The Mechanics of Modern BREASTSTROKE Swimming

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Breaststroke is the least efficient of the four competition strokes because a large amount of water resistance is created due to body position and an underwater arm recovery. FINA rules stipulate that the arms (i.e. defined by the position of the elbows) must remain underwater during the recovery movement. Even though some swimmers recover the hands slightly above the surface, the forward movement of the arms is primarily underwater, and thus resistance is high. The width of the kick also influences body position and streamlining. Development of the 'wave technique' has allowed some breaststrokers to achieve improved streamlining when compared to a fixed angular position of the body's axis.

When compared to the other strokes, breaststroke technique relies upon greater balance in the contribution of propulsive force from arm and leg action. Precise timing as well as streamlining the upper and lower body segments improves swimming efficiency. Although some swimmers may still rely on an exceptional kick for peak propulsive force the breaststroke model should consider the balance in both arm and leg propulsion and resistance.

Streamlining

There are three key phases of the stroke where streamlining of all, or part, of the body is critical. First, at the beginning of each stroke cycle the body will be completely streamlined with the head or face submerged. Arms are extended, hands together, and line of sight is down-and-forward. Hips are at, or just below, the surface with the legs fully extended and toes pointed. The second phase of streamlining occurs as the insweep phase of the armstroke is completed. Because the insweep is a very powerful propulsive action, the trunk is moving forward and the shoulders lift. At this instant the hips are slightly below the surface and the legs are held in an extended position. To maintain this body alignment there must be stability in the lower back and abdominal regions. The leg recovery begins as a very subtle movement of the heels forward (i.e. toward the buttocks), just below the water surface. If the swimmer starts drawing the heels forward too early there will be a sharp increase in resistance against the

thighs. The shape of the body at this point in the stroke allows water to travel smoothly backward without being deflected sharply. Streamlining the legs in this way helps to maximise the forward propulsion generated by the arms by reducing resistance against the legs and along the length of the body.

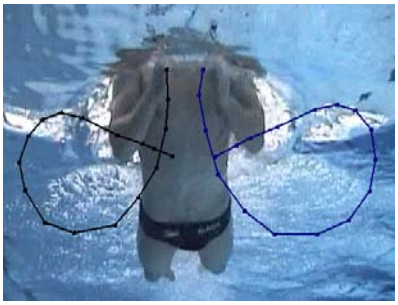
The third phase of streamlining occurs as the legs drive backward; this is the propulsive phase of the kick. Streamlining of the upper body is achieved when the head is lowered between the extending arms and the trunk is stretching forward. Because the trunk is following the arms forward the hips will tend to lift. The hips will also lift as a result of leg extension and inward rotation of the feet. Breaststrokers using a 'wave' style stroke will lift the upper body at the completion of the armstroke and then lunge forward. This is often combined with an arm recovery that carries the hands and forearms slightly above the surface as they push forward.

Armstroke – Propulsive Phase

The armstroke generates propulsion from both an outsweep-downsweep and insweep-upsweep of the hands and forearms. From a full streamlined position the hands move outward with the palms angled slightly. The initial application of propulsive force, as the hands scull outward, probably results from greater application of lift forces than drag (i.e. push) forces. Some breaststrokers begin the armstroke with the hands in a slightly deeper 'catch position' to allow an upward sculling movement of the hands as they move outward. At the widest point in the stroke the elbows remain in a high position and begin to flex so the hand-forearm position can generate drag propulsion. An isolated view of a breaststroker's arm position at this point resembles the pattern used by a butterflyer.

During the outsweep the hand/elbow position remains slightly forward of the shoulders. Muscular control in the upper back allows the scapula to remain stable in preparation for the insweep of the arms. If the elbows slip back at this point in the stroke the transfer of force through the trunk will be reduced. The transition from outward to inward movement of the hands requires a very sharp directional change and some propulsive power is lost for a split-second. However, once the directional change of the hands is made the relative

contribution of drag force continues to increase. Drag force is perhaps more important to breaststroke propulsion than previously thought.



