



MLB PREVIEW

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FORCE OF HABIT

WHEN ACE AFTER ACE BLOWS AN ELBOW FROM THE SAME BIOMECHANICAL FLAW, TOMMY JOHN SURGERY KEEPS THEM IN THE GAME. BUT SCIENCE, NOT THE SCALPEL, IS THE REAL SOLUTION. TOO BAD FEW MLB TEAMS ARE PAYING ATTENTION.

By
LINDSAY
BERRA

Illustrations by
+ISM

Faulty mechanics seen as a pitcher's foot comes down—note the unhealthy inverted W's of the arms above—have forced, clockwise from top left, Kerry Wood, Adam Wainwright, A.J. Burnett (now a Pirate), Joel Zumaya (now a Twin), Chris Carpenter, Jordan Zimmermann, Shaun Marcum and C.J. Wilson to have Tommy John surgery.



Stephen Strasburg, drafted No. 1 in 2009, has yet to pitch a full season. Some biomechanical experts see his strained motion and worry he never will.

Every pitcher, no matter his age, generates enough force on each pitch to rupture the ulnar collateral ligament in his elbow. It's a scary thought, for sure, but also an easy one to forget in the idyllic, emerald-grass setting that is Viera, Fla. Though Washington Nationals spring training has only just begun, a healthy crowd has turned out to watch fireballer Stephen Strasburg throw today's bullpen. It's been 18 months since the Nationals star underwent Tommy John surgery—the reconstruction of that oh-so-delicate UCL—at the age of 22; note the four-inch scar on the inside of his right elbow. Strasburg, who's known for touching 100 mph, doesn't disappoint. The fans, with their noses pressed through the chain-link fence, are thrilled. The Nationals, with their \$15 million starter back on the mound after a year on the disabled list, couldn't be happier. He looks exactly the same as he did before his elbow blew up.

And therein lies the problem. Thirty-seven baseball seasons have passed since orthopedic surgeon Frank Jobe performed the first UCL reconstruction on Dodgers southpaw Tommy John, whose name would become synonymous with the procedure. At the time, John was 31 years old with 124 wins and 11 seasons under his belt. He never threw heat like Strasburg, instead relying on a bottom-out sinker that forced ground balls. But the two pitchers—as well as many others who have undergone UCL reconstruction—have one thing in common: a mechanical flaw in the timing of their deliveries that causes the arm to lag behind the rest of the body, putting extra stress on the shoulder and elbow.

John wasn't told any of that in 1974, but he did learn the UCL connects the ulna in the forearm

to the humerus in the upper arm and acts as the elbow's primary stabilizer. He also knew from fellow Dodger Sandy Koufax, who had retired in 1966 at age 30 after a short but brilliant career, that a damaged UCL meant you were done. What Jobe proposed to John sounded both crazy and simple: replacing his torn left UCL with a tendon graft from his right wrist. Though the physician gave him only a one-in-100 chance of returning to baseball, John liked the slim odds better than the idea of working at his buddy's car dealership back home in Terre Haute, Ind. So the surgeon sliced through the muscle on the inside of the pitcher's left elbow to expose his shredded UCL, drilled holes in the ulna and humerus and threaded the graft from John's opposite wrist through them in a figure-8 pattern. Then he sutured the remnants of John's original UCL to the graft for added strength, whispered a few words of encouragement and closed up.

Eighteen months later, John defied the odds and returned to baseball. Jobe's procedure soon proved so successful that it became the norm. Today, about 50 active major league pitchers have undergone Tommy John

surgery—around one in seven.

Despite the inevitable yearlong stint on the DL that rehab from the surgery requires, teams and pitchers seem to barely flinch at the diagnosis of a compromised UCL. "It's become an accepted side effect of the job," says George Paletta, the Cardinals' head team physician and orthopedic surgeon. That's because the surgery works; 92% of elite pitchers with reconstructed UCLs return to their prior level of competition for at least a year.

As miraculous as that sounds, it masks a loaded situation. To understand the epidemic of UCL injuries, *The Mag* interviewed dozens of biomechanics experts, pitching coaches, coaches for hire, pitchers and front office personnel. (Only a handful of major league pitching coaches accepted our interview requests.) The picture that emerges is of baseball at war with itself over the health of its arms. In one corner stands a cottage industry of scientists and biomechanics-promoting coaches who study motion for a living and have determined, through high-speed video analysis, that the sport's ignorance of arm-saving science

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REGULAR-SEASON DAYS MLB PITCHERS RECOVERING FROM TOMMY JOHN SURGERY HAVE COLLECTIVELY SPENT ON THE DL IN THE PAST FIVE YEARS.

is a shameful oversight. In the other is major league baseball, which, with rare and fleeting exceptions, clings to a deep-rooted tradition: If it ain't broke—or can be fixed after a year on the DL—don't fix it.

