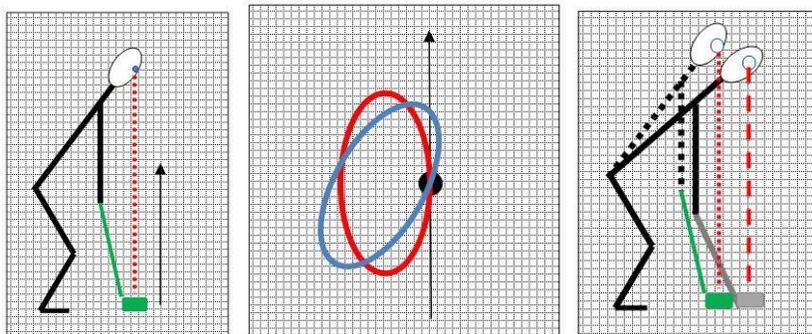
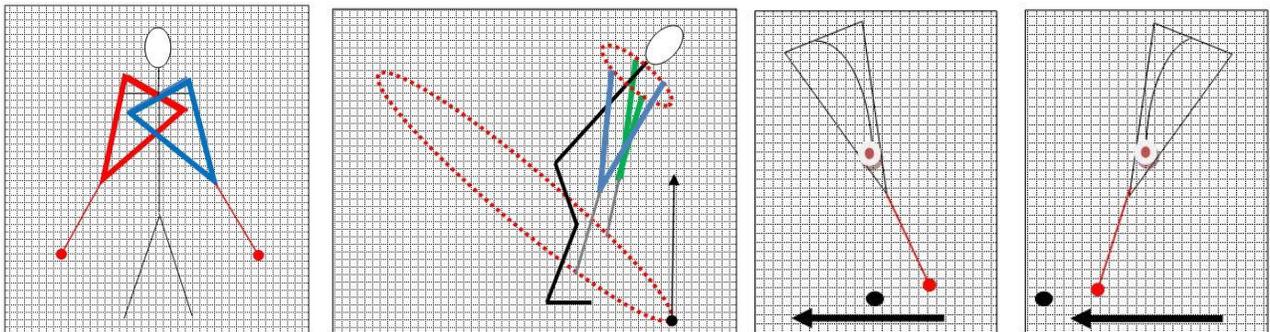
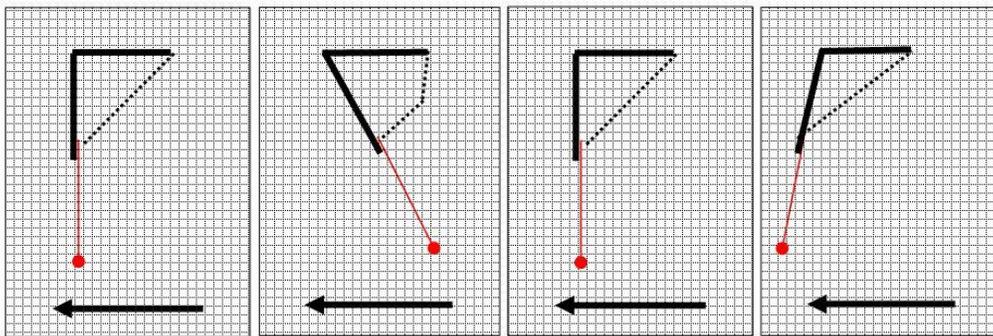
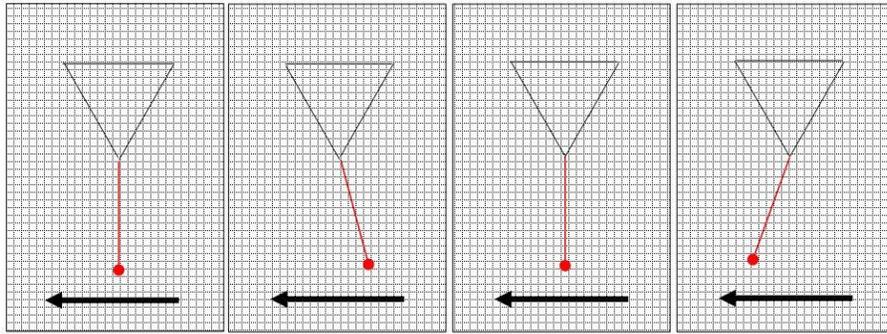


Guide to the Putting Stroke



Generally Eclectic

Guide to the Putting Stroke

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Chapter One: Introduction

In *The Theory and Practice of Gamesmanship or The Art of Winning Games without Actually Cheating*, Stephen Potter suggests when your opponent has been draining putts throughout the round and you need to resort to desperate measures to win the match, you politely ask your opponent what muscles he or she is using when putting. With attention focused on muscles, your opponent proceeds to miss everything, and you win the match. Despite the timing, the question is a good one: what muscles should we use when putting?

This guide is dedicated to the years of bad putting, due at least in part to the failure to understand the putting stroke, and written with the hope that you may learn from bad experiences and improve your putting.

To be a good putter, you have to:

1. Figure out how hard to hit the putt, taking into account elevation changes and speed of greens.
2. For your chosen weight, decide on the line to the hole, taking into account slopes, etc.
3. Line up along your chosen line, so that you are actually hitting the ball in the exact direction you want.
4. Stroke the ball according to your line up, with the clubface perpendicular to the intended line at impact and the stroke proceeding along the intended line at impact.
5. Stroke the ball with the chosen weight.
6. Be able to do all these things, putt after putt in a variety of conditions, short putts, long putts, pressure putts, high winds, etc.

This guide focuses on point 4, namely the execution of the putting stroke on the correct line.

To master the other points, read good golf books and magazines; watch the golf channel; take some lessons; and more than anything, practice.

We have five basic options for the putting stroke:

1. Moving the wrists, and only the wrists (the wrist stroke).
2. Moving the upper arms in the shoulder sockets, particularly the lead upper arm, and only the upper arms (the lead upper arm stroke).
3. Moving the shoulder sockets in some combination of forward and backward, up and down, and only the shoulder socket (the shoulder socket stroke).
4. Twisting around the spinal column, and only twisting around the spinal column (the spinal twist stroke).
5. Tilting the spinal column to each side, and only tilting the spinal column (the spinal tilt stroke).

In addition to these basic options, the putting stroke can consist of some combination of these basic options. These combination movements we call “hybrid” strokes.

