The Tennis Serve Essay, Research Paper

The tennis serve is the stroke that puts the ball in play and is often referred to as the most important stroke in the game of tennis. It has become a principle weapon of attack and is used to place the opponent on the defensive by forcing a return from the weak side or by moving the receiver out of position. A good strong serve can sometimes be the basis of winning a game of tennis. I have included eight picture sequences to illustrate the tennis serve.

Represented in picture A is the stance of the serve. In this part of the serve, the person needs to take a position sideways to the net, about three or four feet to the right center mark behind the baseline. The left foot is two to three inches behind the line, the toes pointing toward the net post. The back foot is parallel to the baseline and spread conformably from the front.

Pictures B and C represent the preparation phase. In these pictures, the execution of the ball toss is performed. The ball toss is the key to a well-executed serve: a good release consistently places the ball in the proper hitting position. A poor release can throw off timing and ultimately cause a bad serve.

In pictures D-F the action phase is represented. In picture D of the action phase, the elbow reaches a position slightly higher than the shoulder, then the elbow bends and the racket head drops down behind the back into what is called the “back scratching position.” In picture E, the ball should be at its maximum height of the toss before striking it. In picture F, the last of the action phase, the movement of striking the ball is explosive in an upward and forward motion until contact

Pictures G and H represent the follow through. In the follow through the action is performed up and out, not down, in the direction of the intended target area. The follow through is a natural continuation of the stroke. A good follow through will help prepare for the next step in approaching the net for a return.

Kinematics is defined as the study of motion. It is compiled of different bodily planes and different joint motions. In the beginning of the serve, during the stance (picture A), the feet are outwardly rotated. The hips and the trunk are extended. The left shoulder is slightly flexed along with the right shoulder and the shoulder girdles are slightly abducted. Both of the wrists are pronated with the elbows slightly flexed.

During the preparation (pictures B and C) the feet are still in an outwardly rotated position. The hips slightly abduct with the trunk still in full extension. The shoulders are abducted, with slight elevation of the shoulder girdle. Both elbows are extended, but the right wrist stays in a pronated position and the left wrist is supinated.

During the action (pictures D-F) the right foot inwardly rotates along with it performing planter flexion but the left foot stays in an outwardly rotated position. The hips are adducted but then they shift to abduction. The trunk starts in hyperextension then get fully extended and slightly rotate to the left. Both knees flex but the left knee extends while the right knee stays flexed. The left shoulder goes from flexion to extension while the right shoulder performs high diagonal adduction. The left elbow goes from extension to flexion and the right elbow goes from flexion to extension. The left hand goes from supination to pronation while the right hand stays in a pronated position.

Finally, during the follow through (pictures G and H) the left foot inwardly rotates along with some planter flexion. The right foot inwardly rotates and goes back to a naturally flat position. Both hips are flexed along with the flexion of the trunk and it’s rotation. The left shoulder remains in an extended position but the right shoulder follows through with the high diagonal adduction, while both shoulder girdles perform abduction. The right elbow slightly flexes but the left elbow extends. The knees go from flexion to a greater degree of flexion.

The kinematics of the tennis serve is a complicated thing, it consist of many laws and principles. One law is the law of inertia and the principles deal with motion, force and projectiles. These laws and principles can be applied to a skill, for example the tennis serve.

The first principle deals with stability. This principle consist of smaller groups dealing with mass, friction, height of the center of gravity, position of the center of gravity, and base of support.

The mass of the person in pictures A through H is of a certain weight. This mass or weight throughout the serve is considered to be constant. This observation is made because during the tennis serve the person performing the serve cannot gain or loss mass during the serve.

Friction can be a major factor in a sport or game. The type of footwear available can help an althea to the point of better counter force when jumping or better traction for different surfaces. A tennis shoe does not need to have great counter force because there is not a lot of jumping but traction is important because of different surfaces like clay, grass, and concrete. Each surface performs differently for each athlete so there should be a traction on the shoe to benefit sprinting forward but also being able to move side to side.

Height of center of gravity is one important factor in good equilibrium. In the stance position of the tennis serve (picture A), the height of gravity is in the middle around the navel. This remains constant through the prep phase (picture C), but when the action phase starts (pictures D – F) the height of gravity moves up with the extension of the racket arm and trunk. Then in the follow through (picture G, H) height of gravity starts to go down because of the descending motion of the racket arm and trunk.

