BIOMECHANICS OF KICKING

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Biomechanics is the study of the mechanical basis of movement.

1. What is the fundamental movement pattern of kicking?

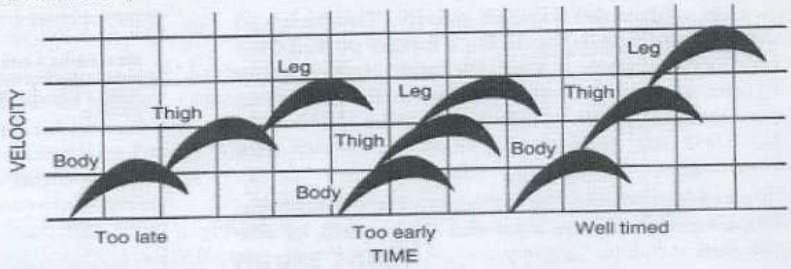
- The overall performance objective of kicking is to project the football over distance accurately; therefore ball speed is of great importance.

- Ball speed is dependent on the speed of the foot.

- Like many patterns of motion relying on high 'end point' (foot) speed, kicking is classified as a 'throwlike' motion. 'Throwlike' motions are characterized by a proximal (e.g. thigh) to distal (e.g. foot) sequence of movement between the body segments or links involved in the skill. The thigh is accelerated while the foot 'lags back' until the thigh achieves full speed, at which time the foot moves forward.

- The cracking of a whip is a good example of this transfer of momentum out along the chain of links. The rotation of the handle of the whip is relatively slow but as the energy is transferred outwards to smaller and smaller links the speed increases until the tip of the whip breaks the sound barrier. Kicking is similar to this; the transfer is from the trunk to the pelvis, thigh and then leg.

- The simple model of kicking shown below demonstrates how the correct sequencing of the body (trunk), thigh and leg segments results in the greatest speed of the final segment (leg). The early or late action of a segment will reduce the ultimate speed reached.



In a well-timed kick the leg begins to extend at the knee joint just as the thigh reaches maximum speed. If this leg action commences either before or after this point then the final speed is reduced.

2. What can go wrong with this pattern?

- The optimal technique will result from the correct sequencing of all available segments. If a segment is missing from the action, speed will be reduced. An example of this would be for the kicker to maintain a straight leg in the back swing, thereby removing the leg-straightening component prior to contact with the ball.

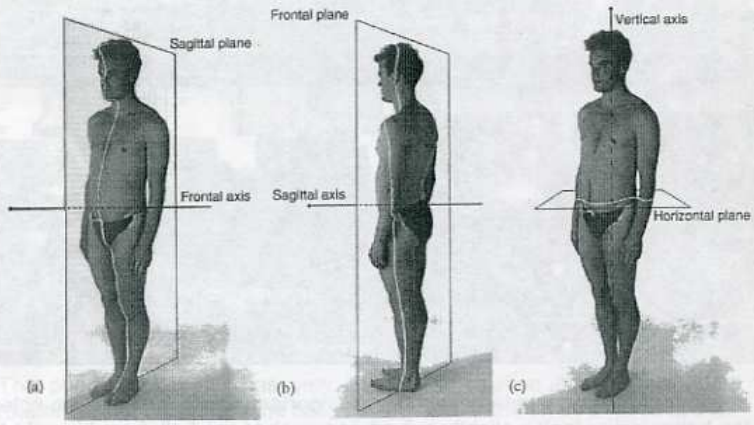
- Joint flexibility plays an important role in kicking. The range of motion available to each segment is crucial to optimizing foot speed. A segment accelerated over a greater distance will reach a higher speed than one accelerated over a short distance. For example, a player with tight quadriceps may achieve reduced knee flexion (bend) in the back swing. As they are then accelerating the leg over less distance, lower foot speed will result.

- Errors made early in the kicking technique will have a flow on effect as the kick progresses. A player may not move a segment through its entire range because another segment was incorrectly used. For example shoulders rotated too far away from the line of the kick will reduce the range of rotation available to the pelvis.