What do we want to achieve with the putting stroke? Here are some ideas:

1. Muscle joint consistency. By this, we mean a good stroke would minimize the muscles used, seek intrinsic coordination of the muscles that are being used, and involve joints with limited range of motion.
2. “Yip” prevention. “Yips” are very poor strokes that arise under pressure. Conventional wisdom suggests that “yips” can be prevented by using larger rather than smaller muscles. Presumably, “yips” can also be prevented by moving larger rather than smaller masses through the putting stroke. The momentum involved with the movement of larger masses would prevent exceptionally poor strokes.
3. Stillness of the eye sockets. Conventional wisdom holds that a still head (and eyes) produces consistently better putts than a head (and eye sockets) that move during the stroke.
4. On-line direction. Getting the putt on line is optimized with a vertical rotation in the stroke, a larger rather small diameter to the rotation circle, and a steady rotation centre.
5. Eye alignment. Conventional wisdom holds that the eyes at address should be directly over the ball, or at least over the target line, so that the player can see the putting line more clearly.
6. Power. While power is not a factor in short putts, it becomes relevant in longer putts where the lack of power may prevent the player from using the putting stroke.
7. Back health. Back health is directly related to putting posture. Upright putting postures are more conducive to back health. In some cases, forward bending can improve putting performance but lead to back problems after continual practice.

Chapter Two will explain and examine these criteria more fully. Chapter Three to Seven will discuss the various basic putting strokes in terms of the criteria. Chapter Eight will compare the putting stroke options in terms of the criteria, and provide some suggestions about best practices.

Chapter Two: Putting Stroke Criteria

In selecting an “ideal” the putting stroke from the various options available, it is useful to have some criteria on which to base the selection. Here are some ideas:

Muscle Joint Consistency

The Number of Muscle Groups Involved

The fewer the muscle groups involved, the simpler the stroke and the greater the consistency.

With only a few muscle groups involved, it is possible for the player to concentrate on contracting the relevant muscles at the relevant time.

Putting strokes can be divided between “basic” strokes that use only those muscles needed to propel the ball forward, and “hybrid” strokes that use some combination of the basic strokes. In this Guide, we focus on the “basic” strokes, and suggest all things being equal (particularly practice time), “basic” strokes will be better than “hybrid” strokes, because they are simpler and more likely to be consistent. With a simple stroke, the player can think about contracting one or two muscles and the ball will be propelled in the proper direction.

The Degree of Coordination between the Muscle Groups Involved

When more than one muscle group is involved, consistency drives the need to coordinate the work of the muscle groups. Because the putting stroke is symmetrical in the sense that muscle groups on both sides of the body typically operate to execute the backstroke and forward stroke, the need to coordinate muscle activity is almost always unavoidable. It is desirable that these muscle groups not work independently, but work in a coordinated way. This will produce intrinsic consistency in the stroke, and reduce the need for continual coordination practice to get the consistency. An example of muscle groups acting independently is when the stroke involves moving the right and left shoulder blades. These blades can move independently. One blade can move up, the other back and down, etc. An example of muscle groups acting in a coordinated way is when the stroke involves rotating around the spinal column. The muscles on both sides of the body are forced to work in a coordinated way because the spinal column links them. In fact, the brain has learned to instruct these muscles to operate in coordination, so the coordination occurs without conscious thought.

The Range of Movement in the Joints Involved

Some joints in the body allow movement in a wide variety of directions. Examples include the wrist and ankle joints, which allow the movement move up and down, forward and backward, and directions in between; and the shoulder and hip joints. These are ball and socket joints which allow the upper arm and upper leg respectively to move in a variety of directions. The brain is so accustomed to moving these ball and socket joints within their full range of motion that getting consistent movement along one path is not automatic. Other joints allow restricted movement. Examples include the elbow and the knee, where movement is allowed in one plane with minimal twisting. Unfortunately, the knee and elbow are not key parts of the golf swing.

“Yip” Prevention

The Size of the Muscle Groups Involved

The conventional wisdom is that the use of bigger muscles over smaller muscles is more likely to be effective in minimizing the likelihood of the yips in pressure situations. This argument was used to justify the movement away from putting with the wrists. One counter argument is that muscles that are commonly used for precise movement (e.g. wrists and hands) might be better suited to the precision needed in putting.

Momentum and the Mass Being Moved

Regarding the yips and putting under pressure, an additional factor that may have some relevance is the mass being moved. When moving a large mass, effort is needed to get the mass moving, but once in motion, momentum takes over and the mass moves in the direction set for it. In putting, there is less momentum in a wrist stroke that moves only the putter, and more in a spinal twist stroke that moves not only the putter, but the wrists, the upper arms, and the shoulder sockets.

Stillness of the Eye Sockets

It is useful to keep the eye sockets still on the back and forward strokes. Still eyes are useful in monitoring the stroke in progress, controlling the length of the back stroke, monitoring rhythm, and making subtle in-stroke corrections. Note that a still eye sockets require a still head. A still head would normally, but not always entail, a still spinal column, particularly at its top. While it is conceptually possible to have a still head without a still body, a lot of muscular activity is needed to generate a still head. This activity requires the involvement of additional muscle groups and complicates the stroke.

The importance of the eyes in the putting stroke is illustrated by the fact that very few players putt with their eyes shut. In theory, an intrinsically sound stroke should be effective without using the eyes.

On-Line Direction

The Rotation Plane in Relation to the Vertical

Like the full golf swing, the putting stroke relies on rotation. The putter head is tracing out a path around the perimeter of a circle.

The circular nature of the putting stroke is under appreciated. One reason is that the putting stroke represents on a small portion of the perimeter of the circle. If one uses a wrist stroke and a 32 inch putter, a putting stroke that involves a 12 inch backstroke and 12 inch follow-through represents only 11.94 per cent of the circle radius. If one uses a shoulder based stroke, the putter stroke represents only 7.64 per cent of the circle radius. Despite the fact that the putting stroke covers only a small part of the circle radius, it is important to realize that the throughout the stroke, the putter clubface is moving around a circle.

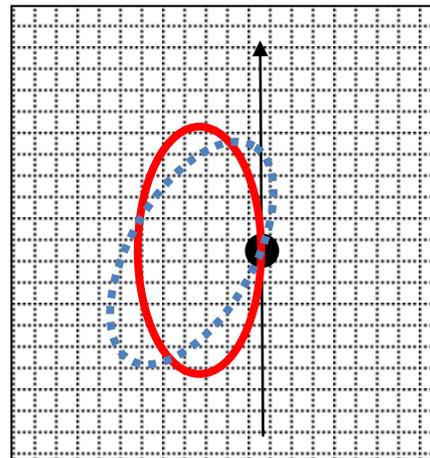
The most obvious manifestation of the circular path of the putter head is the rising of the putter head off the ground on the backstroke, its return to a low point around impact, and the rising of the putter head on the follow-through.

When we perceive the putting stroke as a rotation, then several questions arise. What is the rotation plane relative to the vertical? Where is the centre of the rotation? What is the radius of the rotation circle?

A stroke that sees a properly aligned putter head go back along the line of the intended path and forward along the line of the intended path will always put the ball on the intended line intended. Getting the club head on this path requires that the plane of the rotation should be vertical to the ground and in the direction of the target. With this type of rotation, regardless of the low point in the circle traced by the putter head, the ball will set off on target (assuming the putter face is aligned correctly).