"The definition of insanity is doing the same thing over and over again and expecting different results."
—multiple biomechanics experts interviewed for this story

To throw a baseball properly, a pitcher must get into the right position at the right time with the right succession of movements, like dominoes falling. Disruptions in this kinetic chain, as experts call it, cause problems at the weakest link, most often the elbow or shoulder.

Problems usually begin below the waist. The most telling moment in a pitcher's delivery, for instance, is the foot strike. When the foot makes contact with the mound, the pitching arm must be up and ready to throw. A righthanded pitcher should be showing the baseball to the shortstop, a lefty to the second baseman. (Among active hurlers, Cliff Lee is a good example.) But if a pitcher's elbows come higher than his wrists and shoulders, with the ball pointing down, he's demonstrating an "inverted W"—a sign that his sequence is off and he's fighting his own body. Such poor timing leads to arm lag, evident when the throwing elbow trails the shoulder once the shoulders square to home plate. Strasburg

exhibits both problems, forcing him and others like him to rely more on the arm's relatively small muscles instead of the more massive ones in the legs and torso. Throw after throw, the shoulder and elbow are under extra stress. The higher the pitch's velocity and the worse the flaw, the more the arm suffers. And the more a pitcher throws, the worse it gets.

Arm lag and improper sequencing were likely to blame for Strasburg's UCL tear, as well as for those of almost everyone else knocked out by the injury. "The timing is subtle," says the American Sports Medicine Institute's Glenn Fleisig, who has analyzed more than 2,000 pitchers and is one of the world's foremost authorities on pitching biomechanics. "It's the difference between good and great and healthy and injury-waiting-to-happen."

Strasburg was probably in trouble from the get-go. He didn't rupture his UCL on one pitch with the Nationals—even if a pitcher feels a pop on a particular pitch, his UCL was anything but pristine before the incident. Like a rope, Strasburg's UCL probably started to fray the moment he began pitching off a mound, the extra height of which can compound the stress of each pitch. It likely got worse not only because of his mechanics. Kids who throw the hardest pitch the most: They get hitters out. Famed orthopedic surgeon James Andrews, who founded ASMI in 1987, says he has seen a

five- to sevenfold increase in high schoolers requiring UCL reconstruction since 2000. "The No. 1 risk factor for UCL injuries is poor mechanics," he says. "The No. 2 factor is overuse. And if you overuse with poor mechanics, you're doomed."

God-given genetic superiority and freakish athletic ability often help those with less-than-ideal pitching mechanics make it to the majors, which is why you will find shockingly few exemplars of pitching mechanics on *Sunday Night Baseball*. "Everyone knows smoking is bad for you, yet people still smoke," says Yankees pitching coach Larry Rothschild. "It's the same with pitching. I've seen guys who don't have great mechanics pitch for a long time. The body adjusts."

Until it doesn't.

"You have to be open-minded. Closed minds don't make progress."

—Rangers president Nolan Ryan

To anybody involved with the biomechanical analysis of pitching, it's difficult to imagine a world without it. To anybody even half interested in baseball, it's also difficult to understand why it's not more accepted at the sport's highest levels.

For more than a hundred years, pitching mechanics have been evaluated at 32 frames

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BY THE NUMBERS

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AMOUNT MLB TEAMS HAVE SPENT ON THE SALARIES OF PITCHERS RECOVERING FROM TOMMY JOHN SURGERY IN THE PAST FIVE YEARS.

per second—the best the human eye provides. A pitcher's delivery, from first movement to ball release, can take as little as 1.4 seconds. In that tiny window, coaches, scouts and fathers try to assess dozens of variables, such as "hip and shoulder separation" and "pitching arm external and internal rotation." It's a tall order, if not an impossible one. "What the eyes see and what actually takes place are two different things," says Tom House, a former big-leaguer-turned-pitching-coach who now heads the Rod Dedeaux Research and Baseball Institute at the University of Southern California. "You see reality when you see what happens at 1,000 frames per second. It's a humbling experience."

