the third or fourth finger leading the arm, with the wrist slightly bent at the line of the goggles. If the thumb enters the water first, it can cause the shoulder to internally rotate and can lead to a shoulder injury.

When a person initiates a pull, pressing hands outwards with pinkies up and the arms have been extended away from the head, and hands are wider than the shoulders, a person can pull down with a strong early vertical forearm to catch the water. Next, the head should be lifted to breathe. Then dropping the head back down into the water, while the arms should explode forward to gain power. The "pull" is the sweeping phase when the arm pulls through the water to move the body forward. The hand and arm should enter the water as an extension of the

shoulder. If the arm crosses over the midline or is too wide, it could cause shoulder injury. Next, don't forget to lift the head to breathe. Next, a person should drop the head back down into the water, the arms should explode forward to gain power.

Knees are fully bent, and the feet are above the buttocks. Both the feet and legs are in an everted, dorsiflexed position. The legs are the propeller or power drives in the water, this is what pushes a swimmer forward to gain power and speed.

The flexibility of the ankles is crucial in insuring the most water is caught. An athlete must initiate the pull from the streamlined (starting position). Pulling hands apart and creating a large triangle of space, driving the hands forward and back to the starting/streamlined position, catching the water.

The breaststroke body motion is centered around the hips. However, the feet, and ankle motion is frequently used as a frog or dolphin kick, a symmetric, bilateral action.

The out sweep of the hands, the elbows will bend throughout the pull and then a person needs to think about where the elbows are going to be. On the out sweep, the elbows will be 'pointed out'. This is where the elbows rotate up and will be helpful to get the forearms engaged as the hands pitch down.

The out sweep part has been described as having arms in a M-like shape with the elbows close to the top of the water as the fingers pitch down during the catch and release phases of the stroke. (Cokie Lepinski, 2014 USMS Coach of the Year)

Lots of swimmers drop their elbows on their breaststroke pull, which significantly reduces the amount of water they are able to pull with each stroke. A person should follow proper techniques at all times which initiates the pull by bending at the elbow and keeping the hands in line with the forearms. Pull straight back and then the arms have just become massive paddles to pull the

water and create performance and speed in the water.

EVF is one of the most common concepts in technical swimming, so a competitive swimmer must grip the maximum amount of water during the pull of the stroke. By following this technique, a person can find full efficiency in the water, swim faster with speed and reduce the chance of over-use injuries. Goal is to position the forearm as close to vertical as early as possible in the catch phase of the stroke to grab the most water as early as possible. By doing this, a person will increase the surface areas of the pull, where the forearm and arm has much more surface area than just by the hand.

There are steps in the EVF technique, which consists of Entry – Extension – Fingertip Press – High Elbow and Early Vertical Forearm (EVF).

3. <u>Kick</u>

Many have called the breaststroke a frog kick, which requires a person to flex their feet rather than pointing the toes. Below is the correct form of the frog kick to ensure an efficient and powerful breaststroke.

The kick motion starts when the legs are fully extended horizontally. The knees bend and move forward as the ankles/heels/feet are brought as close to the buttocks as possible. This engages the muscles gluteus maximus. When the heels reach the highest point, the feet rotate outward, so the toes point to the side and will move wide of the knees. The knees and feet push backward and inward from that position until they reach full extension with the legs together.

UP – pull feet/ankles up towards the buttocks. This is the highest resistance in the kick on strengthening the hamstrings to get the heel to the butt faster and can increase the strength/power/tempo.

OUT – Next, kick the legs out. Try not to spread the knees too wide. Knees should be kept about shoulder-width apart. The wider the kick creates more resistance.

AROUND – Sweep the legs around, beginning to pull the feet back together.

TOGETHER – Squeezing the legs together, while extending the arms into a triangle position, remember to breathe, then return to the starting streamline position.

Timing - (1) Pull (2) Kick (3) Glide (one of the most important aspects of breaststroke)

Pull = Starting at the streamlined position (as above) – a person essentially pulls themselves through the water to create speed and power while maximizing the full breaststroke form.

Kick = This essentially is the frog kick, as above. While the hands and arms are extended during the pull, driving hands forward the feet must kick to enhance the motion.

Glide = Gliding is the proper streamline which helps maximize the distance per stroke. The duration of the glide depends on the event a person is swimming. Longer events can allow for longer glides. For breaststroke, however, a competitive swimmer can swim in a 25–50-meter pool, performing breaststroke lengths to gain speed and power, while maximizing the correct swimming technique.

If a comparison is done of 50, 100 and 200 breaststrokes, there would be a difference in tempo and timing. 50 breaststrokes call for a fast tempo, but an elite swimmer will hold their glide for a split second longer. In 100 breaststrokes, the tempo is high, but there appears to be more opportunity to glide. With breaststroke and during competitive swimming, the goal is the same

which is to get back to the starting/streamlining positions as quickly as possible to beat their competitor in the pool.

4. Pull Out

The pull-out is completed after an athlete starts at the wall, then pulls out from the wall. In many competitive swims, an athlete can only have one pullout per length. The normal routine for a pull-out is to begin in streamline, hold it for 2-3 seconds, then pull down extending the arms, sending the body forward. Next, the feet must kick with the frog kick (or dolphin-style kick) at any point during or after the arms are extended. A big problem with the dolphin kick, however, it can cause more drag in the water and requires a swimmer to reset the body position again before beginning the regular stroke again. This method can be quite intense offering only a small range of motion which increases fatigue of the muscles.

According to US Master Swimming, there is a proper technique to follow:

- Turn thumbs down and twist palms out at end of the glide, ready to start the next stroke
- Keep fingers loose, removing tension from the hands
- The hands and forearms act as one unit. A good way for an athlete to mimic this motion, is to pretend they
- have a steel plate running from the palms to the forearms
- When transitioning from out-sweep to in-sweep, “turn the corner” near the head
- Don't let the elbows collapse. Elbows should be locked on the out-sweep and into streamline from the
- shoot through and high on turning the corner and the in-sweep
- Shrug the shoulders and pull the elbows in towards each other on the in-sweep and shoot-

through.