Dave Pelz, in his Putting Bible, argued convincingly about the merits of a vertical rotation plane (although he did not characterize it this way).

Variants from the ideal rotation include vertical rotation aligned to the left or right of the target; non vertical rotation; and combinations of the foregoing. With non-vertical rotation, the putter head is moving around the circumference of a circle relative to the target line. There is only one impact point in the rotation that will set the ball on target. Other impact points will set the ball to either the left or the right of the target. In the diagram, the solid red line illustrates the top view of a non-vertical rotation where the impact point sets the ball along the intended target direction. The dotted blue line illustrates the top view where the impact point sets the ball to the right of the target direction.



Rotation Circle Radius

The bigger the radius of the circle around which the putter is travelling, the less significant are the direction problems related to a non-vertical rotation plane. With a putting stroke using wrists only, the radius of the rotation circle is the length of the putter. Putters tend to be in the 32 to 34 inch range. With the putting stroke using other options, the rotation radius is approximately the distance from the shoulder to the ball. This distance depends on the player's height from ground to shoulder, the amount the player leans forward, and where the body is placed relative to the ball. This distance could be in the 48 to 52 inch range. The problem with the lower circle radius is that for a 12 inch backstroke and follow-through, one is going much further around the circle and therefore more exposed to the curve in the circle.

Steadiness of the Rotation Centre

With rotation, it is important to know where the rotation centre is. For example, is the rotation centre the wrists, the lead shoulder socket, the mid- point between shoulder sockets, etc.?

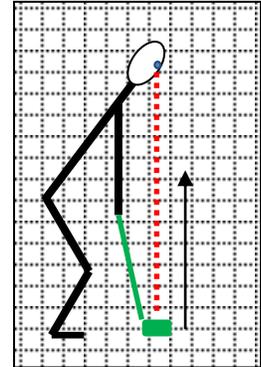
With rotation, particularly non-vertical rotation, if the centre of rotation is moving during the putting stroke, the likelihood of starting the ball toward the target diminishes as there is only one point on the rotation circle that works, and movement makes it more difficult to find that point on a consistent basis. Vertical rotation is

more tolerant of movement, since movement directly away from or directly toward to the target still puts the ball on target.

Eye Alignment

A conventional golf teaching is that the eyes should be directly above the ball at set up, or at least directly over the target line, and not to the left or right of the ball when seen from behind. The conventional argument is that with the eyes directly over the ball, or at least on the target line, by rotating one's head toward the ball, the eyes will track out the correct line.

This argument makes sense when the spinal column is horizontal to the ground and perpendicular to the target. Turning one's head will move the eye sockets directly down the path to the target.



When the spine is not horizontal to the ground (and it rarely would be) or perpendicular to the target, the rotation occurs in the neck and is perpendicular to the spinal column. Rotating one's head would move the eye sockets to the left of the target for a right hand player and right for a left hand player.

Note that the eyes move independently of the head position. In addition, they can move in a multitude of directions. Regardless of what one does with one's head and neck, the eyes movements are critical to getting a good line. One can have an online head rotation horizontal to the ground sabotaged by eye movements, and an off line head rotation corrected by eye movements.

In other words, getting one's eye sockets on or over the target line is not critical to getting a good line.

However, there is much to be said for setting up on a consistent basis. Even though turning one's head will not put the eye sockets automatically on the correct path, a consistent approach will teach the brain to make the necessary adjustments that relate target to the alignment. Getting the left or right eye or the mid-position between the left and right eyes over the ball can form the basis for a consistent, repeatable body set up position.

Power

There are limits how far the various joints can move. This puts limits on the length of the putting stroke, and how far one can hit the ball with a particular stroke. For particularly long putts, it is desirable to have a stroke that can get the ball to the hole, without resorting to another type of golf shot.

Back Health

No one putts with the spine vertical. Every one leans forward to some extent. The execution of some putting stroke options improves considerably with more forward lean. This performance related incentive to lean forward can lead to back problems. Forward leaning can put stress on the player's back, particularly if the player is inclined to practice long hours on the putting green. These stresses can be mitigated through a

posture that involves knee bends. At the end of the day, posture needs to be taken into account when considering the putting stroke.

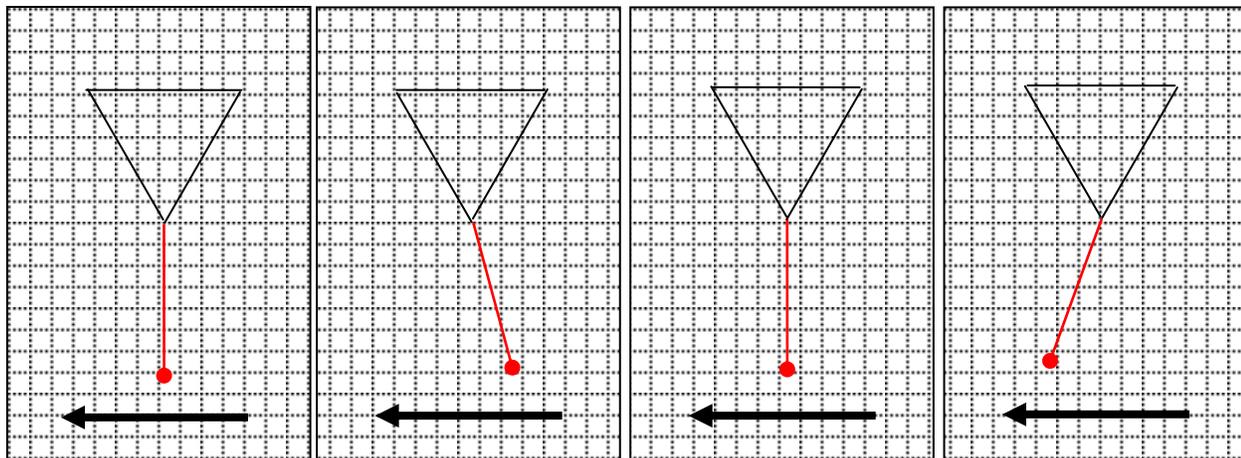
Chapter Three: The Wrist Stroke

In this stroke, the only body parts that move are the wrists. The forearms, upper arms, shoulders, and back remain motionless.

On the backstroke, the muscles on the back of the trailing forearm and the front of the lead forearm contract. The contraction causes the wrists to cock so that the club moves away from the ball. The reverse happens on the forward stroke; the muscles on the front of the trailing forearm and the back of the lead forearm contract, causing the wrists to propel the club forward toward the hole.

To get a sense of what happens when only the wrists move, one can hold the forearms tight against the body. This immobilizes the forearms, so the only movement is the cocking and uncocking of the wrists. Note that holding the forearms tight to the body is a practice useful only to get a sense of the movement. The actual execution requires the forearms to be away from the body.

