**Grant Waite**

So, from the explanation side bio mechanically it's really impossible to have a fixed hub, that is only possible if there is no translation on the x y and z plane. This is not possible. There is a cop and com shift during backswing and downswing as well as GRF vectors moving and tilting as well as wrist angles, kinetic chain and geometrical alignments of the sweet spot and face path, spin loft etc.
Now, the question becomes, is there an advantage to have golfers think in terms of minimal translation by understanding the relationship between extending, lateral bending and rotation in order to control the sway, thrust and lift of the spine both on backswing and downswing. At some point we have to consider the teaching aspect of this and figure out a relatively simple way of explaining to golfing public how to go about putting all this together.
The concept of the hub was to help golfers visualize the golf swing. The higher up the hub visualized the more extension and left lateral bending of the thorax is needed to control it. This leads to different shoulder plane and amount of hip slide on the downswing in order to put in right lateral bending on downswing. There have been players who have played great doing this. If the hub is thought of lower then there is LESS lateral bending left and extending on the backswing and less slide of hips on downswing in order to put in right lateral bending of the spine on downswing. Some players have played great doing this.
So in the case of MOST women and elderly I see they don't have the hip speed to have more versus less left lateral bending and extension of thorax on backswing.
This post could go on forever but I hope you get my thoughts. What do you guys think?

**Dr Kwon:**

I think the answer depends on what you expect from the hub. If you expect a stationary point which provides a constant rotation arm such as the one depicted by Cochran and Stobbs, the answer is 'NO.'

The mid-shoulder point has often been considered as the hub but the arms are attached to the trunk through the 'shoulder joints,' not through the 'mid-shoulder point' so, anatomically speaking, it is impossible to develop circular motions of the hands about the mid-shoulder point. The body posture at ball contact is quite different from that at address so it is meaningless to insist on a stationary hub. The downswing motion is quite different from the backswing motion so expecting a stationary hub is somewhat unrealistic.

If you allow the hub to move and the distance to the hands to change, however, the answer is 'YES.' I believe we can find a biomechanically meaningful hub, instead of a geometric hub.

As I posted some time ago, the human body can be viewed as a functional double pendulum (<https://www.facebook.com/media/set/?set=oa.490852934302559&type=1>). I also proposed this model in our X-factor paper (<http://www.tandfonline.com/doi/full/10.1080/14763141.2013.771896#.UcdKR00o7b0>). The golfer-club system overall works as an open-chain system with an embedded closed chain: legs-pelvis-upper lever (closed chain)-lower lever (club). The upper trunk, shoulder girdles, and the arms collectively form the closed chain.

I use the mid-trunk point (the center of xyphoid and T12) as the hub in my analysis model for several reasons. 1. The mid-trunk point is located near the functional swing plane. If the end goal is to produce a planar motion of the club, it is conceptually correct to expect the hub near the body part the functional swing plane passes through. 2. The upper trunk shows substantial flexion and lateral flexion motions during the downswing about the mid-trunk point so the upper trunk motion cannot be ignored in the argument of hand motion. 3. The hand trajectory is essentially determined by the upper trunk motions (fl/ext, lat fl, and rotation) as well as the shoulder girdle (elev/depr and protr/retr) and arm (shoulder and elbow joint motions) motions. I see it mechanically problematic to place the hub (center of rotation) in the middle of a closed chain (mid-shoulder area).

The hub (mid-trunk) moves during the course of downswing. I think the important argument here is not about whether the hub moves or not, but how it moves and how the double-pendulum system rotates about the hub to generate consistent impacts. And how the hub motions differ among different swing styles such as free weigh shift, restricted weight shift, S&T, ...?

Dr Kwon

 It could be that what we know as efficient (ideal) may not be so efficient (ideal). A golf swing is different from a baseball pitch or tennis stroke in the sense that the upper trunk and arms form a closed chain. If you throw a golf ball or swing a club with your right arm only, you can come up with the ideal pattern easily but a golf swing does not work that way.

Dr Kwon

Multiple connections between the club and the trunk (through the arms) can actually play as constraints. Imagine learning the two-hand stroke technique in tennis. You cannot master it using the typical one-hand stroke technique.

I'd like to consider the golf swing more in the perspective of orchestration than summation. Kinematic sequence (proximal to distal) more emphasizes the summation aspect. It may be problematic to view tour pros' swing in the perspective of sequence alone.

Dr Kwon

Kinematics deals with manifested motion while kinetics deals with its cause (force and moment). These are perhaps two faces of a coin. In forward dynamics, you predict the motion based on the forces and moments applied, whereas in inverse dynamics you figure out forces and torques based on the motion. Inverse dynamics is often used to compute the joint forces and moments and eventually the powers (linear and angular) and the energy flow/generation/absorption.

A golfer-club system presents a unique problem due to the closed chain formed by the upper trunk, shoulder girdles, and the arms in the middle of the overall open chain. (Although the legs also form a closed chain with the ground, the ground reaction forces can be measured for individual feet so analytically speaking it is not a closed chain.)

Because of this closed chain, it is impossible to compute the joint forces and moments for the shoulder, elbow, and the wrist joints unless one makes assumptions. (The assumptions are subject to validation, of course.) This is why inverse dynamics studies are not popular in golf swing biomechanics.

[Scott](https://www.facebook.com/scottzenolink), It sounds like you are actually using the kinetic link perspective, instead of the kinematic link one in your work. So what do you measure and how? The ground reaction forces are just an input to the kinetic link model. How do you quantify the muscle torques? What assumptions do you use?

Scott Beaumont

We have always used the kinetic link modeling. Chris Welch was involved in redesigning clinical software in developing techniques to integrate Motion, force/force plates and emg technologies, which enables us to measure the kinetic link. To find out how he does this your best asking Chris about it he did all the engineering. We can measure the maximum rate of load, the rate of stretch and rate of shortening, between the lower body and upper body and upper and arms relationship. Not only do we use this in golf this is applied to all the other rotational sports we also measure. My field is practical application training athletes how to improve their kinetic link Chris would be best to ask about the engineering side of things.