One Dimensional Performance Does Not Translate to 3D Movements

Performance with traditional sagittal plane movement testing did not translate to frontal and transverse plane movement proficiency when looking at historical Proteus data.

by Will Waterman, PT, DPT, OCS, PRT, COMT, CSCS

Abstract

Data collected on the Proteus Motion system was utilized performed to measure the difference in the performance of power and acceleration of athletes. Performance was categorized into 1 of 4 classifications: Low Strength, Strength Dominant, Speed Dominant, or High Strength and Speed. Results showed that performance in the sagittal plane was much more biased towards strength compared to the frontal and transverse planes (3D movements), with fewer individuals falling into the Strength Deficit category (52%) vs 3D movements (58%) and more individuals falling into the Strength Dominant category in the sagittal plane (26%) vs 3D movements (21%). Furthermore left to right imbalances were more frequently present in 3D movements (31%) vs traditional sagittal plane movements (19%).

When assessing athletic performance with movement patterns in the sagittal plane, performance does not translate to other planes. This highlights the importance of assessing movement patterns in all planes and indicates why testing with traditional equipment in the sagittal plane with uniplanar, single vector resistance will not give an accurate assessment of athlete performance outside of those planes. Since most sports contain a large mix of movement patterns in all planes, assessment in all planes should be performed to optimize performance, training efficiency, athletic preparedness, and safety.

Introduction

Historically, strength and power testing have been limited by resistance technology, requiring movements to be performed in one plane. This is primarily due to the overwhelming majority of implements creating resistance in only one plane in a single vector. Additionally, the majority of assessments are in the sagittal plane due to the ease of performing and proliferation of these testing methods.need to focus on different aspects of training.

You will find the majority of strength and power testing consisting of upper body horizontal pushing movements like the bench press, med ball chest toss, or push-ups. For the lower body, vertical jump and broad jump testing is most common. Upper body pulling movements are not tested as frequently but are often assessed with horizontal movements like rows or vertical movements like pull-ups. It is rare to see coaches test rotational movements, but they will sometimes utilize med ball throws for distance.

Because testing is difficult and time-consuming, many coaches simply stick to simple sagittal plane tests for the sake of efficiency and hope this will translate toproficiency in the other planes. We wanted to compare performance in the sagittal plane to movement patterns in other planes to see if performance was equivalent or if there is indeed a gap between traditional sagittal plane testing and 3D testing.

Methods

To investigate these differences across planes, Proteus analyzed males from 20-30 years old across all of our locations who performed the same standardized test (Cressey Performance Test) from September 1, 2021, to Aug 31, 2022. This is an ideal test for evaluating performance of rotational sports. It was specifically designed for baseball players but is also used with Tennis, Golf, MMA, and other athletes.

The test consists of the following movements: (17 total), 5 reps each, at max effort, performed in the standing position, on the left and right unless otherwise noted:

- **Single Hand Horizontal Push**
- **Single Hand Horizontal Pull**
- **PNF D2 Flexion**
- **PNF D2 Extension**
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**
- **Lateral Bound**
- **Counter Movement Vertical Jump (not performed unilaterally)**
- **Full Body Rotational Shot Put**

We then placed these movements in 2 groups:

Traditional/Sagittal Plane

- **Single Hand Horizontal Push**
- **Single Hand Horizontal Pull**
- **Counter Movement Vertical Jump (not performed unilaterally)**

3D Movements Frontal Plane

- **Lateral Bound**

3D Movements Transverse Plane

- **PNF D2 Flexion**
- **PNF D2 Extension**
- **Static Start Straight Arm Trunk Rotation**
- **Counter Movement/Plyo Straight Arm Trunk Rotation**
- **Full Body Rotational Shot Put**