The diagrams below illustrate the stroke. The triangle is formed by the arms and the line between the shoulder sockets. In the back swing and forward swing and at impact, the arms and the shoulder socket do not move.



Address

Back Stroke

Impact

Forward Stroke

This putting style was popular in the 1950s and 1960s. Here is an assessment of this putting stroke in terms of the criteria discussed above.

Muscle Joint Consistency

The Number of Muscle Groups Involved

Four muscle groups are involved – the muscles at the front and back of the forearm on both arms.

The Degree of Coordination Between the Muscle Groups Involved.

The stroke engages muscle groups in both forearms. The muscle groups in each forearm operate in a coordinated way. The actions of muscle groups in one forearm are restricted because both hands are holding the putter.

To ensure the same muscle groups in both forearms are used, the putter should be gripped with the palms facing each other and the thumbs on top of the shaft. This will ensure that the muscles that pull the back of the hand away from the body centre, and the muscles that pull the palm of the hand toward the body centre, are used.

The Range of Movement Related to the Joints Involved.

The wrist joint can move in a variety of ways – up, down, left, right and directions in between. As a consequence, the joint's movement taken alone does not guarantee consistency.

“Yip” Prevention

The Size of the Muscle Groups Involved

The muscles involved in moving the wrists are relatively small. Their purpose is to carry out the precise movements required by the wrists.

Momentum and the Mass Being Moved

With a wrist stroke, the only mass being moved is the putter. There are no other body parts that need to be moved.

Stillness of the eye sockets.

Since only the wrists move, the eye sockets remain still.

On-line Direction

The Rotation Plane in Relation to the Vertical

The axis of rotation is perpendicular to the forearms. The contraction of the muscles in the front and back of the forearms causes the wrists to move around the forearm at the wrist joint. When the forearms are perpendicular to the ground, the rotation plane is vertical to the ground. When the player assumes a posture with a forward lean and lets the arms hang, the arms including the forearms will hang straight down and vertical to the ground. When the player uses only the muscles in the front and back of the forearms and the forearms are aligned to the target, the stroke will go straight back and straight forward toward the target.

The Rotation Circle Radius

At a maximum the rotation circle radius will be the length of the putter. The maximum circle radius will occur when the putter is a straight extension of the forearms. In most cases, there will be an angle between the arms and the club. This angle will reduce the radius of the circle followed by the putter head. Note that the plane of this smaller circle will continue to be vertical to the ground. The smaller the rotation radius, the greater will be the lift of the putter head on the back stroke and forward stroke.

Steadiness of the Rotation Centre

Since only the wrist joints are moving in the wrist stroke, the rotation centre, which occurs at the wrist joints, is steady.

Eye Alignment

Essential features of the stroke include a forward lead and arms hanging straight down from the shoulder sockets. With the forward lean, the head and eye sockets will be further away from the body than the shoulder sockets. The distance will be greater with a greater forward lean. The eyes will only be over the ball if there is an appropriate angle between the arms and the putter. The greater the angle between the arms and the putter, the smaller the rotation circle.

Power

The wrists have a limited range of motion. A muscle contraction on the palm side of the forearm can only move the hand about 45 degrees from a neutral initial position. A muscle contraction on the back of hand side of the forearm can only move the hand about 45 degrees from a neutral initial position. With a 33 inch putter, the maximum backstroke would be about 26 inches.

Back Health

This wrist stroke does not necessitate a great deal of forward lean, and consequently, should not place undue strains on the back.

Overall

Here are some ideas for the performance of the wrist stroke:

1. Grip the putter with the palms facing each other and thumbs on top of the shaft. This will lead to the activation of the muscles at the front and back of the forearm (not top and bottom).
2. Position the all slightly ahead of the wrists. This point is around the middle of the stance. The natural low point in the rotation circle will occur directly below the wrists.
3. Position the eyes over the ball. With the ball position more or less in the middle of the stance, the player can adjust the forward lean to position the eyes over the ball. Having the eyes over the ball will lead to consistency in setup and help with alignment. Line the body, particularly the shoulder sockets, parallel to the target line.
4. Let the arms hang vertically downward from the shoulders at set up. This will help put the axis of rotation horizontal to the ground, since the wrists rotate naturally around this axis relative to the forearms.
5. Think of contracting and relaxing the relevant forearm muscles during the execution of the stroke. This will get the club moving backward and forward on the correct line.
6. Fit the putting club to the foregoing in terms of size of grip, length of shaft, and angle between the putter shaft and the head.

The strength of the properly executed wrist stroke is the vertical plane of its rotation. This will get the putts moving on line. The primary weakness is the limits to the power that can be generated through the stroke.

Chapter Four: The Lead Upper Arm Stroke

This stroke uses the muscles in the lead shoulder. Contracting muscles at the front of the shoulder pull the arm across the chest. Contracting muscles at the back of the shoulder pull the arm back to its start position, and then onward into the follow-through.

To get a sense of the motion, stand straight and hold your arms straight out in front so they are horizontal to the ground and ninety degrees to the spine. Now, move both arms to the left, and then to the right. To move the arms toward the centre of the body, muscles connecting the upper arm and the shoulder contract, pulling the upper arm toward the centre of the body. To move the arms away from the centre of the body, muscles connecting the upper arm and the shoulder contract, and pull the upper arm toward the back.

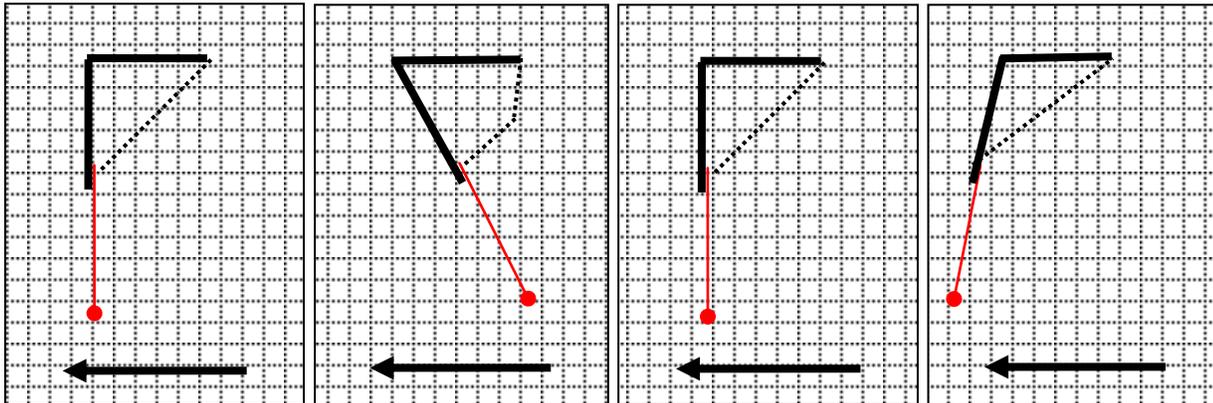
The trailing arm is essentially along for the ride. The reason has to do with body geometry. As the lead arm moves across the body, the distance between the trailing shoulder and the grip gets smaller. Eventually the distance is so small that the trailing arm must bend at the elbow. This elbow bend creates unpredictability in the stroke. For this reason, one does not want to use the trailing arm as a power source to push the putter along. The reverse occurs in the forward stroke, with the lead arm bending in a long follow-through. By this point, however, the ball is already on its way, so the bending does not matter.

