

A Simple Model of the Pelvis-Thorax Kinematic Sequence

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March 2009

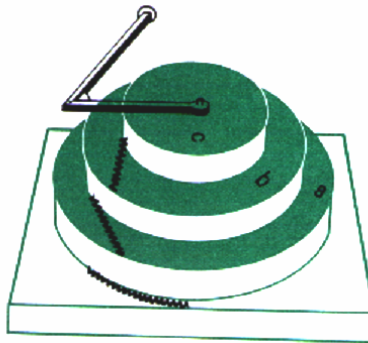
Summary

A simple disk-spring model of the pelvis and thorax does a good job at explaining the reason for acceleration and deceleration in the kinematic sequence curves during the downswing in golf.

The Model

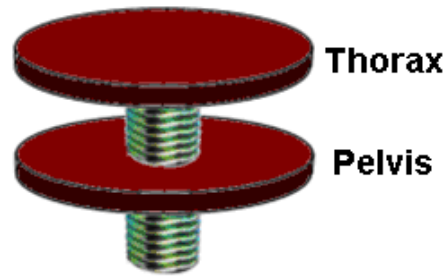
Cochran and Stobbs (1968) in their famous book “Search for The Perfect Swing” described the golf swing action using a disk spring model. Each disk represents a part of the body; disk a, the pelvis, disk b the thorax (upper body) and disk c the arms and club; the springs represent the muscles across the joints between the body segments. They stated in their article:

“The question is now; in what order should the springs be released to impart the greatest possible rotation speed to the topmost cylinder? The answer is that they should operate in sequence from the bottom upwards with each successive spring releasing when all or most of the energy of the previous spring has been imparted to the system.”



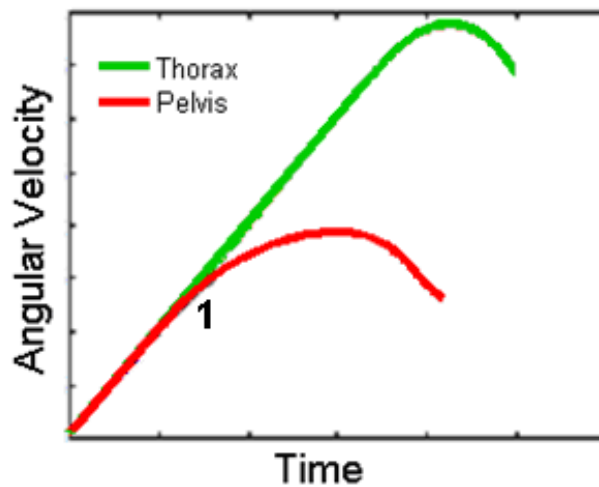
Disk-Spring Model

Let's simplify their model and look at it in terms of the kinematic sequence. We will use only the bottom two disks, one to represent the pelvis and the other the thorax. We will use a torsional spring as shown in the diagram. The principle is still exactly the same.



Pelvis-Thorax Model

We will wind the bottom disk to say 45 degrees of turn and the top disk to say 90 degrees of turn. We will also have control of when both springs release. Once we are at full backswing turn, we release the bottom spring but keep the top spring locked. So initially, at the beginning of the downswing, both segments rotate and accelerate together in the downswing direction. They both accelerate together by the action of the torsional spring connected to the ground.



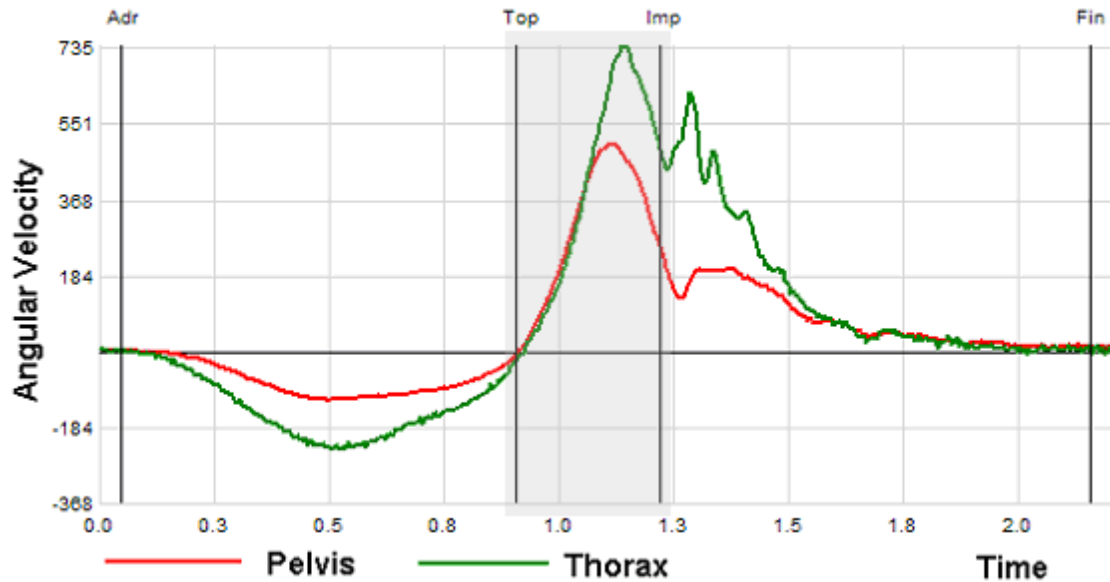
Pelvis-Thorax Angular Velocity v Time Graph

They produce the same line on the graph sloping up depending on how fast they accelerate. At time 1, the second spring, the one between pelvis and thorax is released. Its action “sling-shots” the thorax, pushing it faster in the downswing, but at the same time due to the action/reaction principle, it pulls on the pelvis in the opposite direction and slows it down. The pelvis curve “peels” away from the thorax curve; “maxes out” then decelerates. Meanwhile the thorax continues to accelerate due to the torque acting on it from the spring between the pelvis and the thorax. Soon the same will happen to the thorax curve by the action of the arms and later the arm curve by the release of the club.

The Real Curve of a Golfer

Now compare the model curve from the spring system to the real curve of a world class golfer; focus on the gray highlighted section from Top to Impact. This graph looks

very similar to the one from our disk model. So the simple disk-spring model just discussed does a good job of conceptually explaining why the kinematic sequence looks like it does!



Kinematic Sequence of Pelvis and Thorax in a World Class Golfer

One final point; it is very important to realize that at no time did the bottom disk “put the brakes on” intentionally, in fact the pelvis spring kept turning as hard as it could the whole time. The reason the pelvis slowed down is because the acceleration of the thorax disk pulled back on the pelvis.

Reference

Cochran, A. and Stobbs, J. (1968). Search for the perfect swing. Triumph Books, Chicago, Illinois.

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