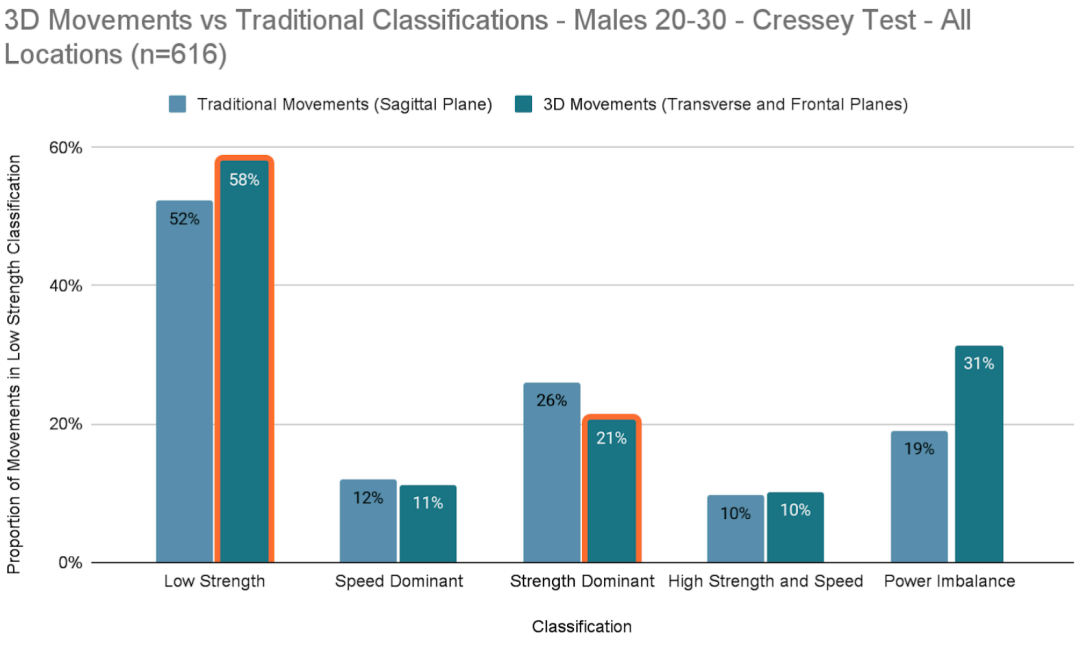
Categorization

We then categorized athletes into 4 specific classifications based on their overall average percentile rankings for each plane in both power and acceleration among all males between 20-30 years old. Below are the criteria for these classifications:

LOW STRENGTH	SPEED DOMINANT	STRENGTH DOMINANT	STRENGTH & SPEED
Individuals that fall below the 50% baseline of power production	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of speed production over strength (>5 percentile points acceleration over power)	Individuals that possess baseline power (>50 percentile) but have a significantly higher amount of power production over speed (>5 percentile points power over acceleration)	Individuals that possess baseline power (>50 percentile) and have a balanced amount of speed and strength production (<5 percentile points difference between power and acceleration)

Results

A total of 616 tests were analyzed for a total of 52,360 reps (616 tests x 17 movements x 5 reps each). For sagittal plane movements, 52% of individuals fell into the Low Strength classification, 26% fell falling into the Strength Dominant classification category, and 19% possessed imbalances from left to right. For 3D movements,58% of individuals fell into the Strength Deficit classification, 21% into the Strength Dominant category, and 31% possessed a power imbalance from left to right. The sagittal plane had 12% fall into Speed Dominant while 3D movement had roughly equivalent at 11%. Both sagittal plane and 3D Movements had 10% of individuals fall into the classification of High Strength and Speed.



Discussion

Traditionally testing one's ability in strength and speed has been limited to sagittal plane movements. These result highlight that the performance profiles of sagittal plane movements do not perfectly mirror those of the frontal and transverse planes in the same group of athletes. Failing to recognize those differences and train those movement patterns individually along the proper points on the force-velocity curve leaves a lot of room for improvement.

In general, the sagittal plane is more proficient in strength, with fewer individuals falling into the Low Strength category (52% vs 58% for 3D movements) and more falling into the Strength Dominant category (26% vs 21% for 3D movements). This is likely due to the fact that sagittal plane movements are prescribed in training programs at a much higher rate as they are very easy to perform and easy to load with typical training equipment.

Frontal and transverse plane movements are harder to load yet are just as, if not more important to sports performance than proficiency in the sagittal plane. Sports are rarely played in a straight line in the sagittal plane and injuries often occur in frontal and transverse plane movements such as when cutting and pivoting. If these "3D movements" were easier to load and train, there would likely be more training specificity and therefore, improved outcomes and preparedness in these less trained movements.

Furthermore, power imbalances are present at a much higher rate in 3D movements (31%) vs sagittal plane movements (19%). Imbalances can lead to decreases in performance but also an increase in injury risk. Considering the fact that most sports rely on high levels of unilateral performance in the frontal and transverse planes (which are also the planes that have higher rates of injury), the significance of the gap in the current lack of measurement and training in these planes is highlighted.

3D Resistance eliminates this gap by making measurements in 3 dimensions possible, highly efficient, and easier to train and load.

Summary

A retrospective data analysis of power and acceleration metrics in males between 20-30 years old utilizing Proteus 3D Resistance shows that performance in sagittal plane movements does not translate to a similar performance in frontal and transverse plane movements. Sagittal plane movements display a higher bias towards strength and lower amounts of power imbalance than 3D movements. This is likely due to the increase in testing, monitoring, loading, and training frequency. Training programs should include measurements of 3D movements as well as an increase in training volume, load, and frequency to minimize the gaps in performance, reduce injury risk, and improve overall outcomes.