The shoulders remain horizontal to the ground throughout the stroke.

Care should be taken to not move the lead shoulder socket while moving the upper arm in the lead shoulder socket, particularly toward the end of the range of motion of the upper arm in the shoulder socket. In our daily lives, we often move both the upper arm in the shoulder socket and the shoulder socket together. One can tell whether the shoulder socket is moving by sensing the muscles that are contracting. Muscles that move the upper arm in the shoulder socket are close to the shoulder socket. Muscles that move the shoulder socket are further away. At the front, they are in the chest. At the back, they are close to the spine.

To practice the stroke, putt with only the lead arm. While it may feel awkward at first, one should eventually get the feel of the stroke.

The graphic below illustrates key aspects of the stroke.



Muscles Joint Consistency

The Number of Muscle Groups Involved

In this stroke, only two muscles groups are involved, specifically those that are attached to the upper arm and shoulder and that contract to pull the lead upper arm to centre of the body on the back stroke and away from the centre of the body on the down-stroke and follow-through.

The Degree of Coordination between the Muscle Groups Involved

Only the muscles in the lead shoulder are involved, so the degree of coordination is high.

The Range of Movement Related to the Joints Involved

The shoulder joint is a ball and socket joint, which allows a wide range of movement. In this stroke, the joints will not provide automatic control to the stroke through limited range of movement.

“Yip” Prevention

The Size of the Muscle Groups Involved

The shoulder muscles are of medium size.

Momentum and the Mass Being Moved

With this stroke, the shoulder muscles will be moving both the putter and the arms. There is more mass being moved than with the wrist stroke.

Stillness of the eye sockets

Eye sockets are still, since only the arms are moving. The head, spine and lower body remain motionless.

On-Line Direction

The Rotation Plane in Relation to the Vertical

The rotation plane is vertical when the player leans forward, lets the lead arm hang straight vertically down, executes the stroke from this initial position, and lets the shoulder muscles move the arm across the body on

the back stroke and away from the body centre on the forward stroke. With a vertical plane, the putt will be on line with proper alignment and a stroke that goes directly away from and toward the target.

The Rotation Circle Radius

The rotation radius is the distance from lead shoulder socket to the ball. This distance will be directly related to the length of the putter, the length of the lead arm, the extent to which the lead hand is down the putter grip, and the angle between the putter and the arm. The rotation radius will be considerably larger than with the wrist stroke. In practical terms, the larger circle radius in combination with the vertical rotation plane will mean the putter will stay closer to the ground on the back stroke and forward stroke.

Steadiness of the Rotation Centre

The rotation centre will remain absolutely steady in the properly executed stroke.

Eye Alignment

The comments here are the same as for the wrist stroke. The key aspect of the stroke is achieving the vertical rotation plane by leaning forward, letting the lead arm hang through gravity to the vertical position, and executing the movement from this vertical position. Whether the eye position is directly over the ball will depend on a number of factors, but particularly the amount of forward lean and the angle between the arm and the club.

Power

The length of the putting stroke will be directly related to the amount of rotation of the upper arm in the shoulder socket. A 45 degree rotation is reasonable and similar to the rotation in the wrist stroke. However, the rotation circle radius will be larger, and this will allow a longer stroke.

Back Health

The amount of forward leaning is not excessive, so the stroke should not cause problems in terms of back health.

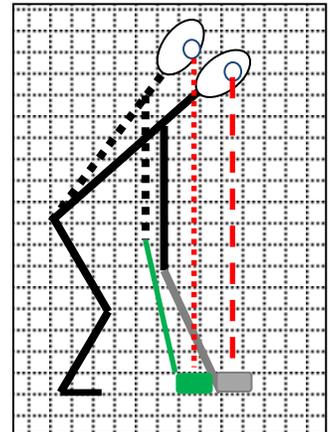
Overall

Here are some ideas about performing the stroke:

1. Think about the position of the lead hand on the grip. Putting the lead hand below the trailing hand on the putting grip will give greater sense of control of the putter; however, placing the lead hand at the top of the putting grip with the trailing hand below will cause the bend in the trailing elbow in the back stroke to start sooner.
2. Practice using only the lead arm, since the lead arm dominates the stroke. Pay particular attention to not using the wrists to hit the ball.
3. Position the ball toward the front of the stance, under the lead shoulder. The centre of rotation is the lead shoulder, so the low point in the rotation circle circumference will occur under the lead shoulder.
4. Find a degree of forward lean that is comfortable, that positions the lead eye over the target line for better eye alignment and that does not stress the back. Some degree of forward lean is essential to

allow the lead arm to hang vertically down. With the low point in the swing under the lead shoulder, the lead eye socket will normally be several inches behind the lead shoulder socket when one's body is lined up parallel to the target line. Consequently, the lead eye socket cannot be over the ball, but should be behind the ball over the target line.

5. Let the lead arm hang vertically from the shoulder socket. Gravity will define the vertical plane.
6. Execute the movement from this position, with muscles in the shoulder contracting to pull the lead arm to the centre of the body on the back stroke, and away from the body centre on the forward stroke.
7. Use your eyes to tell you whether you are keeping the club face square to the target line during the stroke.
8. Allow the trailing arm to bend in a long back stroke.
9. Get your putter fitted in terms of length, grip, and angle between the club face and the shaft to accommodate your stroke. Not that a larger forward lean (versus a relatively upright stance) will mean a shorter putter and a greater angle between the shaft and the club face, which should sit on the ground. Note that as you lean forward, your eye sockets move further in the horizontal plane from your shoulder sockets. Since your arms hang vertically down from your shoulder sockets, and your hands are at the end of your arms, this greater horizontal distance will have to be managed by the angle between your putter face and the shaft.



The lead upper arm stroke has several strengths. From a muscular point of view, the stroke is incredibly simple, and therefore offers the potential for consistent results. It delivers a vertical plane and the potential for on-line putting. It presents no significant problems in terms of back health or eye alignment over the target line. There is ample rotation potential in the stroke; however, the lead upper arm stroke does not generate a lot of acceleration. The stroke will rely on rhythm and momentum. This may be positive, since rhythm and momentum reduce the potential for the “yips”.

Chapter Five: The Shoulder Socket Stroke

In each shoulder, the scapula and clavicle make up a bone structure which holds the shoulder socket. This bone structure sits up there, held in place by muscles attached to the body's core. The bone structure can move around. Each shoulder socket can move upward (as in a shrug), downward, forward and backward, and points in between.

