Swimming Technique

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To swim fast, a swimmer must engage in a constant battle of trying to maximize the propulsive force that can be generated while also minimizing the resistive forces he/she experiences. Swimmers adopt many different techniques in an attempt to accomplish this feat; sometimes these techniques are good, other times not so good. Technique also plays a role in injury prevention, as poor mechanics often place stresses on joints and structures in the body that they were not meant to handle. Most often, injuries pop up in the shoulder. As you analyze your own stroke technique, it is always recommended that you view a tape of your swimming strokes, preferably with a coach, to determine where your technique can be improved.

Important Consideration: Every Athlete is Different

The material presented in this article should help you be able to learn a little about stroke technique. However, with that said, it is important to realize that no two athletes will have the same optimal technique, even though they may swim the majority of the stroke the same. That is where the expertise of a coach and his/her involvement in analyzing technique can prove to be invaluable.

The information in this article tends to be general in nature; in other words it covers the technique pointers that will benefit most swimmers. The article focuses mainly on freestyle technique since this is the fastest stroke and the one performed most frequently by swimmers of all ages and abilities. When appropriate, we will try to illustrate some of the variations in stroke technique and help you to understand some of the technique variations commonly seen in swimmers today.

Common Threads in All the Strokes

Stroke Length and Stroke Rate

The four competitive swimming strokes are freestyle/crawl, backstroke, breaststroke, and butterfly. In all strokes, the main goal is to finish the race in a faster time than your competitors. Before discussing the techniques used in the freestyle stroke it is important to identify several general factors that will help you in all of the competitive strokes.

In all strokes there are two components that contribute to swimming speed: stroke length and stroke rate.

Stroke length is the distance a swimmer travels with one pull. This term is commonly expressed in the units of meters/stroke cycle—as in a swimmer traveled two meters with each stroke cycle. Many things contribute to the distance that is traveled with each pull. A few of the more important factors are:

- The strength of the swimmer;
- The shape of the swimmer (i.e. long limbs and long body);
- Proper technique to generate propulsion;
- Proper technique to minimize the resistance experienced by the swimmer.

Stroke rate is the frequency at which the swimmer turns his/her arms over. This term is commonly expressed in the units of cycles per second (or more commonly cycles per minute)—as in a swimmer swam with a rate so that she took 45 stroke cycles in a minute. Again stroke rate is affected by a number of factors, with some of the major contributors being:

- The physiology of the athlete;
- Shorter limb lengths;
- Stroke mechanics;
- Body size.

Putting these two variables together we find that…

Speed = stroke length x stroke rate

This is a simple, but important, relationship to understand because the bottom line is there are different ways to generate speed while swimming. Ideally, you would like to see a swimmer swim with a long stroke length and maintain a high stroke rate—that would result in the fastest performances. However, that is difficult to do. On the bright side, a swimmer can swim fast using a high stroke rate even if the distance he/she travels with each pull is somewhat shortened. Similarly, a swimmer can swim with a high rate of speed by maintaining a long stroke length while holding a moderate stroke rate.

It is also important to recognize that swimmers who swim the same stroke, but compete at different race distances, will typically adopt different combinations of stroke length and stroke rate.

Balance and Stability

Another trait that is common to all strokes is the need to maintain balance and stability in the water. A swimmer who has good control over his/her posture will be able to pull and kick correctly and more efficiently than someone who is not balanced in the water. A swimmer who becomes unbalanced in the water will attempt to gain stability by moving the arms or legs, typically in an unproductive manner. For example, when breathing in freestyle, many swimmers will pull either very deep or very wide to regain the stability that was lost when the head/body were turned to take a breath.

Stability in swimming comes from the core of the body—the abdominal and lower back muscles that surround the body's center of mass. A swimmer with good strength in, and good control over, the core musculature will be more efficient in the water and less likely to suffer injury.