- Keep the elbows in front of your shoulders, don't let them get trapped underneath your chest.
- As soon as your chin is over the hands on the in-sweep, immediately drive the hands forward for the shoot-through
- Swimming with the head out of water increases drag and slows the athlete down, it makes the whole breaststroke process harder and more awkward
- A big advantage is to submerge the head while giving a much greater confidence in the water. Good breaststroke technique is so important and will ensure a regular breathing pattern
- Injuries can occur if athlete wears contact lenses in the pool, this may cause injuries on the pool floor or the pool wall, if they can't see the end of the pool properly, so in often times can injure their head first. To prevent such an injury – there are many prescription goggles which are available and makes a huge difference, so the athlete can then see clearly.

According to a world-class breaststroke coach Joszef Nagy, the best hand position on the shoot-through and recovery is palms down. Second best, prayer recovery. Worst position is palms up.

> *"If you recover your hands up, this slows your recovery because you must flip them to start your stroke."*

Pertaining to wrist or even hand injuries – they do occur. Simply by overextending the fingers by placing the hand on the bottom of the pool, a sprain can happen or swimming so close to the wall of the pool, that a person hits their finger against the wall, which could lead to injuries ranging from swelling to a broken finger. Accidentally hitting someone's hand while wearing swim paddles sends a shock all the way up the arm and leaves the arm tingling with numbing pain. When swimmers wear paddles, they are usually focusing on rotating and finishing their

stroke. They are putting a lot of force behind moving the water to generate speed and power in the pool. It is so important to have the proper wrist and hand position when doing breaststroke.

Some preventable measures include:

Keep fingers slightly separated in the pool, this may slow the speed a person generates, but reduces tension on the fingers.

When recovering the hands, most breaststrokers have their palms facing each other, but reduce potential pain in shoulders, a swimmer should flatten their hands so that their palms are parallel to the bottom of the pool. In addition to flattening the hands, swimmers should begin the pulling phase when their hands are shoulder-width apart

Avoid stiffening the wrist or fingers. Instead, a person should simply flow through the water, because locking the joints reduces blood flow and makes the hands and fingers more vulnerable to injuries.

If an athlete experiences weak hands or wrists, a number of grips strengthening exercises can be achieved prior to any swimming workout or competition, this can help strengthen hand muscles.

To prevent stiff wrists - make sure not to rotate, fold or drop hands in relation to the forearms. When swimming, a good rule to follow is a person must try to imagine that he/she doesn't have a wrist so that he/she can move the hands without moving your arms.

During your workouts, swim first with one arm and then with the other, keeping the arm not stretched out in front of you. This will help you to gain awareness of this technique before swimming fast with both arms.

Arm movement should always be in front of a person. If you lose sight of the hands because they are underneath your body or beyond your shoulder line, then you are making a mistake

The spine should remain relatively straight from the head to the tailbone

If the head remains out of the water – a person is unnecessarily straining the vertebrae in the neck with an unnatural arch

Position the head slightly forward with a m tuck in the chin to help keep the neck straight

Pull in the abdominal muscles to support a straighter back

Keep the hips as close to the surface as possible to avoid bending the lower spine

When the arms start the pull phase – bring the head out of the water and breathe through the mouth. Keeping the head and shoulders relaxed and free from tension

When the arms reach the forward position in the recovery stage – extend the head forward into the water with the ears in line with the biceps. Exhale slowly through the nose or mouth

Position the head slightly forward with a milk tuck in the chin to help keep the neck straight

Pull in the abdominal muscles to support a straighter back

Keep the hips as close to the surface as possible to avoid bending the lower spine

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It is so important to prevent swimming injuries, have and maintain the proper swimming technique. These tips will help avoid straining the neck and back while perfect the efficiency in the water, minimize water resistance and engage in how to swim faster.

These simple swimming tips will help minimize water resistance and engage in how to swim faster.

Individual Joint Injuries:

Certain techniques are essential as each one depends on the other and can include race distance, and stroke ability. Swimming is a full body sport and requires the coordinated activation of muscles in legs, core and upper body (neck to the knees, including all of the upper back and shoulder muscles, the abdominal muscles and the truck and upper-leg muscles). With proper execution of these muscles, it sets an athlete up for a better formed stroke and power in the pool. Given the unique swimming mechanics, power comes from the shoulder girdle.

Although swimming has many benefits, it can cause a range of injuries to any given individual from repetitive movements and overuse. Injuries such as musculoskeletal, muscle overuse and concussions can happen. The most common injuries in swimming are the upper

body extremities of swimmer's shoulder, rotator cuff tears, rotator cuff tendonitis and breaststroke knee. Neck pain and lower back pain are also common.

Shoulder:

Because of the great number of stroke repetitions and force generated through the upper extremity, the shoulder is uniquely vulnerable to injury in the competitive swimmer. The term swimmer's shoulder was first defined in 1978. It was used to describe anterior shoulder pain during and after workouts. The underlying cause of pain is normally post workout muscle soreness from repetitive movements, or a more serious symptoms, such as tendonitis, instability, impingement, labral tears, or symptomatic os acromiale.

Rotator cuff tears and rotator cuff tendonitis are also very common. The rotator cuff has many functions which work together to determine crucial functions of the shoulder. It stabilizes the top of the humerus of the shoulder, it helps to lift the shoulder up and sideways, it helps to rotate the shoulder externally, and it allows free movement of the humerus during elevation. Research proves that over 2 million people each year have rotator cuff problems, including tears.

The rotator cuff is complex consisting of four muscles that cover the top of the upper arm bone. The four muscles come together in the shoulder as tendons. The muscles begin at the shoulder blade and stretch to the humus (the upper arm bone). Four muscles consist of the (1) Supraspinatus – the muscle begins over the spine of the shoulder blade and terminates near the rounded top of the humerus bone (the greater tuberosity). (2) Infraspinatus muscle – begins underneath the spine of the shoulder blade and connects to the back of the humerus. (3) Teres Minor muscle, begins on the outer side boarder of the shoulder blade and connects to the smaller side of the humerus' rounded top (lesser tuberosity), and the (4) Subscapularis muscle, which begins on the front of the shoulder blade sitting directly above the ribs. It also connects to the

lesser tuberosity.