- As the distance to be kicked reduces, the sequencing of the segments should remain the same. However, the range of motion that each segment is moved through should reduce. The segments are therefore accelerated less than in a maximal kick, resulting in lower foot speed.

3. What are the segments involved and how do they move?

- Correct kicking technique is a 'whole body' movement, it is not just a back swing and forward swing of the thigh and leg. Body segments rotate in different ways to maximize foot speed. For example the kicking thigh and leg move mainly backward and forward in the Sagittal plane. The non-kicking arm initially moves up to the side in the frontal plane. The pelvis rotates around in the horizontal plane.



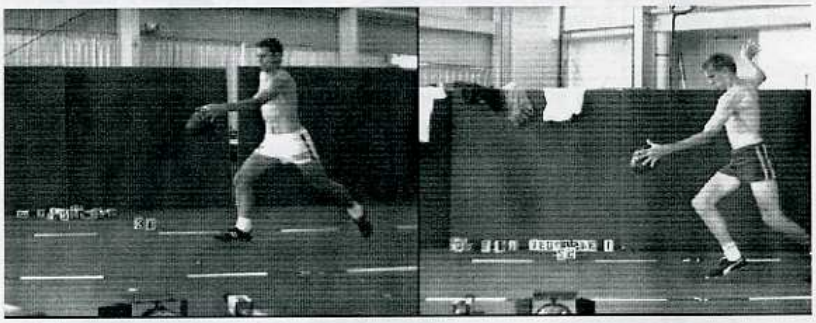
4. Kicking comparisons

Below is a sequence of video frames comparing a better kicker (left) with a poorer kicker (right.)
Both players are kicking for maximum distance, the better kicker, kicked 50.70 metres, the poorer kicker kicked 35.10 metres.

An examination of the difference between these two techniques highlights the complex and coordinated series of motions involved in kicking a football.

(Note: kicks are on the player's dominant side, the poorer kicker is a right foot kick and the video has been flipped to make comparison easier.)

Frame 1 – Ball Release



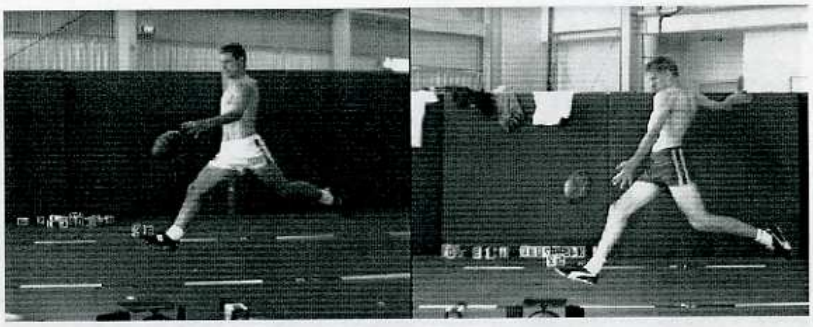
The above frame demonstrates a number of important points. It should be noted that the better kicker took a slightly curved approach to the ball, from his right to left.

- Orientation of the hips and shoulders.

The better kicker has rotated his left hip away from the ball while his shoulders remain square to the target. The poorer kicker has done the opposite, his hips are square and his right shoulder and arm are rotated backwards.

The hips should be rotated away from the shoulders, not the opposite. Later in the kick both will counter rotate their hips and shoulders back into alignment – the poorer kicker's position means this movement will drive his right shoulder forward rather than his left hip forward. That is, the poorer kicker rotates his shoulders back to the hip, which will not contribute as much to leg speed as rotating the pelvis into line with the shoulders will.