The baseball community that makes a living off analyzing that reality is a quirky lot. Some are mechanical or biomedical engineers, like Fleisig. Some are retired pro pitchers, like House and Cy Young winner Mike Marshall, who has a Ph.D. in exercise physiology. Some are kinesiologists. Some are even self-taught, like coach-for-hire Alan Jaeger, who helps clients "merge the mechanics of the Western athlete with the insight of the Far Eastern mind." Their approaches vary, but they all believe that by addressing a pitcher's biomechanics and physics, they can improve performance and decrease injury. Not that they always agree. For example, Marshall advocates an ultrahigh arm slot. Jaeger is an advocate of long toss to build arm strength and stretches pitchers out as far as 380 feet. They find each other's untraditional approaches controversial and often fail to present a completely united front. While the small particulars they disagree on nearly bring them to fisticuffs, all agree that any flaw that disrupts the timing of a pitcher's kinematic sequence is problematic.

Collectively, their research can be as persuasive as it is cutting edge. A total of 2,000 pitchers—including six future Cy Young winners—have visited Andrews and Fleisig at ASMI's lab. Using a camera-and-computer system that three-dimensionally tracks data from reflective markers affixed to a pitcher's body as he throws, ASMI takes 41 measurements; think of it as an MRI of the pitching delivery. Afterward, Fleisig compiles a detailed report called a Biomechanics Evaluation about



Orthopedic surgeon Frank Jobe, right, saved Tommy John's elbow, and the game changed forever. Thirty-seven years later, John remains the most successful pitcher post-UCL reconstruction.

the pitcher that diagnoses problems with annotated video stills and recommends solutions. "When pitchers are young, they're receptive and willing to fix problem areas," says Reds minor league pitching coordinator Mark Riggins, who made several trips to ASMI while working with the Cubs. Crucially, the packet compares the pitcher to the exemplars in ASMI's database who threw the hardest without injury.

And yet despite the stature of Andrews and Fleisig, only about one-tenth of ASMI's clients played pro ball at any level. When pros do visit, they often find the screening advantageous. Braves pitcher Tim Hudson spent the early part of his career in Oakland, where pitching coach Rick Peterson, a biomechanics guru, took him to ASMI for mapping. "I think it's a great test," says Hudson. "You can do it when you're pitching really well, and then, if you struggle or have pain"—Hudson himself later had Tommy John surgery, from overuse—"do it again. Instead of trying to eyeball it with regular video, you can actually use the science to compare the two." Fleisig also recalls CC Sabathia and Cliff Lee visiting in the early 2000s as promising young Cleveland Indians; he's mum on the details, but they soon became two of baseball's most dominant pitchers.

Such an analysis reveals, for example, an issue late in the delivery—such as a tilted head position—that biomechanics-minded coaches address much earlier in the pitching motion, just as an engineer would need to right a listing skyscraper at its foundation rather than at the

15th floor. The pitching coach also creates a full program of mechanical drills specifically tailored to correct nearly anyone's woes, even a habit like arm lag. "With a big-picture approach that includes both strength training and mechanics, there's not much you can't fix," says independent pitching coach and former scout Paul Reddick.

"I'm not going to let new-school ways get in the way of my old-school thinking. I don't need biomechanics. I have experience. I have my eyes. I just watch and look."

—White Sox pitching coach Don Cooper

Baseball, it's been said, is the only thing besides the paper clip that hasn't changed. And in the case of MLB pitching mechanics, the status quo is stickier than pine tar. Whether you're a pitcher, scout, coach or GM, the goal is to keep your job and win baseball games—not shift paradigms.

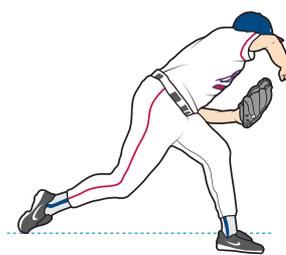
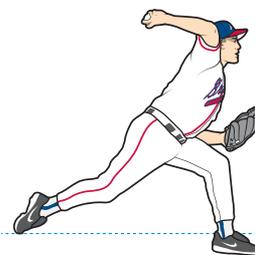
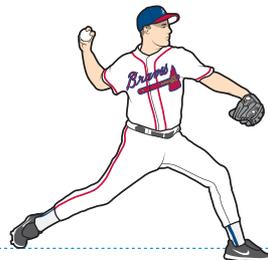
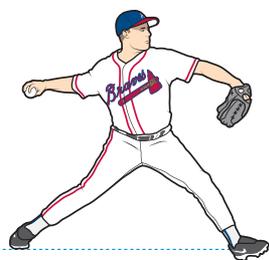
Take major league pitching coaches. They're paid to get outs. They spend hours looking at pitch charts, spray charts and video of opposing hitters. They develop a plan of attack for each batter and help their pitchers execute that game plan. They work with trainers on a throwing program, preside over bullpen sessions and manage workloads. Occasionally, they'll make adjustments to a delivery or change the mechanics of a certain pitch to make it better or more deceptive, but their main priority never changes: Send the man at the plate back to the dugout.