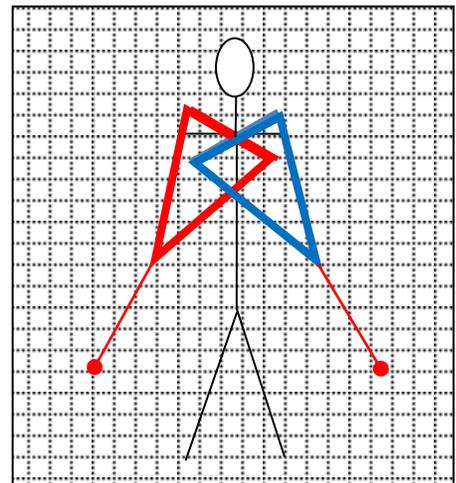
One can raise and lower the scapula and clavicle. This occurs through the contraction of muscles attached to the scapula/clavicle and the neck and skull. The contraction of these muscles can pull the scapula/clavicle up. Muscles attached to the scapula/clavicle and the ribs can contract to pull the scapula/clavicle down.

One can also move the scapula/clavicle forward and backward. The forward movement in comes by contracting the serratus anterior and the pectoralis minor, which connect the scapula to the ribs. The backward movement in the downswing comes by contracting the trapezius, which attaches the scapula and the various vertebrae in the upper part of the spine, and the rhomboids, which attach the scapula to vertebrae in the middle of the spine.

The coordinated movement of the shoulder sockets by themselves can create a putting stroke. For example, if one shoulder socket moves forward and the other backward, the resulting movement by itself would create a partial rotation around the spinal column. If the player stood erect, this rotation would be horizontal to the ground.

If one socket moved up and the other down, the resulting movement by itself would create a partial rotation centred approximately around the mid-point between the shoulder sockets. If the player stood erect, this rotation would be relatively vertical to the ground.

A reasonable application of the shoulder socket putting stroke would see the player leaning forward, and then applying a combination of moving the lead shoulder socket to the front and down and the trailing socket back and up on the back stroke, and reversing the motion on the forward stroke, with the lead shoulder socket moving to the back and up on and the trailing shoulder socket moving to the front and down. The amount of movement of each socket would be the amount necessary to achieve a rotation vertical to the ground. All other parts of the body would not move.



Muscle Joint Consistency

The Number of Muscle Groups Involved

In each shoulder, there are four muscle groups - the socket-up group, the socket-down group, the socket-back groups, and the socket-forward group. These muscle groups operate in both shoulders, giving the involvement of eight muscle groups.

The Degree of Coordination between the Muscle Group Involved

One could argue that the four muscle groups in each shoulder function on a coordinated basis, because the bone structure is a common element for all groups. However, the left and right shoulder sockets have the potential to move independently of each other.

The Range of Movement Related to the Joints Involved

There are no inherent restrictions on the movement of the shoulder sockets. Each socket can go forward and backward, up and down, and points in between.

“Yip” Prevention

The Size of the Muscle Groups Involved

The muscles groups are medium sized.

Momentum and the Mass Being Moved

In this stroke, the muscles are moving the shoulder sockets, arms and the putter.

Stillness of the eye sockets

Since the only the shoulder sockets are moving, the eye sockets remain still. This is critical in this stroke, because the eyes are the mechanism coordinating the stroke and making sure that the stroke is on track.

On-line Direction

The Rotation Plane in Relation to the Vertical

A vertical rotation plane is not inherent in the stroke, but can be manufactured by moving the shoulder sockets in a particular way for a particular degree of forward lean. An appropriate alignment toward the target in combination with the vertical plane can get the ball on target.

The Rotation Circle Radius

The centre of the rotation will be a point mid-way between the shoulder sockets. This radius will be greater than the radius on a wrist stroke, but similar to the radius for the upper lead arm stroke.

Steadiness of the Rotation Centre

The rotation centre will generally be steady, since the legs, spine and head are not moving. However, if the movements of the two shoulder sockets are not symmetrical in the back and forward strokes, there will be some movement of the rotation centre.

Eye Alignment

The stroke does not prevent the player from getting an eye alignment over the target line.

Power

While the shoulder sockets can move, the movement is relatively small. The amount of movement of the socket from a neutral start position is only a few inches forward and backward. The movement up is a few inches, but the movement down is less. The movement of the shoulder sockets is amplified by the arms, so a few inches of rotation of the shoulder sockets creates more rotation at the ball. Nevertheless, the power in the stroke is limited.

Back Health

The stroke should not cause issues with back health. It can accommodate a variety of degrees of forward lean, through adjustments in the way the shoulder sockets are moved.

Overall

Making the stroke work entails the following steps:

1. Position the ball near the middle of the stance, as the low point in a symmetrical stroke occurs below the rotation centre, which is the mid-point between the shoulder sockets.
2. Select a degree of forward lean that is comfortable and puts the eyes in a consistent position over the ball (e.g. left eye over the ball, right eye over the ball, mid-point between the eyes over the ball).
3. Practice putting by using the shoulder socket movements only. One's eyes will tell whether the movement is correct, since the movement should create a vertical rotation, which would see the putter head staying on the target line and the club facing remaining perpendicular to the target line.
4. Get a putter that fits the stroke i.e. correct length, and correct angle between the shaft and head.

The shoulder socket stroke can achieve a vertical rotation, with a good eye position over the target line and a comfortable degree of forward lean. However, the stroke is complicated, relying on the coordination of four groups in two shoulders. The coordination comes primarily through the eyes. The complexity of the stroke approximates the complexity in hybrid strokes. The stroke is sufficiently complex that it would be difficult to try to putt by thinking about the contraction of relevant muscles at the right time.

Chapter Six: The Spinal Twist Stroke

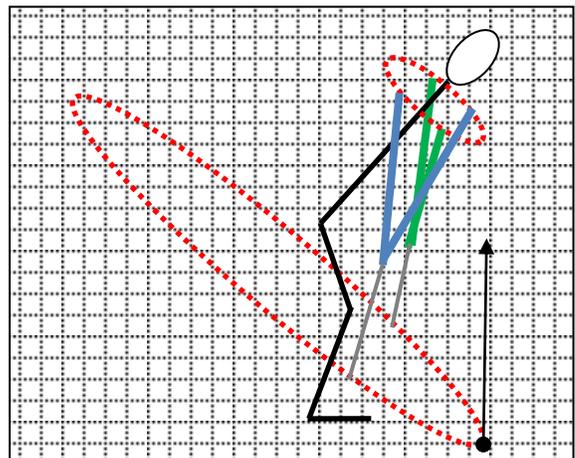
The spine includes vertebrae, many of which are separated by disks, which are like cushions. These cushions allow each vertebra to move slightly relative to the vertebrae above and below it. Cumulatively, these small movements between individual vertebrae allow the spine to bend forward, bend backward, tilt to the left, tilt to the right, and twist clockwise and counter-clockwise.