Frame 2 – Split Stride



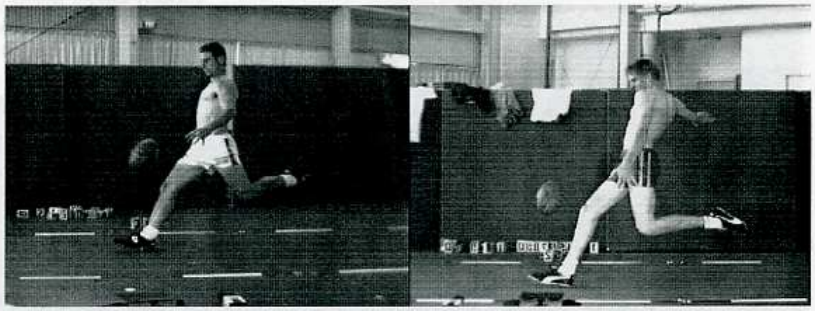
- Leg Split

The better kickers left hip has rotated a long way back from square at this stage; this is combined with a large hip hyperextension, providing an excellent leg 'split'.

This acts to put the leg and trunk muscles that will act in the forward swing on stretch, meaning they will be more efficient in driving the thigh and leg through. The good range of motion achieved through the hip and pelvis also means he can accelerate the distal segments for longer on the way back to the ball

The poorer kicker still has very little pelvic rotation and his shoulders have rotated further away from the ball. His leg split is limited as a result of this.

Frame 3 – Wind Up



- The Better Kicker

The foot has contacted the ground. The better kicker has hyper-extended his lower back to increase the stretch across the oblique abdominal muscles; these muscles act diagonally up and across the trunk and are beginning to pull the hips back to square.

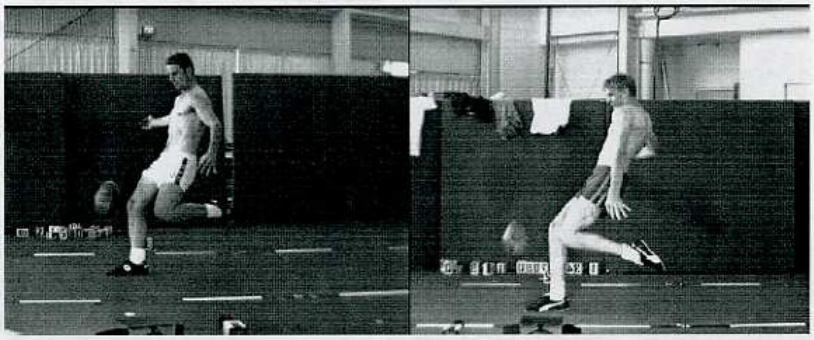
His left leg is above the horizontal as he begins to reduce his knee angle for the drive. He has still maintained a large amount of pelvic rotation and hip extension at this stage. As he is now in contact with the ground he is in a strong position to pull against its resistance and use the ground reaction force to add momentum to the kick

- The Poorer Kicker

Has less pelvic and hip wind up in the split, he has wasted much of what he did have by flexing his hip back to vertical before being in contact with the ground.

Beginning the drive before ground contact is a waste of a segments rotation, as while he is in the air he cannot add any momentum to the kick. Note too that the poorer kickers left leg, does not go past the horizontal.

Frame 4 – Leg Drive



- The better kicker

Has rotated his pelvis almost back to square and he has flexed his hip back in line with his trunk, note how tight his knee angle remains. This serves two related purposes.

Firstly it makes the thigh and leg easier and faster to rotate around the hip by moving the mass of the leg closer to the axis of rotation.

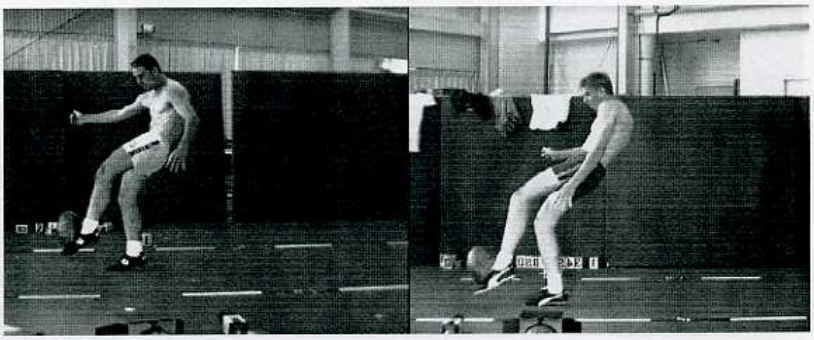
Secondly it means that the leg has a greater distance to accelerate to the ball as it nears impact. A faster thigh and leg obviously result in a faster foot.