Flexibility

Flexibility is another important factor that contributes to being able to swim efficiently and without injury. The ability to assume a full range of motion about the joints will make it easier to maintain proper stroke mechanics. A lack of flexibility in the shoulders/pectoral muscles, for example, will negatively impact a swimmer's ability to recover the arms over the water in the butterfly. In addition to this placing added stress on the shoulder, the swimmer must also adopt compensatory mechanisms elsewhere in his/her stroke to recover the arms without the hands dragging through the water. The three areas that I have noticed are in the greatest need for flexibility are the:

1. **Ankle plantar flexors**—flexibility in these muscles is extremely important for being able to develop an effective kick in freestyle, backstroke, and butterfly.
2. **The pectoral muscles**—these muscles are often tight in swimmers, limiting shoulder range of motion. Many swimmers incorrectly stretch these muscles, and in the process, place undue stress on the joint capsule of the shoulder. Shoulder flexibility is especially important in backstroke and butterfly.
3. **The hip flexors**—flexibility in this muscle group is extremely important for breaststroke swimmers. A lack of flexibility in these muscles will force swimmers to drop their knees as they initiate the kick, thereby causing increased drag.

Freestyle Technique

Freestyle is the fastest of the four competitive swimming strokes, and is probably the stroke that most people are familiar with. In addition to being the stroke that makes up the majority of a swimmer's training yardage, it is also the one most highly associated with shoulder pain, an injury so common in swimmers that it has been termed swimmer's shoulder.

The athlete swims freestyle in the prone (face down) position, propelling him/herself with the arms, which pull in an alternating pattern, accompanied by a flutter kick. Elite level swimmers swim several different styles of freestyle today.

Styles of Freestyle

There are two main styles of freestyle you will see in watching elite level swimmers compete. The first we will call "stroke length dominated freestyle" and the second we will call the "stroke rate dominated freestyle." In reality, there is a continuum between these two swimming styles, but these "extremes" provide good examples of the styles that are commonly seen in swimmers today.

Stroke length dominated freestyle

As the name suggests, athletes who swim with this type of stroke travel a great distance with each pull. At the same time, the stroke rate (turnover rate) may be relatively low. Characteristics of the stroke length dominated freestyle, and the swimmers who typically adopt the stroke, are:

- **Body roll**—Swimmers with a stroke length dominated freestyle tend to swim with a large amount of body roll. This allows for a greater reach in front of the body and adds to the "distance traveled per stroke." Body roll also aids in propulsion.
- **Body shape**—Stroke length dominated freestyle is often adopted by swimmers who are long and lean. This lends itself to a streamlined shape in the water, and the ability to travel farther with each pull.
- **Limb lengths**—Swimmers who use the stroke length dominated freestyle tend to have longer limbs. These longer limbs make it energetically prohibitive to adopt a high stroke rate.
- **Strength/Power**—Swimmers adopting this stroke style will tend to have a high degree of upper body strength. Since these swimmers take fewer strokes per length to cover the same distance as someone who swims with a higher stroke rate, they must generate greater propulsion (and force) with each pull.
- **Kick**—The kick is typically strong and contributes to propulsion as well as stabilization of the body in the water.
- **Higher elbows**—Having high elbows during the underwater pull places the palm of the hand and forearm in the same pulling plane oriented towards the feet, making it possible to generate maximal amounts of propulsion. **Note:** the forearm generates as much propulsion in swimming as the hand.
- **Swim orientation**—Most of the swimmers adopting this style of freestyle are sprinters or middle distance swimmers (although there are many exceptions, especially in male swimmers).
- **Male swimmers**—Males tend to exhibit many of the qualities already listed (upper body strength, long and lean, long limbs…) making this the more "natural" stroke style for males to adopt.

Stroke rate dominated freestyle

Again, the name says it all. Athletes who swim with this type of stroke have a high rate of turn over and do not travel as far with each stroke as swimmers using a stroke length dominated freestyle. Characteristics of the stroke rate dominated freestyle, and the swimmers who typically adopt the stroke, are:

- **Smaller bodies**—Shorter athletes are not "built" for long stroke lengths. Because of their size, they are at a disadvantage when trying to travel as far with each stroke as a swimmer who is taller.
- **Shorter limb lengths**—The arms have an inertia associated with them. The bigger (longer) the limbs, the greater the inertia, and the more metabolic energy that is required to move them. Athletes with shorter limbs are at an advantage for being able to maintain a high stroke rate.
- **Physiology**—Following the last point, athletes who have a physiology adapted towards endurance events are better equipped to maintain a high stroke rate for the duration of a race.
- **Kick**—The kick tends to be de-emphasized and used predominantly to provide stabilization to the body, and not much for propulsion. Many swimmers who use the stroke rate dominant stroke also adopt a 2-beat kick (one kick per arm stroke).
- **Swim orientation**—The majority of swimmers who use this type of freestyle are distance swimmers, especially in the female swimming population.
- **Female swimmers**—Because of many of the factors already listed, females tend to be the athletes who benefit most from this type of stroke, although once again there are exceptions.

