Breaststroke

Breaststroke is the only swimming stroke in which the legs are as effective as the arms in terms of propulsion. This stroke is also characterized by the absence of an aerial recovery of the arms (with rare exceptions among certain elite swimmers who project their arms just above the water surface) (Lacoste & Semerjian, 1998, p. 72).

After the start and after each turn, the swimmer may perform one arm movement extending to the legs, during which the swimmer may be completely submerged. After the start and after each turn, a single butterfly kick is allowed at any time before the first leg movement. The head must break the surface of the water before the hands turn inward at the widest point of the second pull. From the start and throughout the race, the movement cycle must include one arm movement and one leg movement in that order. All arm movements must be simultaneous and in the same horizontal plane, without alternating motion (World Aquatics. Rules, 2023-2025).

Although breaststroke swimmers are capable of generating greater force during the propulsive phases than swimmers using other techniques, they noticeably decelerate each time they bring their legs back to prepare for the next kick. This consequently reduces the average speed per cycle well below that of the other strokes.

3.3.1. Body Position

Breaststroke, originally a horizontal stroke but one that generates significant resistance to forward motion particularly during leg recovery has progressively evolved toward a more pronounced vertical orientation. Flat (horizontal) breaststroke gives relatively balanced importance to arm propulsion and leg propulsion. Vertical breaststroke is characterized by a marked lifting of the upper body and a forward “dive” that allows the swimmer to return to a hydrodynamic position. An upward dolphin kick complements this structure (Chollet, 1997, p. 124).

More than any other swimming stroke, breaststroke technique evolves very rapidly. Experts disagree on the relative effectiveness of a very flat swimming style versus a highly undulating style closer to butterfly. A recent rule change has led more swimmers to adopt an undulating style. This regulatory change allowed swimmers to submerge their head during certain parts of the cycle, thereby enabling greater freedom of body movement. The undulating style, currently the most popular, is known as the *wave motion*. Many elite swimmers have adopted this style or other techniques incorporating undulation (Costill et al., 1994, pp. 87–108).

3.3.2. Arm Movement

The arm movement in breaststroke consists of four phases: the outsweep, the catch, the insweep, and the recovery.

3.3.2.1. The Outsweep

Swimmers begin the outsweep by gliding the arms outward and forward at full extension. At the end of the recovery phase, the hands should trace a semi-circular path, sweeping outward, forward,

and slightly upward until the arms are positioned outside the shoulders, where the catch will be performed.

During the outsweep, swimmers should flex the arms at the elbow in order to position them facing backward as early as possible. The swimmer performs the outsweep to reach the catch position, which occurs when the hands are outside the shoulders and facing backward. The arms remain extended for most of this sweep, although they flex slightly in preparation for the propulsive phase as they approach the catch position.

At the beginning of this sweep, the hands should be oriented downward. They rotate outward as they approach the catch position so that they are oriented outward and backward at the end of the outsweep.

The outsweep is not propulsive; therefore, swimmers should perform it smoothly and slowly. Its purpose is to correctly position the arms for the following phase, the insweep (Maglischo, 2003, p. 232).

3.3.2.2. The Insweep

The insweep is the only propulsive phase of the arm movement. It begins once the catch is established, with the arms positioned outside the shoulders. At this moment, swimmers should perform a wide semi-circular sweep directed downward and inward, then upward, until the arms are close to the shoulders. The insweep should stop just before the swimmer's hands meet.

From the catch position, the arms continue to flex, reaching an angle greater than 90° at the end of the insweep. The palms, initially facing outward, gradually rotate inward during this sweep. Hand speed should increase progressively throughout the insweep, reaching a maximum as the hands approach each other (Maglischo, 2013, p. 6).

The first part of the underwater pull is similar to that of front crawl and butterfly. The movement is initiated by the clavicular portion of the pectoralis major, quickly joined by the latissimus dorsi. During the second part of the pull, powerful contractions of the pectoralis major and latissimus dorsi draw the arms and hands toward the body's midline to complete the pull. The forces produced during the final phase propel the body forward and lift the trunk upward, a movement aided by contraction of the paraspinal muscles. The swimmer thus raises the head and shoulders out of the water. Flexion and rotation at the elbows bring the hands toward the midline of the body, marking entry into the recovery phase (McLeod, 2012, p. 6).