A breaststroke swimmer can experience symptoms of swimmer's shoulder and rotator cuff tears and tendonitis, or even breaststroke knee. These injuries are often caused by incorrect techniques. Swimmer's shoulder results from repetitive use of the joint, which leads to irritation, inflammation, tears and scarring. Symptoms include pain, muscle weakness, shoulder instability and limited range of motion. As we know many swimmers experience repetitive strain on the shoulder joint which irritates tendons and muscle tissue. Shoulder bursitis and tendinitis are common causes of shoulder pain and stiffness. Tendinitis occurs as a result of sports injuries, by repetitive minor impact on the affected area, or from a sudden, more serious injury. This damage prevents the joint from moving smoothly. Left untreated a swimmer's shoulder can cause rotator cuff tears, which makes it hard to raise and move the arm. Shoulder pain and weakness are especially common.

Elbow and Forearm:

Because of the great number of stroke repetitions and force generated through the upper extremity, the elbow can be prone to injuries, such as swimmer's elbow, swimmer's arm, dropping elbow, lateral epicondylitis, also known as tennis elbow, rotator cuff tears and rotator cuff tendonitis are also very common. The rotator cuff has many functions which work together to determine crucial functions. Research proves that over 2 million people each year have rotator cuff problems, including tears. Lateral epicondylitis, also known as tennis elbow and occurs when a person repeatedly perform the breaststroke, in which the elbow is bent, the forearm is facing downward and the upper arm rotates toward the center of the body. The repeated motion causes the tissue to become inflamed and produces tiny tears in the tendons that attach to the bony point outside of the elbow and the forearm muscle.

Many swimmers experience repetitive strain on the elbows and forearms which irritates tendons and muscle tissue. Elbow bursitis and tendinitis are common causes of pain and stiffness. Tendinitis occurs as a result of sports injuries, by repetitive minor impact on the affected area, or from a sudden, more serious injury. This damage prevents the joint from moving smoothly. Left untreated it can cause rotator cuff tears, which makes it hard to raise and move the arm.

Wrist and Hand:

Potential injuries to the muscles in the hands, wrists, and fingers. Overstretching the hand, or moving the hand in strange angles, having weak or overworked muscles can all lead to strains and sprains. DOMS especially is a common muscle soreness among swimmers. This is delayed muscle soreness which with long swimming routines can increase the risk. The American College of Sports Medicine (ACSM), reports that most experts believe that tiny injuries and tears in muscles can cause significant pain. Long swimming routines or workouts can increase the odds.

Other injuries which are not muscular, can occur from the pool water. A person can be exposed to a variety of chemicals which can interfere with a person's skin, such as chlorine. An athlete who has sensitive skin, allergies or eczema, their fingers may end up very sore. This soreness usually happens from small scratches from bumping into the bottom of the pool. Hands and fingers tend to get swollen, itchy and red.

Other injuries can occur such as having stiff wrists or hands. Having the proper wrist and hand position when doing breaststroke is vitally important to reduce potential injury developments.

Head, Neck and Trunk:

The head, neck and trunk work together with the shoulder, and chest, as everything is interlinked. Keeping the head in line with the spine is so important when doing breaststroke to reduce potential injury developments. The most common cause of neck pain in breaststroke is extending the neck too far when coming up for air. The head must always be aligned with the spine. Incorrect motions and repetitive use can cause neck injuries.

Having the head above water always should be avoided, as this constantly puts pressure on the neck. Other such traumatic injuries can occur which can cause significant and life-threating brain injuries, cervical spine injuries and injuries specific to the spinal cord. These types of serious injuries can even cause paralysis from the neck down.

Spinal cord injuries (SCI) are serious and can be a life-changing event. According to the National Spinal Cord Injury Statistical Center (NSCISC), diving into shallow water is the 5th leading cause of spinal cord injuries. For a breaststroker, preventive methods of not diving in less than 12 feet of water can help prevent such a traumatic event. Preventable measures in use of the corrected swimming form or technique are so important, especially during an athlete performing breaststroke.

Swimming can cause significant strain on the neck, primarily due to the contortion involved in keeping the head above water during the breaststroke or rotating the neck to breathe. It is better to come up and breathe just enough to get the air a person needs. Instead of twisting or rotating the neck, rotate the entire body instead. Ultimately honing the proper technique to eliminate potential damaging neck movements is the best preventative measure, along with performing neck rolls and stretches outside the pool. An athlete should really try to adjust their position, so the neck isn't arched too far for too long. If not done correctly, swimming head-up

over long term can cause serious damage due to the extra stress and strain on the neck and back.

Pelvis and Hips: *(Lumbo-Pelvic Injuries include)*

Torsional Strain – occurs when the body does not roll as a whole unit during breaststroke causing abdominal loading at the point in the spine where the rolling stops. This causes injury to the swimmer by over-use or acute injuries or both.

Tight hip flexors and Anterior hip pain can especially cause pain while reducing hip extension resulting in hyperextension of the lumbar spine and anterior pelvic tilt.13

Anterior Pelvic Tilt results in the pelvis assuming a lower-than-normal position in the water which creates a drag and slow motion.

Breaststroke back syndrome – hyperextension motion of the lumbar spine can cause facet joint irritation. This condition with repetitive motions can cause joint inflammation, leading to reflexive spasms of the back muscles and increased pain.

Lower back problems like stress fractures of the pars interarticularis (spondylolisthesis) muscles can occur. Also including overloading of the muscles (repetitive use) can cause an initial feeling of tightness within the area which results in pain during and after a swimming session. Tight and painful hip flexors can cause reduced performance in the pool. Tight hip flexors decrease the streamline position and also decreases kicking strength. Other injuries such as anterior hip impingement and lower back pain are most common.

Knee:

When an athlete has poor coordination during the breaststroke kick phase, it can potentially lead to breaststroke knee, medial collateral ligament stress syndrome (MCL) and plica syndrome. Other injuries associated with the knee include hip, pelvic pain, muscle strains and sprains.

Although these are, in some case, severe symptoms, they can all be prevented with corrected form and strengthening of, most specifically the knees, hips, spine, pelvis and back before jumping into the pool.

Ankle and Foot:

. When an athlete has poor coordination during the breaststroke kick phase, it can potentially lead to many common injuries, such as breaststroke knee, medial collateral ligament stress syndrome (MCL) and muscle strains, sprains, tightness and cramps. Other injuries associated with the ankle and feet include foot and ankle tendonitis = This is a less-common overuse injury that affects the tendons in the front of the foot and ankle due to the frog like kicking motion.