Muscles contractions cause the movements of in the spine. Muscles at the front of the body in the abdomen and chest contract to bend the top of the spine forward, causing the forward bend. Muscles at the back contract to cause the top of the spine to bend backward. Muscles at the side of the body contract to pull the top of the spine to the left or right. These movements are relatively straight forward. The spinal twist is less so.

To get an intuitive feel of the spinal twist, sit on a bench or chair in front of a mirror, rest a club across your upper back below your shoulders (to ensure you are not moving your shoulder sockets), hold it in place with your two hands, and gently try to rotate your shoulders. Keep the club parallel to the ground to ensure that you are rotating your shoulders. Sitting in a chair ensures that your hips are stationary so that any rotation occurs in the spine between the hips and the shoulders. The rotation of the club that you see in the mirror demonstrates the spinal twist. The pictures below illustrate the spinal twist.

Technically, here is what is happening. Primary muscles that twist and untwist the lower spine are the internal and external obliques, and the quadratus lumborum.

- The external obliques are attached to the upper ribs at the one end and various bones in the lower abdomen, including the pubis (crest) and the ilium (anterior crest). To rotate the lower spine clockwise, one contracts the external obliques on the left side. This shortens the distance between the left ribs and the lower abdomen, contributing to clockwise rotation.
- The internal obliques are attached to the lower ribs and linea alba at one end and the lumbar fascia and ilium (iliac crest) at the other. To rotate the lower spine clockwise, one contracts the right lateral oblique. This pulls the right rib toward the right hip, further contributing to the clockwise rotation.
- The quadratus lumborum attaches the iliac crest to the upper lumbar vertebrae and the last rib. To rotate the lower spine clockwise, one contracts the right quadratus lumborum to shorten the distance between the right rib at the back and the right hip. This contributes further to the clockwise rotation.



The spinal twist creates another basic putting stroke. The player grips the putter, leans forward, and twists the spine using the aforementioned muscles. No other muscles contract. This action will cause rotation of the upper body, including the shoulder sockets, around the spine. As the shoulder sockets move, the arms and putter will also rotate around a circle with the same axis in a parallel plane. The arms and club are like appendages fixed to the circle radius that move when the shoulder sockets move. The radius of the rotation circle of the putter head will not necessarily have the same radius as the rotation circle of the shoulder sockets, because of the way the upper arms relate to the rotation circle of the shoulder socket and the angle between the arms and the shaft of the putting club.

While vertebrae in the spine will twist slightly, the spinal column stays in the same place.

The rotation will be at right angles to the spine. If the spine is leaning forward so that it is horizontal to the ground, the rotation circle will be vertical to the ground. More likely, the spine will be leaning forward a bit, and the rotation circle will not be vertical to the ground.

Muscle Joint Consistency

The Number of Muscle Groups Involved

While there are primarily three muscles involved, these are muscles that are accustomed to working together. For practical purposes, they make up one group.

The Degree of Coordination between the Muscle Groups Involved

As there is only one group involved of muscles involved, there is a high degree of coordination.

The Range of Movement Related to the Joints Involved

When the spine is twisting through the action of the aforementioned muscles, there is relatively little range of movement in the joints. Contract the muscles in the appropriate way and one will get a rotation that is perpendicular to the spine. The spinal twist yields a consistent putting stroke.

“Yip” Prevention

The Size of the Muscle Groups Involved

The muscles groups involved are relatively large.

Momentum and the Mass Being Moved

The movement involves the movement of the upper body, the shoulder sockets, the arms, and the putting club. Relative to other putting strokes, the spinal twist requires the movement of the largest mass, and therefore has the most momentum.

Stillness of the eye sockets

The eye sockets will not move in the properly executed stroke, because the spinal column does not change its position. The head sits at the top of the spinal column, and it does not move. Consequently, the eye sockets will also be still.

On-Line Direction

The Rotation Plane in Relation to the Vertical

The rotation plane depends on the amount of forward lean. If the spinal column is horizontal to the group, the rotation plane will be vertical. If the forward lean puts the spinal column at 45 degrees to the ground, the rotation plane will be 45 degrees off the vertical.

There are advantages to a vertical rotation plane. Consequently, the player is likely to perform better with a larger forward lean.

Because the rotation plane is not vertical to the ground, ball position at impact is critical to hitting putts on the intended line. Only one ball position hits the ball exactly on line.

The Rotation Circle Radius

The rotation centre will be the mid-point between the two shoulder sockets. The rotation circle radius will be the distance from the rotation centre to the ball. This will depend on factors such as the amount of knee bend and forward lean, the length of various body parts, and the length of the putting club. Relative to other putting strokes, the rotation circle radius with the spinal twist will be in line with other strokes, but longer than with the wrist stroke, all other factors being equal. However, this stroke benefits from a large forward lean, which has the effect of reducing the rotation circle radius. A larger rotation circle radius can mitigate the potential to hit off line putts when the rotation plane deviates from the vertical.

Steadiness of the Rotation Centre

The rotation centre in this stroke is very steady throughout the stroke, since the spinal column does not change position while it is twisting.

Eye Alignment

An eye position over the ball can be achieved through a combination of adjusting the angle at which the arms fall from a forward leaning upper body, the angle between the arms and the putting club. In particular, there is no requirement for the arms to hang straight down (i.e. perpendicular to the ground) from the shoulder sockets.

Power

The spinal twist can generate a lot of power. A normal person who has warmed up should be able to twist the spine 60 degrees in both directions. This translates into a powerful putting stroke.

Back Health

The forward lean is important to good performance; the more the better. Unfortunately, greater amounts of forward lean are a problem for back health.

Overall

To get the best results from this stroke, try the following:

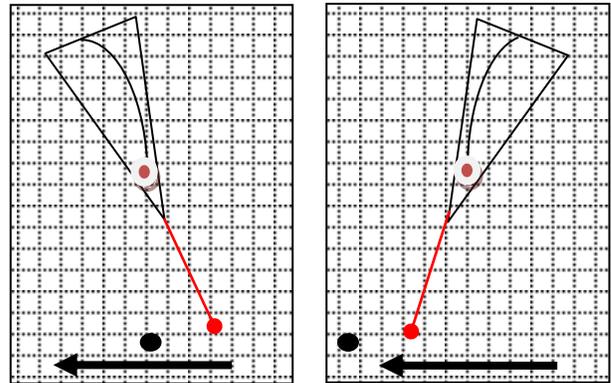
1. Position your feet so that the ball is approximately in the middle. The low point in the stroke occurs at directly below the rotation centre, which is the mid-point between the two shoulder sockets. The mid-point is also the point where the club face is perpendicular to the target line. At other points, it is open or closed.
2. Lean forward as much as you can, as leaning forward puts one's stroke closer to the vertical.
3. Try to develop a consistent body position relative to the ball, by getting the bridge of nose directly over the ball at set up. A consistent head position directly over the ball will help ensure the putter contacts the ball at the precise time when the face is perpendicular to the target line.
4. Think about using the rotation muscles in the abdomen, to get a consistent stroke. Do not move any other muscles.
5. Get the putter fitted to meet your requirements for considerable forward lean (i.e. shorter club) and bridge of the nose over ball (i.e. appropriate angle between club shaft and club head).