As such, they're more equipped to assess

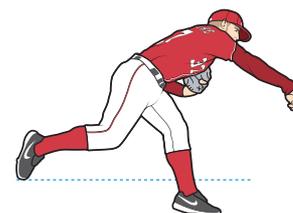
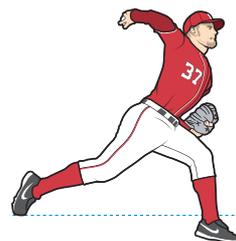
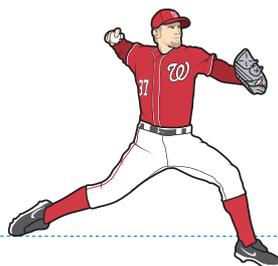
THROWDOWN

Independent coach Paul Reddick helps hurlers throw harder and stay healthier. He has scouted for the Pirates and written books with ex-big leaguer and biomechanics guru Tom House. *The Mag* asked Reddick to compare the flawed delivery of Strasburg with the model motion of retired legend Greg Maddux.

NEAR-PERFECT • MADDUX



NEAR-DISASTER • STRASBURG



"Maddux's lift is very efficient. It brings him only forward. His front shoulder is directly in line with home plate"—denoted above by the dotted blue line. "Strasburg has negative movement toward home plate. He overrotates toward second base; his knee has passed his belly button. Now he has to stop all that energy going back and regenerate it to come forward. He'll never overcome that wasted movement and misdirection."

"Maddux's spine is straighter; he's stable on his back leg with his head and spine over his center of gravity. Strasburg's spine is at 11 o'clock, and his back leg is straight. He's striding too far toward the righthand batter's box. He then has to literally fight across his body toward home plate. He's out of sequence: His shoulders are already pinching back to throw, but his front foot hasn't yet hit the ground."

"Maddux's lower half is still tracking toward home plate. His arm remains back as his hips begin to turn. This is the classic torque position. Strasburg's misdirected stride, mirrored in the tilt of his head"—and reflected by his distance from the blue line—"inhibits his hip rotation. He'll never harness torque as easily as Maddux and will have to strain his upper half to finally face home, which increases the stress on his arm."

"The position of Maddux's chest shows how much farther he is toward the plate. His elbows are in front of his body in a position of strength, with good glove position in front of his knee. Strasburg's elbows are passing behind his body. This is a weak position, and he's working to overcompensate for his lower half's poor position. He's also pulled his glove back to help him square toward home. A sloppy glove is a sign of sloppy direction."

"Maddux's head and shoulders are almost still in line with home plate"—and the blue line. "Strasburg is now leaning way to the left because he's swung over to compensate for veering too far to the right early on. And he's still not on target for home. The follow-through is a byproduct of everything that happened before. You can't have bad mechanics and a good follow-through, and you can't teach a good follow-through."

an opposing lineup's tendency to chase the low-and-away fastball than to address the effects of vectors and valgus stress on their pitchers. The vast majority of MLB pitching coaches, who don't have scientific backgrounds, don't speak biomechanics—and it doesn't speak to them.

According to Hall of Famer Nolan Ryan, the president of the Rangers, MLB pitching coaches can find the new scientific knowledge threatening. "Maybe they don't know how to approach it," he says. "So they just don't." When Ryan began pitching for the Rangers at age 42, House was his pitching coach; the aging ace quickly became a biomechanics believer and worked with the coach, whom he later thanked in his Cooperstown induction speech, to constantly refine his mechanics. "I

had to because of age and because of new info," Ryan says. "If I thought it would help, I'd put it in my routine."

It's practically an unwritten law in baseball that the majors are not the place to make big mechanical changes. The rare times coaches push for them, it's in the minors. "When you're interviewing pitching coaches," says former Reds and Nationals general manager Jim Bowden, who's now with ESPN, "if they're mechanically oriented, you hire them for rookie ball or Low-A ball, where they can make tweaks before pitchers succeed."

But the more success pitchers have, the less incentive anybody has to correct their approach. "Once they reach the majors, they're pretty set into their deliveries," says the Reds' Riggins. "With big leaguers, I don't talk much

about changing mechanics." If a coach risks changing a pitcher's mechanics and he gets hit or hurt, it's the coach's fault; if he leaves a pitcher alone and he gets hurt, it's because the pitcher already had a bad arm. If a team can win in the interim, like the Giants have done with Tim Lincecum and his radically tilted delivery—which critics view as a time bomb—it's managed to get its money's worth. "That's exactly the theory," concedes Astros pitching coach Doug Brocail. "It works until it doesn't."