Muscle Analysis

Shoulder:

As mentioned above, there are certain phases of the breaststroke swimmer's technique and correct form while an athlete is in the pool. Breaststroke tends to use the full body and many muscles are used which provide certain movements for specific joints and strokes.

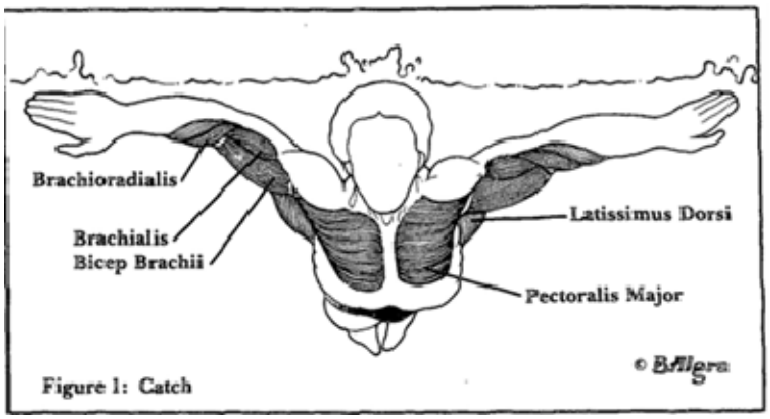


Figure 1: Catch

Upper-Body Muscles -

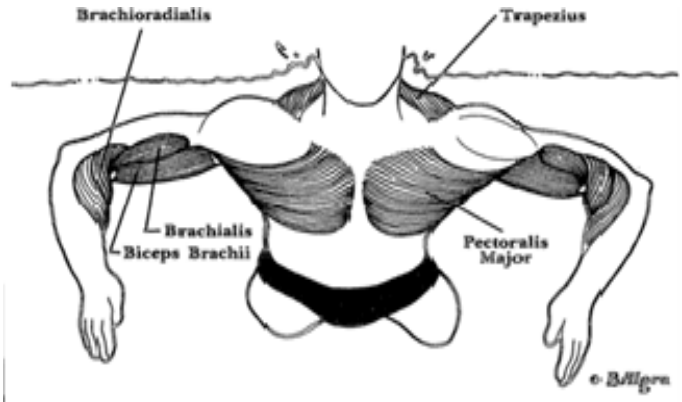
From the start of the stroke in the pull / catch phase, the swimmer's arm is in the streamlined position. The swimmer begins the pull or catch phase by engaging their chest muscles (the pectorals) and the muscles in the middle of their back (latissimus dorsi). This helps to sweep their arms inwards and downwards against the water.

Upper arms and shoulder muscles (biceps, triceps and deltoids) are engaged. The chest, upper

arm and shoulder muscles (pectorals, biceps, triceps and deltoids) help to extend the swimmer's arm and return them to the streamlined position to begin the stroke again.

Primary muscles are triceps brachii, brachioradialis, brachialis, biceps brachii, pectoralis major, latissimus dorsi, subscapularis, teres minor, flexor carpi ulnairs, flexor digitorum profundus, flexor carpi radialis, and palamris longus.

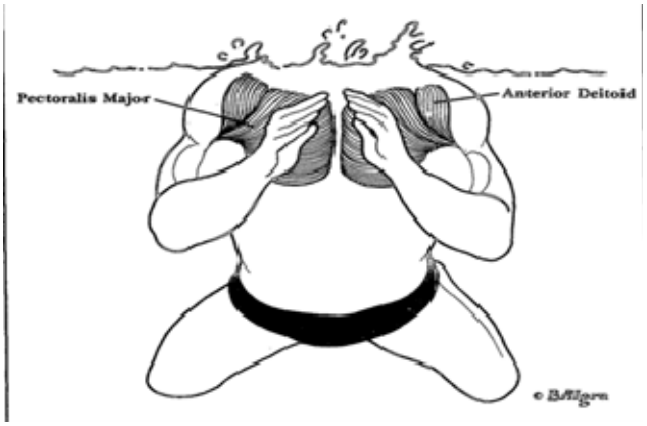
Shoulder & Upper Arm Muscles – Deltoids The shoulder muscles help to stabilize the swimmer's upper body muscles and also help to maximise propulsion.



Upper Arm Muscles - Biceps and Triceps - The upper arm muscles are engaged during the pulling movements in the arm stroke.

The muscles of biceps brachii, brachioradialis, and brachialis bring the hands closer together. The inward and upward sculling motion is created by the biceps and the supinator. The latissimus dorsi, pectoralis major, and teres major adduct the shoulders bringing the elbows together underneath the swimmers chest. The trapezius and levator scapula lift and stabilize the swimmers head.

Middle Back Muscles - Latissimus Dorsi "Lats" - These muscles are engaged during the pulling movements in the arm stroke



Chest Muscles – Pectoralis Major - The chest muscles are engaged during the pulling movement phase in the arm stroke.

Abdominal Muscles - These muscles are the stomach (abdominal) and side abdominals

(obliques) which help to stabilize a swimmer's body, which in turn helps maintain an effective position in the water, to help maximise propulsion and to minimise drag.

Lower Body Muscles – will be discussed in future papers, as we continue to explore anatomical terms of the knees, hips, legs, buttocks and associated muscles.

Elbow and Forearm:

Primary elbow muscles used in breaststroke are the biceps brachii, brachioradialis and brachialis which all contribute to the flexed elbow, additionally the subscapulairs and teres major maintain the high elbow position in the water. Joints in the elbow and forearm, the upper arm bone (humerus), attaches to the radius and the ulna bones of the forearm at the elbow. Three different joint articulations allow these bones to attach together and to move relative to one another. Each joint permits a particular type of movement, such as the joint between the humerus and the radius that allows the arm to fold up and down, and also to twist. The use of the elbow involves four different muscles, two different ligament structures and three individual nerves.

Swimmer's arm is a condition that occurs from repetitive motion of the elbow. In breaststroke mostly from the pull-up motion in the pool. Elbow muscles and rotator cuff tendons are effected. Symptoms include a weakened hand grip, a burning sensation in the elbow, stiffness of the elbow, and a pain that is felt on the outside of the elbow, even when stabilized.