Position of center of gravity is another important part in good equilibrium. In the stance position of the tennis serve (picture A) the position of gravity is about two inches above the belt. Then in the prep phase (picture C) it moves upward about four inches above the navel. Next, in the action phase (pictures D – F) center of gravity moves three inches to the right of the navel and about four inches above the navel. In the follow through (picture G, H) the center of gravity is about four inches outside the body parallel to the belt line.

Base of support is the area formed by the outer most region of contact between the body and a support surface. During the serve (pictures A – D) the base of support is pretty much constant. It is just enough not to fall but good enough to push off of the surface. In picture E the base narrows a little because of the force of pushing off with the left foot. Pictures F and G, the base is wider then narrows and drops down and forward, this is because of momentum pulling the body forward into the follow through. At the end the base of support is narrowed to bring the feet under the body for better equilibrium because the center of gravity is outside the body, this is to keep the body from falling.

The first law of kinematics is the law of interia. This law has principles that deal with motion.

Translatory motion is defined as motion moving in a straight line. Rotary motion is defined as motion moving in a circle. Combining translatory and rotary motion in the tennis serve is shown by the rotary motion of the racket arm and the motion of the trunk in the follow through. Translatory motion is shown by the stepping forward of the trunk, legs, and partially of the racket arm.

Continuity of motion is shown during the action phase (pictures D – F) with the tossing of the tennis ball while bringing the racket into a striking position and also extended the trunk and legs. This is all performed at the same time with no pause. If there was pause in any of these motions there would not be enough momentum to create a very effective serve.

Momentum is the product of a body’s mass and linear velocity. Momentum can be changed by changing direction. To produce an effect of momentum during the serve, since mass is constant, the velocity of the body must be increased. This is done by the extension of the racket arm along with the trunk and moving the center of gravity forward to produce a good momentum in striking the tennis ball, this intern with the racket striking the ball turns it into a force, this force is equal to the momentum of the body.

During the action phase of the serve (pictures D – F) transfer of momentum is achieved by extending the legs, trunk, and racket arm. This is done because mass remains constant, so to increase speed the body must become longer to help contribute to the total body momentum.

In the tennis serve acceleration is proportional to force because mass in the body of the server is constant. So if the server has a great amount of acceleration then there will be a great amount of force when striking the tennis ball with the racket.

Maximum acceleration is achieved by moving the whole body in a forward motion with continuity and timing. There are really no extraneous movements because most movements like the extension of the legs, trunk, racket arm, and the moving forward of the body are all extended to create greater body momentum. Timing is very important and should be practiced because it is probably the hardest thing to get down to create maximum acceleration and effective motion.

In the serve the body’s radius is lengthened so according to the principle the rotation is shortened during the follow through phase, this is because with a lengthened radius the body has more area to cover. This is sacrificed because greater momentum to where the ball must be hit is more important then rotational speed. This is illustrated in the action phase (pictures D – F) with the extension of the legs, trunk and racket arm. This shows the lengthening of the body’s radius.

During the action phase of the serve never unsupported as seen in the pictures D – F. Both feet seem to be on the ground in constant support of the body, so this principle does not apply to this particular serve. Although some people might actually, force a split second, become airborne during the serve, then this principle would apply.

There are three major surface variations in tennis all with different counter force. Clay is the first surface, although it is somewhat soft is does not contain good counter force because it has a bad coefficient of restitution, which means it does not bounce back to original shape very well. Clay is also somewhat slippery so players must slide to position to hit the ball. Grass is another form of surface variation, it is also somewhat soft and does not have a very good coefficient of restitution but it is better then clay. Grass also has a degree slipperiness and also requires the sliding into position. Finally, concrete is the last surface variation, it has no counter force because there is no give and no coefficient of restitution but concrete is not as slippery as the other two surfaces.

During the action phase of the tennis serve (pictures D – F), the direction of counter force is projected down and back which in turn propels the server up and forward. This is done in a perpendicular manner to the surface so there will be no slippage.