General Freestyle Swimming Mechanics for Stroke Length Dominated Freestyle

Some general technique pointers for freestyle swimming are presented below.

- The hand should enter the water at a level slightly in front of the shoulder and the arm should extend in front of the swimmer. The hand should never cross the midline of the body, this includes during the hand entry. There is much debate over the proper hand position as the hand enters the water. A thumb-first entry places the shoulder in a position that may lead to shoulder injury, where as a neutral or pinkie-first entry externally rotates the shoulder some. This has fostered much discussion about shoulder injury and its relation to hand position at entry.
- As the arm reaches in front of the swimmer, the body simultaneously rolls to extend the reach.
- The catch is the first part of the stroke where the swimmer "grabs on to the water" and is initiated by flexing the

elbow to get the forearm and the hand in a position so they both can push water in the same plane and push it towards the feet. The swimmer should not be trying to generate propulsion, but should focus on setting up the hand and arm for the pull.

- At this point the pull is initiated by contracting the muscles of the upper back to adduct the shoulder, which essentially pulls the upper arm backwards and towards the side of the body. The position of the hand and forearm should remain fairly consistent and they should be oriented so they push water towards the feet.
- The pull should be directed, for the most part, straight towards the feet. There should be very little sculling (side to side movement) of the hand. The sculling that does occur should be a natural response to the body roll that is occurring, and the swimmer should not consciously think about moving the hand from side to side more than what happens naturally.
- As the hand pulls through the water, the body should rotate. This rotation can help to increase the pulling power of the arm/shoulder. The arms should be "connected" to the core of the body to tap into this propulsion potential.
- The hand should not cross over the midline of the body during the pull.
- The hand and arm should accelerate through the entire pull for maximum propulsion.
- At the end of the pull, the elbow should not fully extend. The pull should be "rounded off" before the arm reaches full extension, to help conserve momentum and energy.
- If a breath is to be taken, it should start as the underwater stroke is finishing and proceed through the recovery. The head should not necessarily turn to breathe. Instead, the breath should be a natural extension of the normal body roll.
- During the recovery, the arm should be moved by the shoulder musculature. The elbow is typically flexed with the hand dangling just above the surface of the water.
- Throughout the entire stroke, the head should remain in a neutral position, looking at the bottom of the pool or slightly ahead of the swimmer. The head should not be raised to look at the end of the pool.

Differences in Stroke Rate Dominated Freestyle

The differences between stroke length and stoke rate dominated freestyle occur during the initial part of the stroke (i.e. the catch and initial pull). The underwater pull and the kick all remain essentially the same as what was just described.

- These swimmers do not have as much body rotation during the stroke and therefore do not get much reach once the hand enters the water.
- The arm enters the water with a bent elbow, almost in the position seen at the catch phase in the stroke length dominant freestyle.
- There is very little pause at the front of the stroke, since the hand and arm enter the water in the proper pulling position.
- This high elbow position is maintained through the pull, as in the stroke length dominated freestyle.

The Freestyle Kick

The kick is important to swimming because it provides both balance and propulsion to the stroke. However a poorly timed kick can lead to many stroke flaws and the potential for injury. Four styles of kicks are commonly taught:

1. **2-beat kick**—In the 2-beat kick, there is one kick for every arm pull (two per every pull cycle). The timing of the kick is such that the right leg kicks as the right arm is finishing the pull (and the left arm enters the water and sets up for the catch) and vice versa. This kick is used mostly in distance freestylers and is primarily used to maintain balance in the water—very little propulsion is generated.
2. **6-beat kick**—As the name suggests, in the 6-beat kick, six kicks are taken for every stroke cycle (three for each right arm pull and three for each left arm pull). There are three kicks for every arm stroke. Again the timing is similar so that as the right leg finishes the kick as the right arm completes the underwater pull, and vice versa.
3. **4-beat kick**—In the 4-beat kick, four kicks are taken for each stroke cycle (two per arm). This is an asymmetric kick, however. If the swimmer maintains a consistent rhythm, it is impossible to maintain a relationship where the right leg is kicking as the right arm finishes its pull and the left leg kicks as the left arm finishes the pull. In the 4-beat kick the right leg will also kick as the left arm is finishing its pull. This creates a stroke asymmetry.
4. **Modified 4-beat kick**—In the modified 4-beat kick, the timing is the same as a 6-beat kick, but two of the six kicks are left out. The swimmer essentially rests for two kicks. This maintains the proper timing between the arms and the legs, but does not require the energy outlay required to maintain a 6-beat kick.