Lateral epicondylitis is also known as tennis elbow. This is painful condition that occurs when elbow tendons are overloaded from repetitive motions of the wrist and arm. Pain is often felt where the tendons of the forearm muscles attach to the bony bump on the outside of the elbow. The tendon involved in tennis elbow is called the extensor carpi radialis brevis, when injured this tendon prevents the wrist from bending backwards away from the palm. Tennis elbow, or lateral epicondylitis, is a condition in which the tendons that attach the elbow muscles to the bones

become strained; pain from the outside of the elbow shoots inward to the rest of the arm. Tennis elbow can also be due to the high angle style of breaststroke. Inflammation of the triceps tendon, which attaches the triceps muscle in the back of the upper arm to the elbow, is also a common cause of elbow pain in swimmers.

Dropped Elbow is often caused by breaststroke over gliding. Over gliding is an overloaded term when a swimmer swims at slower tempo or turnover. Dropped elbow is also sometimes called nursemaid's elbow. A pulled elbow is a result of the lower arm (radius bone) becoming partially dislocated or slipping out of its normal position at the elbow joint.

Wrist and Hand:

Hand and Wrist muscles in breaststroke are used, which extend from the forearm, elbow and shoulder. Hand = Extensor Policies Brevis

Extensor Polices Longus (EPL) – Contributes to thumb function. The thumb muscle which extends and adducts the thumb metacarpophalangeal (MCP) and interphalangeal (IP) joints.

EPL – long muscle located at the deep layer with extensor pollicis brevis, abductor pollicics longus, extensor indicis, and supinator muscle in the posterior compartment of the forearm. It originates from the mid-third of the ulna, and interosseous membrane then courses down to the distal phalanx of the thumb. It may also assist in wrist joint extension.

Pectoral and Latissimus dorsi muscles are used to sweep the arms inwards against the water.

The arm muscles, such as the biceps, triceps and brachialis, allow the elbow to extend and flex as the arm stroke is performed.

Muscles near the wrist maintain the hands in the proper position for each stroke.

Specific Wrist/Hand muscles used in breaststroke phases:

Catch Phase - The palms are in a 90-degree pronated position, as the wrists create a cup like

position in the water, the arms begin to move slightly laterally. The arms are extended slightly farther than the shoulders.

Muscles used: elbow extension, medial rotation at the glenohumeral joint and pronation.

Down Sweep – As the arms move, the swimmer begins to lift their head to breath. At the end of this phase the swimmer's hand begin to inwardly accelerate, preparing for the in-sweep

Muscles used: shoulder muscles and elbow muscles. The inward acceleration of the hands are created by the biceps brachii and the supinator muscles.

In-Sweep – This phase begins when the hands are slightly turned inward and in an upward position. The hands begin to accelerate throughout this phase, as they accelerate with a lifting motion. This produces speed and propulsion in the upper extremities. The hands and forearms move medially underneath the water. The hand come together underneath the chin, while the elbows are brought together underneath the chest, as well.

Muscles used – The biceps brachii, brachioradialis and brachialis bring the hands together. The inward and upward lifting motion is created by the biceps and supinator, along with the shoulder and elbow muscles.

Recovery Phase – This is when the arms extend until the arms are fully extended.

Muscles used – The triceps brachii, anterior portion of the deltoid, coracobrachialis and clavicular head of the pectoralis major contribute to the extension of the arms as they reach forward.

Head, Neck and Trunk:

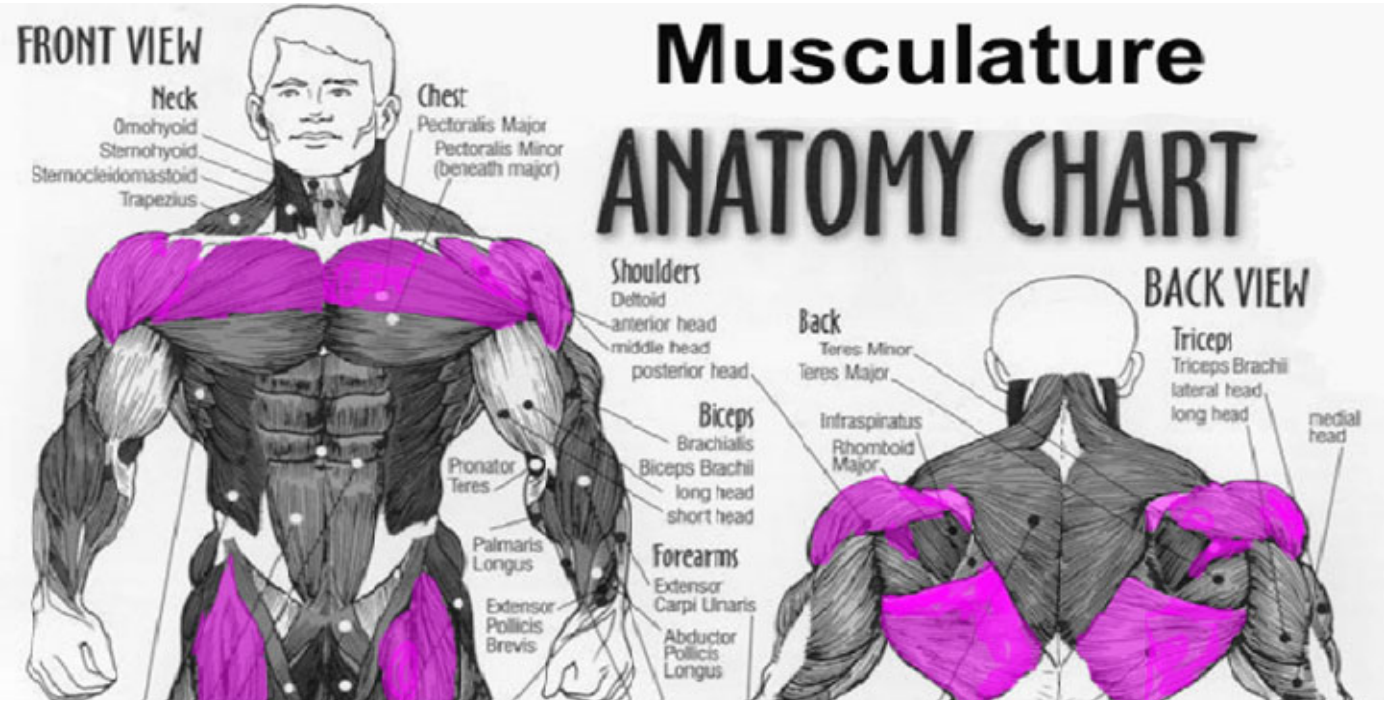
The weight of the head is significantly reduced by the buoyancy and support of the water. However, an athlete must correctly breathe which requires the neck to move. Many of the muscle during the swimming stroke can become tired or strained resulting in pain as many of these

muscles work with the shoulder muscles to provide proper technique in the pool.