The catch is performed with the arms fully extended in front of the swimmer, with the hands touching. The hands establish support and initiate the pull at a depth of approximately 15 to 25 cm, not just below the surface as many swimmers believe. From the start of the pull, the hands should incline so that the palms are oriented diagonally outward at an angle of approximately 45 degrees.

As the pull begins, the hands are drawn almost directly sideways while the elbows remain extended; however, once the arms reach a width equal to or greater than shoulder width, the elbows

begin to flex. In this regard, the first part of the arm movement is very similar to the first part of the butterfly pull, as the direction in which the arms push the water and the corresponding elbow flexion are nearly identical in both strokes (Counsilman, 1986, p. 153).

3.3.2.3. The Recovery

To return the hands to their initial position, the arms must be brought back under the chest. This movement involves the pectoralis major, the anterior deltoid, and the long head of the biceps brachii, all of which contribute to flexion of the shoulder joint. At the same time, elbow extension by the triceps brachii completes the release phase and allows the arms to return to an extended position (McLeod, 2012, p. 6).

According to Maglischo (2003, p. 236), arm recovery should begin when the hands pass inward beneath the shoulders. At this moment, swimmers should stop pushing backward against the water and draw the arms downward and inward under the shoulders.

The swimmer presses the elbows downward and inward as soon as recovery begins. This helps facilitate the change in direction of the arms, which shift from inward to forward. The palms, which were turning inward during the previous sweep, continue rotating until they face each other when the hands meet under the chin. They then rotate downward into pronation as the arms extend forward.

Some swimmers prefer to recover their arms above the water, while others keep them underwater. It is not possible to state with certainty that those who recover above the water encounter less drag resistance. All swimmers using this method generate some drag. It remains to be determined whether the wave resistance they produce is less than the drag resistance created by underwater recovery.

Swimmers who recover underwater must strive to streamline their arms as much as possible when extending them forward. This can be achieved by keeping the arms close together and bringing the hands together to form a spearhead shape. The arms should recover just below the water surface. A recovery that is too deep would create greater drag and could also result in time loss due to the need to raise the hands during the next outsweep.

3.3.3. Leg Action

Swimming regulations stipulate that all leg movements must be simultaneous and in the same horizontal plane, without alternating motion. The feet must be turned outward during the propulsive phase of the leg action. Alternating movements or downward butterfly kicks are not permitted (World Aquatics. Rules, 2023-2025).

Leg action in this stroke has evolved from a wide, circular, snapping kick to a shorter, sharper, whip-like kick. Initially, the whip kick was thought to be superior because water could be pushed backward by extending the feet and using the soles as paddles.

Today, however, it is understood that the feet, like the hands, generate propulsion through circular movements. The leg kick currently used by most breaststroke swimmers is therefore a combination of the snapping and whip styles. Swimmers spread and bring their legs together, but only moderately, no longer separating them as widely as those who used the snapping kick (Costill et al., 1994, p. 101).

The laxity of the ankle joint and the degree of flexibility of the hip and knee joints particularly stressed in this stroke largely determine the effectiveness of the movement (Catteau & Garoff, 1986, p. 215).

3.3.3.1. Recovery

After the end of the propulsive phase of the arm movement, the heels are brought toward the buttocks in a vertical plane. The knees sink slightly to allow the heels to return. The knees move apart without exceeding shoulder width. Care should be taken not to bring the knees toward the abdomen (Pedroletti, 2000, p. 144).

The legs move forward because flexion occurs at the knees rather than at the hips. The legs are relatively narrow and therefore displace much less water forward during recovery.

In contrast, the thighs are much wider. If swimmers push them downward and forward (by flexing the hips) during recovery, the resulting braking effect would be so great that swimmers would almost come to a complete stop. Swimmers must allow their hips to drop and incline the body downward from head to feet in order to recover without flexing the hips. This is the only way to keep the feet underwater, which may be the main reason many elite breaststroke swimmers lift their head and shoulders out of the water.