When the racket strikes the ball there are counter forces. When the ball is in contact with the racket, the racket has momentum but there is one possibility in the make of the racket to help contribute to counter force. If a player has a stiff racket with loss strings the give of the racket is not as great as the strings but when both their coefficients of restitution are activated, they perform in created more force for the striking of the ball. The ball itself also has a coefficient of restitution to help propel itself off the racket. The player also must have a firm grip at impact to reduce of eliminate give at the grip.

Temporarily stored counter force can be found in many parts of the tennis serve. For one, the ball itself has it own ability to spring back to original shape, this all depends on the make of the ball. Next is the racket and the strings, each have a coefficient of restitution which results in temporarily stored counter force. A stiff racket like tightly wound strings have high restitution unlike a flexible racket and loss strings. Finally the shoes an athlete wears can have stored counter force depending on make and material.

In the tennis serve as observed in pictures D – F, during the sticking motion both feet are in contact with the ground to provide maximum to the ball, even though the bodies extended and looks like it could go airborne.

Total force is equal to the sum of the forces of each body segment contributing to the act, if the forces are applied in a single direction and in the proper sequence with correct timing. If the variables sequence, timing, and direction are not all applied correctly together the total force will be minimal. During the action phase, pictures D-F, in the tennis serve total force is achieved by the extension of the arms, legs and trunk along with the timing of the movement of the racket arm in striking the ball, and also the leaning forward of the body.

Force applications should be constant and as even as possible. The force applications should be this way so that maximum force can be used to overcome the resistance of gravity and air or water, and minimum force can be used to overcome inertia.

The relationship between constant force over a greater distance and resulting velocity is a positive one. When the distance over which a force is applied increases, so does the velocity. During the prep phase, pictures A-C, the extension of the racket arm is done to create the distance in which greater velocity will occur and this resulting in a greater striking force of the tennis ball.

Resulting movement depends on the direction and magnitude of the acting forces. If two of these forces act in the same general direction, the direction of the resulting force is somewhere between the two, and the magnitude of the resulting force is more than either, but not as much as the total of the two contributing forces. During the action phase, pictures D-F, the force of the arm, body and racket hitting the ball forward along with gravity pulling it downward, the ball’s flight, although going forward is also going down. This path of the ball is the between result of the two forces acting upon it.

The relationship of muscle length and resulting force is that, the longer the muscle is, the greater the increase in force of that muscle. During the prep phase, pictures A-C, the muscles in the body and the racket arm are tensed or put on stretch to increase the length of the muscle to produce greater force.

The relationship of linear speed to lever length is positive. This means that when a lever gets longer the linear speed gets faster, thus increasing the striking force. During the action phase, pictures D-F, the extension of the levers of the body and racket arm increases the linear speed, resulting in greater striking force of the tennis ball.

Emphasis on proper follow through eliminates the tendency to decelerate a throwing or striking action prior to its completion. Some other benefits of a proper follow through would be to maintain balance and to protect the joint by gradually slowing the body parts. In any case, once contact is broken with the object, follow through actions has no influence on the flight of the object.

There are some external forces that can be used to benefit performance, like water resistance, friction, gravity, and air resistance. Having the correct shoe for the correct playing surface can be very helpful because it could help reduce friction resulting in greater speed. Using gravity and air resistance when striking the tennis ball could be used in the placing of the ball to make it harder for the opponent to hit it.

The relationship of air/water resistance and velocity is that if the velocity at which a body travels is increased by two, the air/water resistance against it will increase by four. During the action phase, pictures D-F, when the tennis ball travels at a certain speed the air resistance is squared. This intern can affect the flight of the ball.

Centrifugal force is only experienced during a rotational (angular) or curvilinear motion. It results from the tendency for an object to continue in a straight line instead of a curved path. It is counteracting by forces (usually muscular) which, if effective, equal or exceed the centrifugal force and tend to maintain the object to continue in its curved path. This counteracting force is centripetal force. In the case of a freely moving body, as velocity increases, centrifugal force increases. Additional weight also increases centrifugal force. The smaller the radius of a curved path, the greater the centrifugal force with the same velocity. During the action phase, pictures D-F, the half circle motion of the racket arm, when in the process of hitting the ball, wants to go in a straight line but the muscles keep it from doing that. Instead, it brings the racket around to strike the ball at the peak height of the ball toss.