Good posture ensures good alignment of the joints and ligaments which allow for optimal contraction of the muscles during breaststroke. As well, by continually to have the head above water, it can strain the muscles and puts pressure on the cartilage between the vertebrae. If the head remains out of the water, the athlete is unnecessarily straining the vertebrae in the neck with an unnatural arch. The spine should remain relatively straight from the head to the tailbone.

Neck pain is commonly associated with stress, anxiety and tension and swimming is one of the best things a person can do to reduce stress and cope with anxiety. Stress can be caused by muscle spasms in the upper neck and Trapezius muscles. It is so important to keep the head always aligned with the spine. When a person breathes in, they should look slightly down and forward so that the head stays in a neutral position. Avoid extending the neck.

Neck pain may not be the only cause from swimming, but it is vitally important to look at the bigger picture from posture and previous injuries to the neck.



Upper Body Muscles used in breaststroke:

- From the start of the stroke, with the swimmer's arms in a streamlined position
- The swimmer begins the catch phase by engaging their chest muscles (the pectorals) and the muscles in the middle of their back (latissimus dorsi). This helps to sweep their arms inwards and downwards against the water
- The catch phase is assisted by engaging the upper arm and shoulder muscles (the biceps, triceps and deltoids)
- The chest, upper arm and shoulder muscles (pectorals, biceps, triceps and deltoids) helps to extend the swimmer's arms and return them to the streamlined position

Chest Muscles (Pectorals 'Pecs'): The chest muscles are engaged during the pulling movements in the arm stroke.

Middle Back Muscles (Latissimus Dorsi 'Lats'): The middle back muscles are engaged during the pulling movements in the arm stroke.

Upper Arm Muscles (Biceps and Triceps): The upper arm muscles are also engaged during the pulling movements in the arm stroke.

Trapezius, Pectoral Muscles and anterior (front) neck and upper back muscles. The Pectoral and Latissimus dorsi muscles are used to sweep the arms inward against the water to gain power and speed. The trapezius and Levator scapula lift and stabilize the swimmer's head. Neck muscles used: Omohyoid, Stemahyoid, Stemocleidomastoid and Trapezius.

Trunk muscles used (mostly in freestyle & backstroke) – similar for breaststroke as well = Pectoralis, serratus anterior (side muscles), external oblique (outer ab muscles), rectus abdominus (abs), latissimus dorsi (back muscle), trapezius, spinus erectus (muscles that support the spine), teres major, teres minor, rhomboid major, rhomboid minor (all of these "major and

minor" muscles help make up the shoulder muscles), gluteus maximus (rear-end muscles), abductor magnus (groin).

Muscles used in specific breaststroke phases:

Catch Phase: Latissimus Dorsi (back muscles) and Pectoralis Major (chest muscles)

Down Sweep Phase: As the arms move the swimmer begins to lift the head to breathe. Pectoralis major, Latissimus dorsi (back muscles) and Teres major abduct the shoulder, allowing the arms to move laterally.

Longissimus capitits, longissimus cervicis, semispinalics capitits, semispinalis cervices, splenius capitis and splenius cervices life the head to breathe.

In-Sweep Phase: Latissimus Dorsi (Back Muscles), Pectoralis Major, and teres major adduct the shoulders brining the elbows together under the swimmer's chest

The Trapezius and levator scapula lift and stabilize the swimmer's head

Recovery Phase: Of the upper extremities begin when the arms extend forward and lasts until the arms are fully extended. The head is returned to the water and the hands reach a few inches below the water, keeping the hips high. Scalenus Group Muscles, Sternocleidomastoid and longus capitis are responsible for bringing the head back to the water. Chest muscles contribute to the arms as they extend forward. Anterior deltoid muscles and Pectoralis major.

Pelvis and Hip:

Hip Abductor Muscles - The hip abductor muscles help the swimmer to move their legs away from their body and rotate their legs at their hip joints.

Hamstrings - The hamstrings help the swimmer to recover their legs and to maximize propulsion

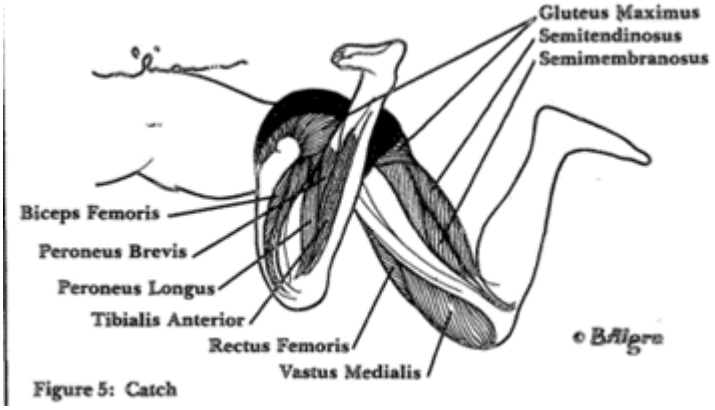


Figure 5: Catch

during the leg kick7 They also provide flexion at the joint and aid the recovery section of the kick by bringing the heels up to the backside.

Thigh Muscles (Quadriceps or Quads) - help the swimmer to recover their legs and to maximize propulsion during the leg kick. Quads run down the front of the upper leg, from the hip at the top to the knees at the bottom. Strong quads are essential for driving the feet back together towards the end of the breaststroke kick. They also aid in providing the power to dive off the starting block/wall and at the turns at either end.

Buttock Muscles (Glutes) - The buttock muscles help to stabilize the swimmer's body position and to maximize propulsion during the leg kick.

Gluteus Maximus, Gluteus Medius and Gluteus Minimums are the most powerful muscle in the back of the upper leg. Responsible for extension of the hip joint and initiating the leg kick action.

Calf Muscles (Soleus and Gastrocnemius) help the swimmer to maximize propulsion and to help return their legs and feet into a streamlined position.