- The Poorer Kicker

In comparison to the better kicker, the poorer kicker has undergone a relatively small amount of hip flexion in this phase. He will therefore have generated less thigh speed to transfer to the leg than the better kicker.

His open knee angle means he will not gain the foot speed benefits the better kicker does by having a tighter knee angle. Also note the relative positions of the kickers heads; the poorer kickers head is positioned further back than the better kickers head. This may be an indication that the poorer kicker has not used his support leg effectively to drive the kicking leg.

Frame 5a – Impact



There appears to be little difference in the position of the kicking legs at impact.

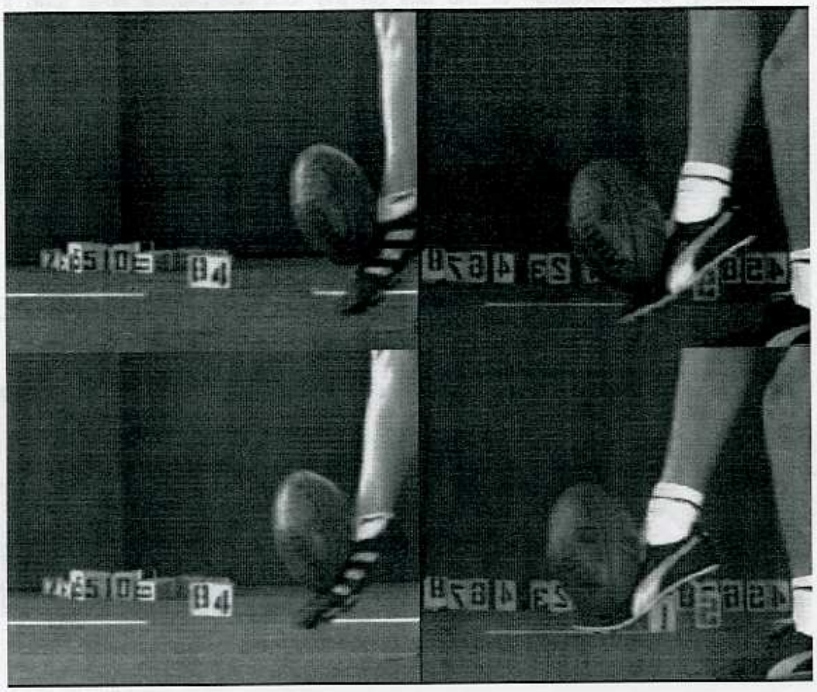
- The Better Kicker

The more effective use of the 'proximal to distal' sequence by the better kicker ensures the feet are moving at greatly different speeds by now. It is also important to note the better kicker's head is now aligned over his support foot while the poorer kickers head is well outside his base of support. The more balanced position adopted by the better kicker puts him in a strong position to apply solid contact to the ball.

- The Poorer Kicker

Poorer kickers lack of balance will compromise his ball impact. One of the bodies fundamental control mechanism is balance. When balance is threatened the brain does not care that you are trying to kick a football. It will override kicking motor control commands with movements to stay upright. This will reduce leg speed and the quality of impact.

5b - Impact Quality



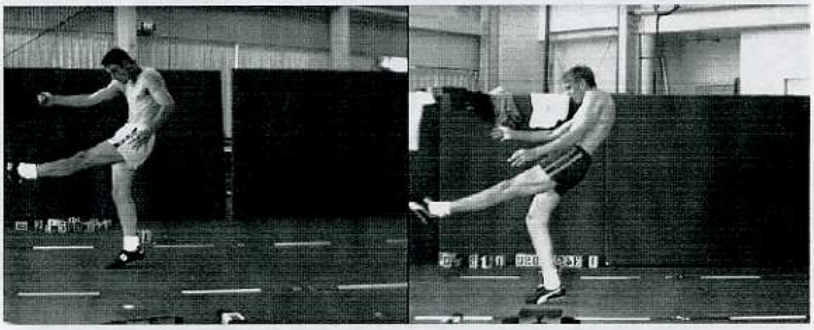
All the good work up until this stage can be undone if the quality of impact is poor. A number of factors influence the impact between two bodies.