This is a reliable, consistent, simple stroke, with limit opportunities for error in the stroke. However, the stroke has a non vertical rotation plane. To get puts on line, the impact point needs to occur at the precise point in the rotation when the club face is perpendicular to the target line.

Chapter Seven: The Spinal Tilt Stroke

In Chapter Six, we noted that muscles at the side of the body can contract to pull the top of the spine to the left or right. The "spinal tilt" is the bending of the spine sideways left and right. It is also known as the lateral flexion of the spine.

This movement is the basis for our final basic putting stroke. In the stroke, the only muscles involved at the muscles at the side of the body which on contraction pull the upper body to the left or right. The contractions cause the shoulder sockets, and ultimately the arms, wrists and putter, to move first in one direction and then the other, producing a putting stroke.



Muscle Joint Consistency

The Number of Muscle Groups Involved

Two muscle groups are involved – a group on each side of the body.

The Degree of Coordination between the Muscle Groups Involved

The groups are not coordinated. One group can contract independently of the other. As a consequence, there is the potential for inconsistency in the stroke.

The Range of Movement Related to the Joints Involved

While there is some range of side bending movement, the range is more limited than with wrists, the ball and socket shoulder joint, and the bone structure holding the shoulder socket.

“Yip” Prevention

The Size of the Muscle Groups Involved

Relatively large muscles on the side of the torso are involved.

Momentum and the Mass Being Moved

The muscles move the upper body, shoulder sockets, arms, wrists and putting club. The mass being moved is relatively large. As such, there is a significant momentum component to the stroke.

Stillness of the Eye Sockets

There is considerable movement to the eye sockets, as the top of the spine moves, causing the head and eye sockets to move. Use of the eyes to control the stroke is relatively difficult.

On-Line Direction

The Rotation Plane in Relation to the Vertical

Theoretically, if the player stands erect with the spine vertical to the ground, the rotation plane of the stroke is vertical. If the player leans forward, the rotation plane leaves the vertical, with the top of the plane moving toward the ball and the bottom toward the body.

The Rotation Circle Radius

The rotation circle radius is somewhere between the shoulder sockets and the ball, and most likely around the abdomen/wrist area. This diagram above illustrates this point. This radius when standing erect is closer to that of the wrist stroke than other strokes. The small radius accentuates problems related to a non-vertical plane of the stroke. The problem is increased because the arms need to be at an angle to the spine. The greater is the angle, the smaller the rotation circle radius. Consequently, the stroke is best performed when the arms are at a relatively small angle to the spine.

Steadiness of the Rotation Centre

The rotation centre is steady only when the left and right contractions cause equal movements of the spine to both the left and right. Without inherent steadiness in the rotation centre, the stroke is prone to inconsistency.

Eye Alignment

The stroke is most vertical when performed standing erect. This means the eye position cannot be over the ball, as the ball will be too far away.

Power

The side bends are limited in extent. In addition, as noted above, the rotation radius is relatively small. Both factors will limit the power of the putting stroke.

Back Health

There is no necessity to lean forward. In fact, the stroke is performed best without the forward lean. However, excessive side bending on, for example, long putts, could be problematic.

Overall

To get the most out of the spinal tilt stroke:

1. Position feet so that the ball is approximately mid-way between them, since the low point in the swing arc is below the rotation centre, which is approximately in the middle of the body.
2. Stand as erect as possible while still be able to stroke the ball. The erect stance puts the club face rotation in the vertical plane to maximum extent possible.
3. Do not expect to make excessive use of the eye sockets to guide the stroke. The eye sockets will be moving. It may be possible, however, to counter this movement through the use of the eye muscles.
4. Limit the angle between the arms and the club shaft by holding the wrists away from the body at set up. This will maximize the radius of the rotation circle.
5. Think about moving the muscles at the sides of the body when executing the stroke, and do not move any other muscles. These are large muscles which lend themselves to mind control.
6. Limit the use of this stroke to shorter putts. When more power is needed, use other strokes.

This is a simple stroke with potential for a relatively vertical swing plane and good line. However, it is intrinsically inconsistent, as it does not provide a steady eye position, nor does it allow the “eye over target” set up opportunity. In addition, it is not powerful.

Chapter Eight: Summing Up

There is no clear “best way” to stroke a putt. Some strokes are better than others in some ways, but no stroke is clearly better than any other in all ways. In the end, it is up to you to try them all and see what works.

However, to give you some idea about the sequence in which to try different strokes, a ranking system is offered here. It also provides a way to summarize the results of the foregoing.

The five putting styles are ranked in terms of the 12 categories outlined above. Each category is allocated 15 points, with the top stroke style for the category awarded 5 points, the second 4 points, etc. Where ties occur among putting styles, points are shared. All categories are given equal value. One could easily disagree with this assumption, and believe some categories are more important than others. The methodology also assumes each category is independent of all the others. Again, one can see that some categories seem related to other categories. The ranking system is applied on assumption that strokes are performed properly.

	The Wrist Stroke	The Lead Upper Arm Stroke	The Shoulder Socket Stroke	The Spinal Twist Stroke	The Spinal Twist Stroke
1. The number of muscle groups involved	2.5	5.0	2.5	2.5	2.5
2. The degree of coordination between the muscle groups involved	3.0	5.0	1.0	3.0	3.0
3. The range of movement related to the joints involved	2.0	2.0	2.0	5.0	4.0
4. The size of the muscle groups involved	1.0	2.0	3.0	4.5	4.5
5. Momentum and the mass being moved	1.0	2.5	2.5	4.5	4.5
6. The stillness of the eye sockets	3.5	3.5	3.5	3.5	1.0
7. The rotation plan in relation to the vertical and the target	3.5	3.5	3.5	1.0	3.5
8. The rotation circle radius	1.0	4.0	4.0	4.0	2.0
9. The steadiness of the rotation centre	3.5	3.5	3.5	3.5	1.0
10. The length and power of the putting stroke	2.0	4.0	2.0	5.0	2.0
11. Eye position	3.5	3.5	3.5	3.5	1.0
12. Forward leaning, posture and back health	4.0	4.0	4.0	1.0	2.0
	30.5	42.5	35.0	41.0	31

The Upper Lead Arm stroke gets highest cumulative points, followed by the Spinal Twist. These two putting styles are substantially ahead of the other three styles.

To conclude, we return to the question posed at the outset. What muscles should we be using when we putt?

Is it helpful to think about muscles when we are putting?