A force from a blow can be diminished by distributing the force over either a greater time (and distance) or area, or both. During the action phase, pictures D-F, the size of the racket head determines the distributing of the force of the tennis ball. The bigger the racket head the more the force of the ball is diminished.

In catching an object, the object’s momentum is dissipated by eccentric muscular contractions allowing the joints to move through controlled flexion; and while momentum is being reduced, body parts flex to grasp the object securely. This principle is not found in the tennis serve because there is no object being caught.

If the application is directly through the projectile’s center of gravity, only linear motion results from the force. As the projecting force is moved farther from the center of gravity, rotary motion of the object increases at the expense of linear motion. If the force is below the object’s center of gravity, backspin results. If the force is above the object’s center of gravity, topspin results. The striking of the ball above or below it’s center of gravity which can intern result in topspin or backspin which can change the direction of the ball when it hits the court and also in the air.

The force of gravity on a object starts to diminish it’s vertical velocity as soon as contact is broken. The factors that determine how soon gravity will cause the object to descend are weight, amount of force driving it upward, and the effect of air resistance on the object.

The relationship of speed and air resistance is that as speed increases air resistance plays a more significant role. Objects that are less dense and streamlined are influenced less by air resistance, and the less surface area an object presents, the less will be the effect of air resistance on the object. The tennis ball being somewhat small, round, hollow, and fuzzy, makes it less dense, more streamlined, and it presents less surface area. This all intern makes the tennis ball a pretty streamlined.

The optimal angle for maximum distance when the beginning and end points are at the same level is 45 degrees. The effects of a less than optimal angle results in little distance. The effect of a greater then optimal angle can also result in little distance.

When starting points are above or below ending points, reduce angle to get maximum distance. Since the greatest angle for projection is 45 degrees, the tennis serve is struck downward as close to 45 degrees as possible.

The relationship of the angle of incidence to the angle of reflection is equal. This means that the angle at which the object approaches a surface is equal to the angle at which it leaves that surface. The factors that could change this would be irregular shapes of the two colliding surfaces, the force resulting from elasticity of the object, and the spin of the object both during and after contact. If all else is constant , the angle the tennis ball hits the ground is the angle it will project of the ground. Also in tennis spin will effect the angle.

A highly elastic object will quickly spring back to its original shape after being compressed. The compression of the tennis ball is somewhat moderate but there is also what is called a high compression ball on the market. The elasticity is really high because the ball is made out of rubber, which has a good restitution. The greatest rebound results from a moderately compressed ball with high elasticity. For tennis, a stiff racket and loose strings will produce the greatest elasticity of the ball because the racket if loose does not have great restitution as well as the strings do. Also the ball is highly compressed and has a lot of elasticity to it, to help propel it fast.

An object propelled without spin tends to waver because of air resistance against the object’s irregular surface. A small amount of spin on an object produces a stabilizing effect which tends to hold it on its line of flight. Increased spin will tend to cause the object to curve in the same direction as the spin because of unequal air pressure cause by the spinning. During the serve or contact with the ball spin is added to the ball to throw the opponent off guard. The effect of the spin is to make the opponent change direction very quickly.

To cause an object to spin in the desired direction, the striking implement should be drawn across the object in the direction of the desired spin. Topspin is caused by an implement striking forward-upward. Backspin is produced when the strike is made forward-downward. In the serve topspin is added to draw the ball out or make it jump up. Backspin is added to make the ball fall short, so to make the opponent run to the net.

Topspin causes a lower angle of rebound, a longer bounce, and more roll. Backspin causes a higher angle of rebound, a shorter bounce, and less roll. In the serve these spins are used to throw the opponent off guard and to make them make a quick decision and mess up.

The effects on a vertical surface are different than on a horizontal surface. Topspin causes a higher rebound , backspin causes a lower rebound, right spin causes a rebound to the left, and left spin causes a rebound to the right. Tennis serve does not happen on a vertical surface at all.

The serve is the most important part of tennis, it starts the game and sets the tone for the match. Many of the professionals today have mastered most of theses principles, and these principles can be seen by just watching a match by a valid tennis player.

Biomechanics

The Tennis Serve

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