The swimmers' toes are pointed backward (feet extended), and the legs remain close together during recovery. The legs should be streamlined within the hip line throughout recovery to reduce form drag. The feet move almost directly forward rather than upward and forward. The knees separate slightly to keep the legs and feet within the body's profile, but they must not move far beyond shoulder width.

The swimmer's forward speed reaches its lowest point during the recovery phase. For this reason, the legs should be lifted quickly but smoothly. The feet should begin to separate as they approach the buttocks, marking the beginning of the next phase: the outsweep (Costill et al., 1994, pp. 101–102).

3.3.3.2. The Outsweep

The outsweep begins with the rotation of the feet outward, produced by a combination of movements at the hips, knees, and ankles. Once the feet are rotated outward, the outsweep continues with extension of the hips and knees. The gluteal muscles and hamstrings extend the hips, while the rectus femoris and quadriceps extend the knees (McLeod, 2012, p. 6).

This phase of the kick is not propulsive. Its purpose is to position the swimmer's feet for the following propulsive insweep. At this point, the swimmer begins to move the feet outward in a circular motion as they approach the buttocks. This movement continues until the feet are outside the hips, turned backward against the water. This position represents the catch position.

The lower limbs are flexed at the knees as much as possible so that they pass close to the buttocks. This allows a higher position and a longer insweep. The feet should be plantar-flexed and externally rotated at the ankle just before the catch. A large range of ankle mobility in these planes is a decisive advantage in breaststroke, as it allows swimmers to position their feet to push water backward earlier during the kick.

Swimmers should slightly flex the hips during the outsweep. Although this seems to contradict earlier statements, it does not. Hip flexion must be minimized during recovery but slightly increased during the outsweep to allow maximal force production during the following insweep. While hip flexion increases drag, it increases propulsive force even more by enabling activation of the thigh and leg extensors during the subsequent sweep.

Foot speed should decrease during the outsweep, reaching a velocity close to that of the body at the moment of the catch. The propulsive phase begins at this point (Costill et al., 1994, p. 102).

3.3.3.3. The Insweep

During the transition from the outsweep to the insweep, the knees and hips are not yet fully extended, and the respective muscle groups continue to contribute to the insweep until full extension is achieved. At the beginning of the insweep, the legs are in an abducted position that allows rapid adduction force production. The legs are brought together by contraction of the adductors located on the upper inner thigh.

To minimize resistance at the end of the insweep, the calf muscles act to point the foot and ankle. The release phase involves activation of the rectus femoris and iliopsoas for hip flexion, and the hamstrings for knee flexion (McLeod, 2012, p. 6).

The insweep consists of two phases. The first could be more accurately described as a downward sweep, as the feet move more downward than inward. Only during the final part do the feet move inward. This phase is described as a single movement in two parts because swimmers perceive it as a continuous leg sweep.

The insweep begins at the catch and continues until the legs are fully extended and nearly together behind the swimmer. It is a semi-circular movement in which the legs move outward, backward, downward, and finally inward. The hips and knees must extend until full extension is reached at the end of the movement. The feet should be oriented downward and inward until the soles face each other.

The feet should be oriented outward and slightly downward during the downward sweep corresponding to the first part of the movement. In this position, the leading edge of the foot is the

big toe side, and the trailing edge is the little toe side. The first part of the insweep continues until the legs are extended. This is the main propulsive phase.

As the legs extend, foot orientation shifts from downward to inward, marking the second part of the insweep. The feet move through the water until they come together. The insweep ends just before the feet touch. At this point, the swimmer releases pressure on the water and begins to lift the legs toward the surface.

In this position, the big toe side continues to function as the leading edge of the propeller formed by the foot, while the little toe side remains the trailing edge. This combination of direction and angle of attack enables the swimmer to push water backward as it crosses the foot from leading to trailing edge. The foot must remain plantar-flexed so that the toes point downward, and the sole should be oriented inward rather than upward.