Forceful adduction of the shoulders directs the hands on their inward-upward movement pattern. This also lifts the head and shoulders out of the water. As the hands come together the elbows are positioned under the outer edges of the shoulders and are pointing downward. The hands travel through a loop-like pattern when viewed from the front. A smooth transition from the propulsive phase of the insweep into arm recovery helps to conserve hand speed and momentum. However, some swimmers start moving the hands forward too early (during the insweep) in an attempt to 'round off' the armstroke into the recovery. While this may have some advantage in producing a slightly faster stroke cycle, it may also reduce the potential propulsive force applied during the final stages of the insweep. During all propulsive sweeping actions the hands are angled so that pressure is felt on the palm surface. Breaststrokers will naturally produce a powerful upward force component during the insweep that results in a lifting of the head and shoulders. Lifting the trunk does not cause a problem for streamlining if the hips remain high in the water. A high hip position determines if the timing of the stroke has effectively combined propulsive force with streamlining effects to produce maximum efficiency.

Armstroke – Recovery Phase

The recovery phase is combined with a lowering of the head position to realign the body into a streamlined position. The swimmer usually has the sensation of diving or lunging forward with the head, arms, and trunk. Hands should remain together as the arms push or lunge forward. Techniques that use a very high arm recovery (i.e. with a large part of the upper trunk above the water) increase the overall stroke-rate. Variations are seen in the position of the palms as the arms extend, some swimmers turn the palms inward and other swimmers position them facing downward. Both hands may break the surface of the water during the recovery, but the elbows must remain below the surface to comply with technical rules. Swimmers using an ‘over the surface’ recovery technique to increase the speed of the arm recovery must balance the timing of the kick to deliver the propulsive thrust as

the trunk extends forward. The swimmer may get the sensation of diving over the bow wave; this contributes to a ‘dolphin’ or ‘wave action’ follow-through by the hips and legs.

Breathing

Positioning the head so that a breath can be taken during each stroke cycle is an integral part of the timing. During the insweep the shoulders will naturally lift and taking a breath at this time makes use of this upward component to help stabilize hip position. If the head is lifted too early in the stroke cycle there is usually some downward pressure created by the arms to help support the lifting action; this reduces the forward component of drag propulsion. If the head is lifted too late in the stroke cycle there is no counterbalancing force from the insweep and the hips drop. As with freestyle and butterfly, there should be a constant exhalation of air from the nose and mouth whenever the face is below the surface and an increase of exhalation pressure just before the mouth breaks the surface. Because breaststrokers keep their shoulders parallel to the surface throughout the stroke (i.e. no body roll) a wave forms in front of the body. The chin must clear this wave during the breathing action. Some breaststrokers position the head with the chin tilted slightly downward, toward the chest, others keep the head in a more upright position.

Kick

The leg movement is correctly referred to as a whip kick because it simultaneously involves extension of the hip and knee and inward rotation of the ankles. From a streamlined body position at the start of a stroke cycle the recovery of the kick begins with a subtle bend of the knees as the arms reach the widest point during the stroke (i.e. the transition from out-to-insweep). As the arms start the insweep the body position changes only slightly; hip position is held stable as the trunk lifts out of the water. Flexion at the knees lifts the heels closer to the buttocks as the ankles dorsi-flex (i.e. right-angle position) and rotate outward. The knees are held ‘back’ for as long as possible and then a rapid increase in hip flexion is followed by extension to begin the propulsive phase of the kick. For a split-second at the completion of the leg recovery the body position is poorly streamlined. However, this position is necessary to fully involve the muscle groups used during hip extension. One of the major differences between breaststrokers having an effective kicking action and those not generating maximum propulsion is the amount of time spent in an ‘un-streamlined’ position. Naturally effective kickers use a quick ‘reflex-like’ action while poor kickers introduce a ‘pause’ between recovery and propulsive movements.

Extension of hip and knee joints is made as the arms extend forward and the head begins to lower. This action positions the trunk, arms, and head so the power of the kick is used effectively to drive the trunk forward. A slight wave action in the trunk results from a combination of actions: (1) lowering the head position to streamline the upper body; (2) changing from a slight concave shape in the upper back to a slightly convex shape (i.e. shoulders rounded forward) as the body dives forward; and, (3) inward rotation of the ankles during extension of the legs. Leg extension is an accelerating movement, when combined with inward rotation of the ankles these actions help to lift the feet slightly at the end of the kick.