Some other kick pointers are:

- The kick should be driven from the hips. Excessive knee flexion should be avoided.
- The strength of the kick comes on the downbeat. Very little propulsion, if any, is generated with the upbeat of the kick.

- For the most effective kick, the knees will be separated slightly, the legs rotated inward a bit, and the feet fully plantar flexed (toes pointed). This presents the most effective kicking surface on the dorsum or top of the foot.

Poor Freestyle Mechanics

While there are an infinite number of ways in which a swimmer can swim incorrectly, there are several things that come up time and time again with swimmers of all abilities. These technique "flaws" are outlined briefly below.

- **Attempting to develop propulsion before having a proper catch**—This is commonly seen with swimmers who pull with a straight arm. They push water towards the bottom of the pool and place added strain on the shoulder structures. Additionally, this is a portion of the stroke cycle where it is impossible to generate significant levels of propulsion.
- **Dropped elbow**—In the middle of the pulling phase many swimmers will drop their elbow so that they no longer are pulling with the hand and forearm, but instead are only utilizing the pulling surface of the hand. In this position, it is extremely difficult to connect the arm to the torso and core of the body. Also, this position minimizes the force contributions of some of the strongest muscles of the back and places the bulk of the load on the muscles of the arm and shoulder.
- **Insufficient body roll**—Body roll is used to help increase the stroke length of swimmers and also adds to the propulsive force delivered to the water. Body roll is commonly taught by coaches, but is not necessarily the best way to swim for all swimmers (i.e. stroke rate dominated freestylers).
- **Poor control of the postural muscles/core muscles**—Balance is one of the keys to swimming effectively and efficiently. It is the base upon which proper pulling and kicking mechanics must be built. These muscles must be strong enough to maintain the body's posture in the water while also contributing to propulsion (think of Tiger Woods swinging a golf club—he uses the core muscles to initiate the swing and then transfers power to the upper body and then to the club).
- **4-beat kick**—As was mentioned, this is an asymmetric kick and it leads to an unbalanced stroke. Any time the stroke is asymmetric, the chance of injury increases while efficiency decreases.
- **Breathing dominance to one side of the body/Stroke asymmetry**—Swimmers who continually breath to one side of the body will certainly develop stroke asymmetries and strength asymmetries between the right and left sides of the body. Again, this can lead to poor mechanics, muscle fatigue, and/or injury.
- **Muscular strength imbalance**—Imbalances are commonly found between the internal and external rotators of the shoulders. Weakness is also seen in the muscles that stabilize and retract the scapulae.

Conclusion

By no means has this discussion contained a complete analysis of the freestyle stroke. There are many modifications and differences that swimmers make to their strokes to suit their body types and physiologies. As was mentioned, it is best to first sit down with a coach and look at your strokes on videotape. Then choose one or two things to focus on first—do not try to fix everything at once. When in doubt, start by addressing how your body is balanced in the water. Many times you will find that if you can properly balance your body, many of the other "stroke flaws" will disappear. Using good technique will help you become more efficient in the water and at the same time cut down on injuries. Best of luck and have fun in the pool.

About the Author

Scott Riewald, PhD, CSCS, NSCA-CPT is currently the Administrator of Sport Science within the USA Tennis High Performance Division. He works closely with the other departments within High Performance as well as the USTA Sport Science Committee to collect and disseminate information relating to sport science and tennis. Prior to working for the USTA, Scott served as Educational Programs Coordinator for the National Strength and Conditioning Association, and spent four years as the Director of Biomechanics for USA Swimming. Scott received a BS degree in biomedical engineering from Boston University and a PhD in biomedical engineering/biomechanics from Northwestern University. He is a Certified Strength and Conditioning Specialist® (CSCS®) and a NSCA-Certified Personal Trainer® (NSCA-CPT®). Scott is married and has a 3-month-old son, Maddox.