The swimmer's hips will undulate slightly if the insweep is executed correctly. This occurs because the legs move downward as much as inward. The downward movement produces drag force that lifts the hips. Swimmers should not attempt to eliminate this slight undulation, as doing so would require sacrificing part of the propulsive force.

Foot speed should increase progressively throughout the insweep, reaching a peak just before pressure on the water is released (Maglischo, 2003, pp. 233–234).

3.3.4. Arm–Leg Coordination

Breaststroke is a simultaneous stroke in which the actions of both the upper and lower limbs are propulsive while alternately creating resistance to forward motion. Overall efficiency depends on motor continuity and thus on general coordination. Several coordination patterns can be observed among elite swimmers; however, the most important associations between arm phases and leg phases follow biomechanically logical principles (Chollet, 1997, pp. 126–127).

A breaststroke cycle can be represented as consisting of three arm phases and three leg phases (propulsion, recovery, glide). The recovery phases of both arms and legs are considered negative because they create significant resistance opposing forward motion. Expert coordination therefore involves synchronizing the recovery phases of both limb systems to reduce the duration of negative phases. This first part of the cycle thus corresponds to in-phase coordination of the recoveries.

Conversely, propulsion of one limb system is a positive phase and should occur while the other system is in a neutral (hydrodynamic) position, with the limbs extended (glide phase, neither negative nor positive). This second part of the cycle therefore corresponds to antiphase coordination of propulsion, ensuring propulsive continuity over two phases, while a third phase is devoted to recovery (Seifert & Chollet, 2007, p. 57).

According to Costill et al. (1994, p. 102), three synchronization styles are recommended by swimming experts: continuous, gliding, and overlapping. In the continuous style, arm movement begins when the legs come together. In the gliding style, a short interval exists between the end of the kick and the start of the arm movement, during which the swimmer glides passively. In the overlapping style, arm movement begins before the propulsive phase of the kick is completed.

Most coaches agree that the gliding style is the least effective, as swimmers decelerate from the end of the kick's propulsive phase until the start of arm propulsion. Advocates of the continuous style believe it eliminates the interval between force application by the arms and legs. However, this reasoning is flawed because the outsweep phase of the arm movement is not propulsive. Consequently, swimmers using the continuous style still decelerate between the end of the kick's propulsive phase and the moment they reach the arm catch.

The overlapping method is the best technique for eliminating or at least reducing the deceleration period between arm and leg propulsive phases. Swimmers should therefore begin the arm outsweep while the legs are completing the final part of the insweep. This allows them to reach the arm catch and begin propulsion almost immediately after the kick's propulsive phase ends.

3.3.5. Breathing

The symmetry of the stroke results in symmetrical head positioning. The spatial position of head elevation at the end of the arm insweep and the anatomical position of the rib cage at that moment logically determine the placement of inhalation during each of these phases (Chollet, 1997, p. 127).

According to Pelayo and Wojciechowski (1991, p. 30), in breaststroke inhalation occurs every cycle but is actually imposed by the regulatory requirement that the head must be submerged during each arm cycle.

In breaststroke, one breathing cycle is generally linked to one movement cycle. Since the arms remain continuously in the water, the head and trunk are permanently supported. As a result, the head remains more stable than in butterfly, facilitating breathing. During the pull phase, exhalation occurs underwater. In the next phase, when the arms press inward and downward, the upper body is slightly lifted, the mouth rises above the surface, and inhalation can be performed quickly and deeply.

Inhalation during this phase is facilitated by the relaxed state of the respiratory system, while the legs are positioned in preparation for their working phase (Lewin, 1981, p. 91).

Swimmers should look downward, with the head positioned between the arms as they extend forward, just before beginning the arm movement. They should begin lifting the head toward the surface as the arms start the outsweep. This is crucial, because if they delay head movement until the catch, much of the force from the initial part of the insweep will be used to lift the head rather than to propel the body.

In such a case, swimmers would need to turn their palms downward during the first part of the insweep to lift the head out of the water, sacrificing propulsive force and reducing forward speed.