Iliopsoas, Rectus Femoris, Sartorius, and Pectineus muscles contribute to hip flexion, which is utilized for maintaining the proper body position in the water.

The groin is a complex junction of major muscle groups, including the hip adductors, hip flexors and abdominals, all of which are primary force producers in the breaststroke kick, and fall under considerable stress during breaststroke swimming. The wider the knees and feet travel from the midline in the propulsive phase of the breaststroke kick, the more the groin load is increased. Groin pain often comes on because of repetitive overload and stress on the joint.9

Pain from the groin and/pelvic area is often most common with competitive breaststroke swimmers:

Adductor related groin pain - pain coming from the inner thigh muscles that act to squeeze the legs together in the propulsive phase of the breaststroke kick and often occurs at the tendon portion of the muscle (musculotendinous junction or tendon insertion).

Hip Flexor related groin pain (iliopsoas) - pain coming from the hip flexor muscles, which are used during the recovery and set up phases of the breaststroke kick. The hip flexor muscles can often be the compensators for deficiencies in gluteal strength, and often become overloaded under fatigue.

Abdominal related groin pain (Rectus Abdominis) - strain or hypertonia of the rectus abdominis at its insertion to the pelvis. The abdominals are likely to function during multiple phases of the breaststroke kick and provide stability of the pelvis and body position as well as a splint to produce lower limb power.

Pubic bone Overload ("Osteitis Pubis" or "Traction Apophysitis") - difficult groin pain condition that can develop from recurrent or chronic groin stress coming from one or a combination of the major muscle groups attaching to the pubic bone.

Knee:

The knee has 3 main bones, the femur, the patella and the tibia. The knee is a hinge joint where the femur and tibia meet. This helps to bend and rotate from side to side. The bone of the knee cap is the patella. Four major ligaments connect the bones to the knees, each end of bone is padded by cartilage called the meniscus. Large adductor muscles, such as the hamstrings and

quadriceps play a role in the mobility and stability of the knee joint. Functionally the knee can support up to three times a person's body weight, as the largest joint in the body along with the hips. The knee should offer a 90-135 degree of flexion in any activity.

The knee on the other hand can be prone to injuries (as mentioned above) from Breaststroke knee, Swimmers knee, Patellofemoral Pain Syndrome (PEPS), Medial collateral ligament stress syndrome (MCL) and Plica syndrome. Often the force and excessive stresses on the knee during the breaststroke kicking motion creates a unnatural lateral flexion in the knee, forcing stress on the ligaments.

Both the hamstrings and the quadricep muscles are the main muscles that need to be stretched to keep the knees healthy.

Hamstrings - The hamstrings help the swimmer to recover their legs and to maximize propulsion during the leg kick. They also provide flexion at the joint and aid the recovery section of the kick by bringing the heels up to the backside.

Quadriceps or Quads (thigh muscles) - help the swimmer to recover their legs and to maximize propulsion during the leg kick. Quads run down the front of the upper leg, from the hip at the top to the knees at the bottom. Strong quads are essential for driving the feet back together towards the end of the breaststroke kick. They also aid in providing the power to dive off the starting block/wall and at the turns at either end.

With the breaststroke kick, knees can be prone to incredible stress. The rotation in the kick affects the medial collateral ligament (MCL) which runs along the inner side of the knee.

Swimmers are more likely to experience knee pain if their hips have a low level of internal rotation during the breaststroke leg kick, often caused by tight hip flexors and poor hip abduction.

Ankle and Foot:

Catch Phase - Primary Muscles Used for the Feet - The tibialis anterior and peroneus tertius are responsible for the maintenance of the dorsiflexion.

Ankles - The peroneus longus and peroneus breveis maintain ankle eversion throughout the catch phase.

The anterior portions of the gluteus medius and gluteus minimus, tensor fasciae latae, and iliopsoas contribute to hip flexion, ensuring the feet are in the optimal position.

The legs are extended backward by the four heads of the quadriceps, gluteus maximus, biceps femoris, semitendinosus, and semimembranosus.

Down Sweep Phase - Extension of the legs as the feet begin to travel in a lateral and downward direction, until they reach their widest point. The soles of the feet begin to turn inward and into an inverted position that is still dorsiflexed.

This is the position of the feet that generates a lot of force on the water aiding the swimmer in the forward direction.

Primary Muscles Used - Extension of the knee as the feet move laterally = The four heads of the quadriceps are responsible for the extension of the knee, as the feet move laterally.

Legs together after the Feet reach highest point = The adductor magnus, adductor brevis, adductor longus, pectineus, and gracilies are responsible for bringing the legs together, after the feet reach their widest point.

Feet = The tibialis anterior and tibialis posterior contribute to inversion of the foot.

The slight lateral rotation of the hip is contributed by the sartorius, quadratus femoris, and obturators.

Insweep Phase - Legs extending and moving in the medial direction, until the inverted feet touch at the end of the kick. Once the feet touch, they stay together for a brief second, allowing the body to glide forward in a streamlined position.

Primary Muscles Used - The feet are brought together by the activation of the gastrocnemius, soleus, and tibialis posterior

Glide Phase - The glide position is prone and streamlined. The ankles are in plantarflexed motion.

Power Phase - From the end of the recovery phase, the kick motion is initiated by internally rotating the hip so that the feet end up lateral to the knees.

The plantar surface of the foot and the medial lower leg engage the water, while the knee and hip extend, rotate and adduct toward the glide position.

