
Rays


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POSTERIOR

A pitcher's gluteus maximus is the biggest muscle in his body, said Jeff Cooper, a former head athletic trainer for the Philadelphia Phillies. Strasburg twists the muscle upward during the leg kick, allowing it to load tremendous energy. Unwinding it, along with the untwisting of the pitcher's trunk, brings the shoulder forward and the arm soon thereafter, like a whip. "Strasburg keeps his hips from rotating until the very last moment, which is a big key for that high ball velocity," said David Stodden, an associate professor at Texas Tech University's department of health, exercise and sport sciences. "It's very good forward momentum."

SHOULDER

Although the shoulder mostly allows for force to be transferred up through the legs and trunk to the arm, a pitcher stores extra energy by rotating his shoulder bone back. (But no more than 30 degrees without tempting injury, said Aaron Sciascia, program coordinator at the Shoulder Center of Kentucky.) When the arm starts whipping forward from energy built up in trunk muscles, the labrum surrounding the shoulder socket and four muscles that make up the rotator cuff work tremendously hard to keep the joint intact.

STRIDE

Cooper said that to allow for forces to be transferred properly up the legs and into the rest of the body, a pitcher's stride length – the distance from rubber to the front foot's ankle bone – should be about 87 percent of the pitcher's height. This translates to about 66 inches for the 6-foot-4 Strasburg.

BACK FOOT

The pitching rubber isn't just a line that the pitcher must touch; his foot goes into a divot in front of it and then pushes off it so hard that a force of about two-thirds his body weight travels up to his hip. (Because this force is highly correlated with wrist velocity, Strasburg probably pushes harder than that.) This is the essence of the so-called "drop and drive" pitcher like Tom Seaver, although some modern coaches prefer a less violent "stay tall and fall" motion.

PITCHING ELBOW

The human elbow normally bends only one way – with the hand rotating to and from the shoulder – but it bends backward, the hand and ball lagging behind, when the pitcher rotates his trunk toward the batter. The ulnar collateral ligament stretches (and requires the dreaded "Tommy John" surgery when it snaps). "It's like a sling shot stretched back as far as possible," said Glenn Fleisig, research director of the American Sports Medicine Institute. At that moment, he added, the strain on the elbow is as if a 40-pound weight were hanging from the pitcher's hand.

LANDING FOOT

Strasburg's left foot lands with two times his body weight (so 440 pounds), so it needs a firm anchor to transfer force up through his trunk and into his arm. During his second start, in Cleveland, the dirt gave way and caused his foot to slip two or three inches on some pitches. "The foot pushes back on your lower body and allows the upper body to thrust forward," said Colorado Rockies pitcher Jeff Francis, who was a physics major at the University of British Columbia. He noted the importance here of spikes. "You can't just rely on friction."

ARM ROTATION

At the time of the ball's release, Fleisig said, a top fastball pitcher's arm is rotating at about 8,000 degrees per second – "the fastest number of any human body part in any sport," he said. Strasburg's long arms generate extra torque and ultimately ball velocity.

BALL IN FLIGHT

An effect called Magnus force nudges a fastball higher or lower in its trajectory depending mostly on spin velocity, said Howard Brody, an emeritus professor of physics at the University of Pennsylvania. Strasburg's long fingers create incredible spin – probably 1,600 rotations a second. His four-seam fastball appears to rise not just because its gravity has less time to pull on it, but because the seams cause more air resistance and Magnus effect upward.