The head must be at the surface at the moment of the catch. Subsequently, the downward arm movement facilitates face elevation so that the mouth emerges from the water as the arms release pressure and begin recovery. The swimmer should inhale during the arm recovery phase. The head should return underwater between the arms during the final part of this movement (Costill et al., 1994, p. 105).

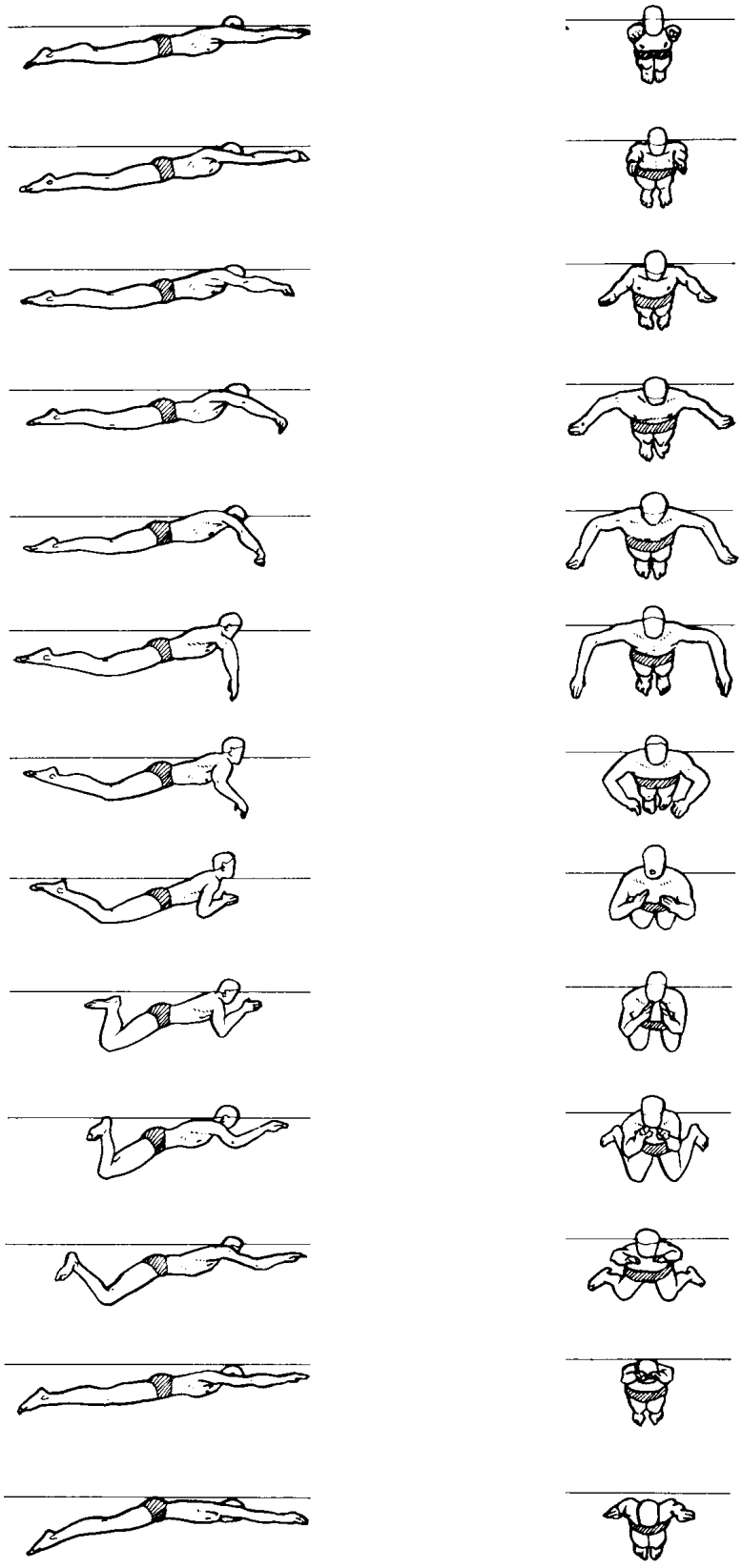

Figure 3: Illustration of Breaststroke Technique