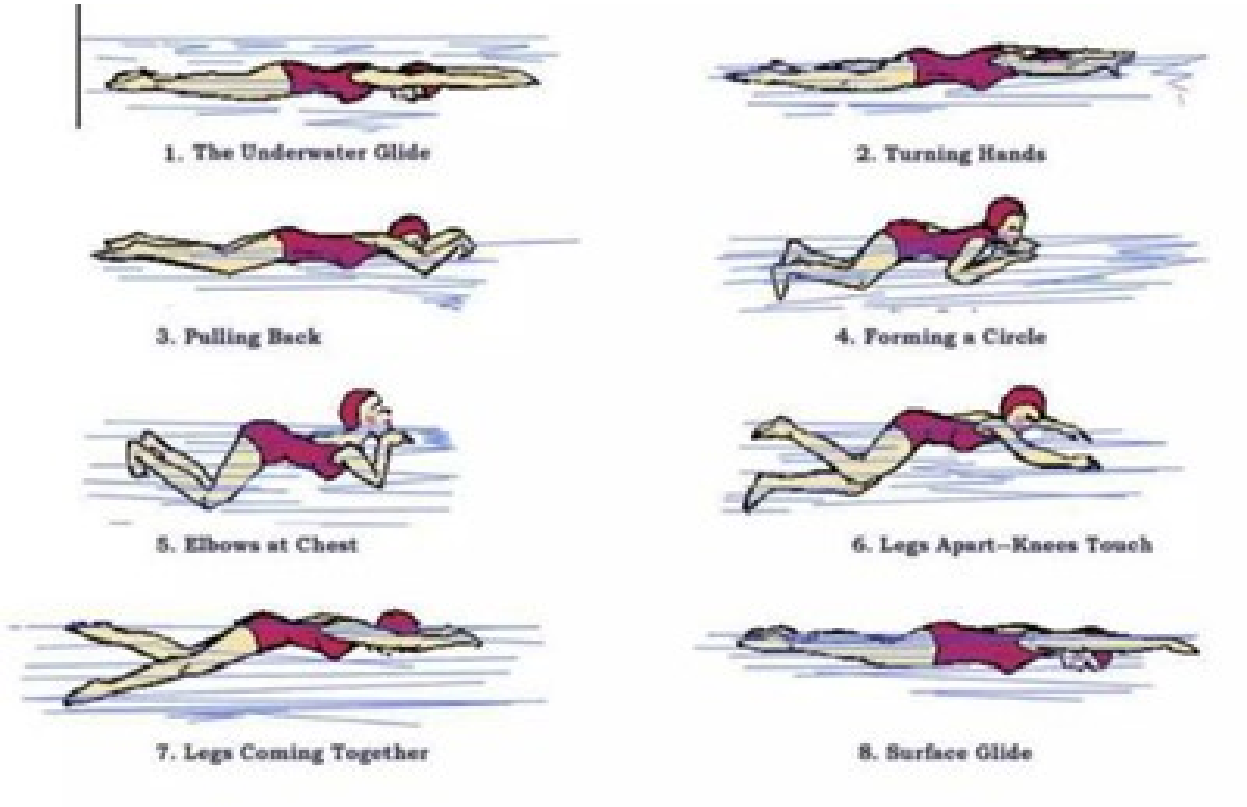
The knee is then almost fully extended when the feet are a few centimeters apart, and the ankle finishes in plantarflexion. The ankle forms a circular motion with this kick, and the legs should be under the surface of the water for the entire power phase.

Recovery Phase - Lower extremity maintaining a streamlined position, with the feet and legs together. After this brief glide the feet are brought up to the buttocks by the flexion of the knee. During this recovery phase the arms generate propulsion. This motion brings the feet/heels towards the buttocks, and the knees are hip-width apart or slightly wider.

At the end of the recovery, the ankles are dorsiflexes and everts. The ankles are just below the surface of the water and the end of recovery, and the hip is flexed to roughly 125 degrees. (American Red Cross, 1992).

The trunk remains in roughly the same position as it is in the glide.

Primary Muscles Used - The biceps femoris, semimembranosus, semitendinosus, sartorius, and gracilis are responsible for knee flexion, this aids in bringing the feet toward the buttocks



Conclusion / Summary -

The breaststroke is a prone stroke with the symmetric movement of the arms and symmetric movement of the legs.

In swimming an athlete's goal is to continue to be as active as possible, obtain therapeutic modalities when needed, and slowly build back up from any injury or slowness, with the goal in mind to return of optimal performance and beat their competitor in the pool.

Every individual is unique, so having the proper form in breaststroke technique and in strength training is all very helpful to gain knowledge of how to do these exercises correctly which increases joint range of motion, strength and function while limiting pain and flare-ups to make things worse. There is always the issue where an athlete can "do too much too soon," the athlete must find that balance in between.

It is highly recommended for any athlete who performs in competitive swimming, to simply

communicate carefully and systematically with their coach or mentor, and other team members, and then use the proper techniques to maximize endurance, speed, strength, power and endurance.

If an injury does strike, it is important to take it slow and obtain a reconditioning programme so the athlete can return to their sport quicker, and so they can engage in optimal speed, performance, and recovery, and over-all continue to do the thing that makes them love the sport, and attempt to beat their competitor in competitive swimming.

During swimming, especially breaststroke the body position changes frequently. It moves from a horizontal position during the glide phase to an inclined position. Breathing is straightforward. With less competitive swimmers, they tend to keep their heads above water, but for competitive swimmers, they need to ensure the proper form and technique co-insides with their breathing, when arms hit the water, their face goes under, then take a breath at every arm turn.

Breaststroke may be stressful for some people due to repetitive motions and spinal extensions and an athlete can be prone to muscle spasms, tightness, and cramps, among other common injuries.

For Muscle Spasms/Cramps – This can be caused by dehydration or over-exuberating / over-use of the muscles. It can last anywhere from a few seconds to up to 15 minutes or longer, and is often very painful. In some instances, an athlete can no longer move their foot or leg, until things ease.

Muscle cramps usually start because of low blood levels of calcium, magnesium, or potassium or from certain medications. It is recommended to try and continue swimming, then exit the pool as quickly as possible. Once on the pool deck, rub the leg/foot and perform a gentle

stretch and then a massage. Apply warmth to the affected area. Always try to incorporate an adequate warm-up and cool-down phase as part of a training session and maintain adequate levels of hydration before, during and after the workout. Fuel the body and replace lost electrolytes to help prevent and alleviate cramps.

On the other hand, swimming can be a fun sport with many benefits. Having the proper technique is imperative for a swimmer. Some may find it stressful on their joints due to repetitive motions or overuse. This type of technique can increase strain on the lower back and with tight hip rotators that have difficulty with kicking feet. Having the correct swimming technique is very important and can be achieved with the proper planning and training for the swimmer, and for positive results which occur in the pool.

In swimming, advancements in biomechanics can help people understand the best body position to reduce swimming drag and maximize speed, understanding the motion behind the human movement in the pool so, the athlete can gain the utmost speed and power they need to beat their competitor.

With the proper techniques as mentioned above, any athlete can build the required strength for breaststroke engaging in power, speed, and endurance in the pool, with reduced injuries, while still enjoying their love for the sport.

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