- Firstly, foot speed is obviously vital, the faster the foot, the faster the ball.
- Secondly, the mass or weight of the bodies is important. A 2kg foot impacting with a ball will make the ball travel faster than a 1.5kg foot (provided both feet are traveling at the same speed). It is thought that stiffening the joints of the leg and foot at impact can increase the effective mass, or weight of the foot. This could result in some of the mass of the leg being utilized in the impact.
- Thirdly, the nature of the two surfaces in the impact effects ball speed. If the foot is soft and gives way under the impact of the ball, some of the energy of the collision will be lost and ball speed will be reduced. It is vital to keep the instep taught and contact the ball on the laces, not the toe. In the frames above the poorer kicker contacts the ball too close to the toe. The bottom frame clearly shows the deformation of the foot.

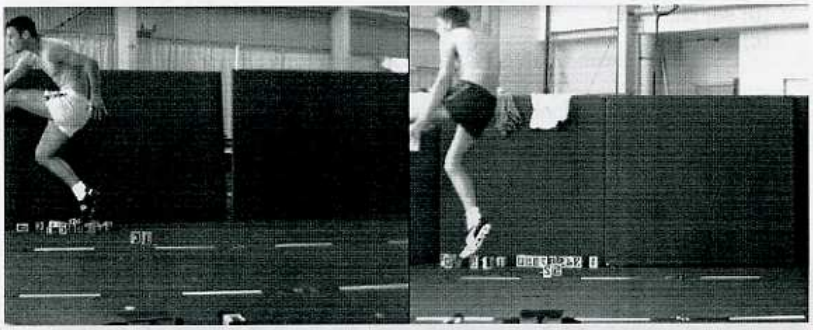
- Finally, the orientation of the ball on the foot will play a large part in determining the flight of the ball.

  If the ball is struck cleanly through its centre of gravity no spin will be applied and the ball will float unpredictably off the boot. Conversely if the ball is struck right on the end, too much spin will be applied to the ball and its velocity will be reduced. For a drop punt the ball should be struck below its centre with the ball close to the vertical.

Frame 6 – Post Impact



Frame 7 – Follow Through



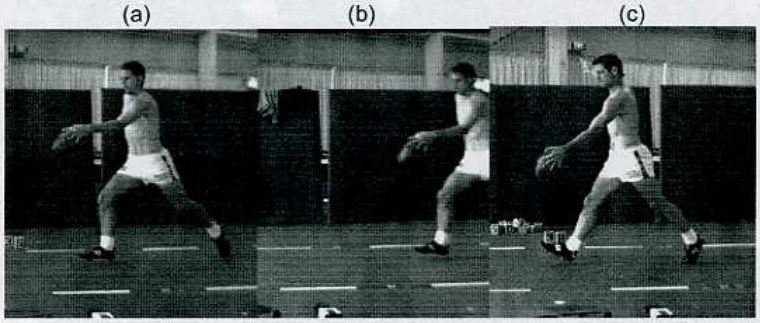
The follow through is an important injury prevention mechanism. It allows the momentum built up in the kick to be dispersed gradually. A sudden stop at impact would put the bones, muscles, ligaments and tendons of the body under enormous strain.

The follow through is also a good indicator of the quality of the kick that preceded it. The better kickers follow through is balanced, straight and puts him in a good position to run on with play or respond quickly. The poorer kicker finishes off balance and the follow through is quite twisted, a position that is representative of his kicking technique.

Frames 8 – Ball Release Position for:

(a) kick for maximum distance,
(b) set shot, and
(c) short pass.

(a) (b) (c)



Frames 9 – Ball Release Position for:

(a) kick for maximum distance,
(b) set shot, and
(c) short pass.

(a) (b) (c)