Timing and Balance

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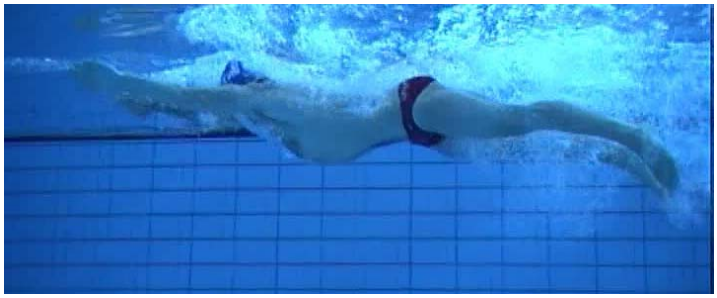

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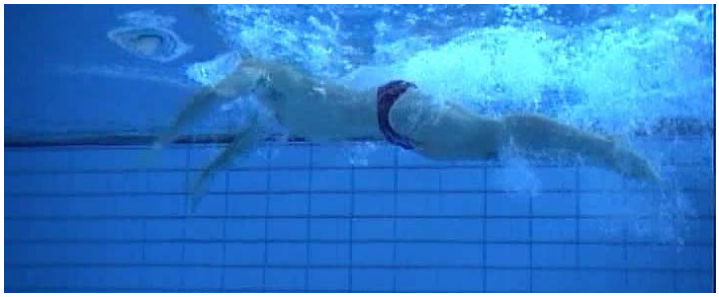

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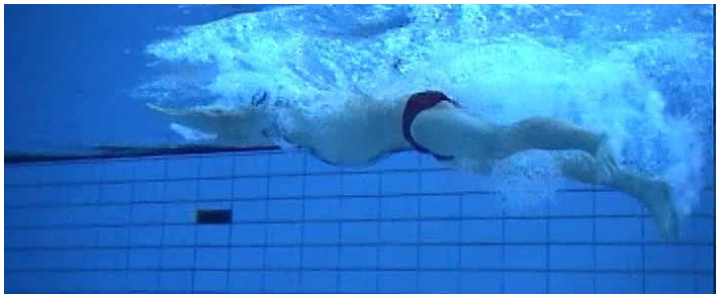

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Timing in the breaststroke is critical to optimal propulsion because any unnecessary overlap in the application of power impulses will decrease the potential net result. If the propulsive phase of the kick overlaps too much with the arms there will be a reduction in net potential propulsive force from the kick. The coach will be able to see when obvious timing errors are made because the stroke will look uneven. Competitive breaststroke has changed over the years to reflect more precise timing of stroke components. An ideal stroke-rate must be determined for each race distance (i.e. 50m to 200m) to take advantage of one's stroke capabilities.

Current competition techniques use almost no pause or glide between the end of one stroke and the start of the next. Sprint specialists will use a very fast stroke-rate, similar to freestylers; usually in a range of 50-55 strokes per minute. Perhaps because of greater resistance factors acting upon breaststrokers, 200m specialists generally maintain slower stroke-rates of 35-45 (elite 200m freestylers would use stroke-rates of 45-53). Because of strength differences elite male breaststrokers generally use a slightly slower stroke-rate than elite female breaststrokers.

Breaststrokers using a fast-rating 'wave action' technique may appear as though the legs are 'dolphin kicking'. However this is not the case, as a dolphin kick involves downward movement of the feet with the knees bent. This would not be permitted under FINA rules for breaststroke swimming. What's actually happening is the inward rotation of the feet serves to lift the soles at the end of the kick; simultaneously the trunk lunges forward and the head/shoulder position is lowered. The affect appears to be an undulating movement of the trunk. The high foot position (i.e. soles at/just below the surface) during the leg recovery and the immediate transition from leg recovery to propulsive kicking action creates the illusion that the feet are moving up and down. Biomechanical analysis indicates the body's centre of gravity (located at the hips) does not move too much in the vertical plane. The vertical displacement of the feet during wave action breaststroke is no greater than swimming styles that maintain a 'flatter' overall body alignment. However, the changing position of body segments produces the resulting 'wave action' appearance.