Experts with biomechanics backgrounds find this approach painfully illogical. "Baseball is a game of failure coached by negative people in an environment of misinformation," says House. Not surprisingly, pitching coaches who preach biomechanics rarely crack the bigs. They say what they think, which is often that

A PITCH FOR HEALTH

A proven way for an aspiring pitcher, or even a pro, to improve his mechanics is through biomechanical analysis, a process that maps his delivery to identify weaknesses. The analysis costs \$500 to \$1,000 at ASMI's facility, where cameras capture images of pitchers from multiple angles. Markers affixed to the pitcher's body establish their coordinates in space and time. The data and images are later extrapolated into 3-D and computed to generate 41 measurements diagnosing mechanical flaws.



pitchers need to change the mechanics they've been throwing with since grade school.

In MLB's defense, the research has yet to reach a level at which it can predict and prevent every UCL blowout. "There's a lot of data," says a skeptical Bowden. "But even with all the research that's been done, you still can't perfectly articulate who will get hurt and when it will happen."

So teams are hesitant to stick their toes in the pool—and few, if any, want to really swim. At ASMI, Fleisig estimates that in the past decade, 20 of the 30 teams have brought at least one player to be mapped, but they usually bring only prospects. Even then they don't always use the information. Fleisig tells the story of a team that brought a major league pitcher to see him in 2005. After the evaluation, Fleisig told the team that the pitcher's mechanics increased his risk of injury; his elbow was above his shoulders when he squared to home plate. But the player, who later had labrum surgery, claims the club never told him about his analysis or helped him make adjustments. Only after he was traded did his new team finally address his delivery issues.

It would require a risk-taking franchise to explode the status quo. A GM would need biomechanics experts, coaches who listen to them and an owner who believes the forward-thinking approach will save his pitchers' arms—as well as millions in payroll. Baltimore GM Dan Duquette may be that man. In January, he hired Peterson as the Orioles' director of pitching development. "I really think our industry is behind the times," says Peterson, who believes his tenures with the Mets and Brewers were short-lived because of his propensity for applying biomechanical analysis to change his pitchers' deliveries. During spring training, Peterson invited ASMI to map 37 Orioles pitchers, including the team's major leaguers. "This is now the philosophical path this organization is going in," he says. "The format of those reports is so vital. What do you do with the pitcher after you get the report? That's where I come in. Other teams get the reports and go, 'Now what?'"

In the meantime, as we all know, the rest of

MLB's teams aren't doing *nothing*. They count pitches. The Nationals announced in late February that they'd limit Strasburg to 150 to 160 innings this season. Other pitchers who have had Tommy John surgery, such as Brian Wilson and Kerry Wood, work out of the bullpen to extend the life of their arms. Pitch counts are important to the biomechanics community—Fleisig and Andrews championed the Little League decision to limit pitch counts nationwide in 2007. But pitch counts alone, they say, can't protect UCLs from poor mechanics. At best, they prolong the inevitable.

"I've been throwing this way my whole life. I'm not going to try to reinvent the wheel."

—Nationals pitcher Stephen Strasburg

Tommy John never did work at that car dealership back home in Indiana. His surgeon saved him. But it wasn't only the scalpel that made him—to this day—the most successful pitcher following UCL reconstruction.

During rehab, John hooked up with his teammate, Mike Marshall. "The surgery worked for Tommy because I made him put his hand under the baseball," Marshall says. John acknowledges a change in grip. "If you move it to the side, the ball is pointing back when your

hands break and you can come up nice and high," says John, who pitched another 14 years, won 164 games and retired at age 46.

The Nationals hope that Strasburg, at 23, has an equally long career ahead of him. After all, he's brilliant. Following his yearlong rehab, Strasburg made five starts last September. He pitched 24 innings, with 24 strikeouts, just two walks and a 1.50 ERA. His command was good; 224 of his 328 pitches were strikes, the prettiest of which was a 99 mph, letter-high, 0-and-2 fastball that fanned Marlins slugger Giancarlo Stanton in the top of the first inning on Sept. 17.

But earlier in the game, Nationals TV analyst F.P. Santangelo recalled a one-inning stretch six days earlier when Strasburg was hitting only 92 and 93 on the radar gun, causing some concern inside the Beltway. "He's getting out front, and his arm was dragging," Santangelo said, referring to Strasburg's habitual arm lag, which takes more of a toll when the pitcher tires. Play-by-play man Bob Carpenter piped up a few innings later, relaying what Nationals pitching coach Steve McCatty had told him: "I don't want to be the one that screws the kid up." And then: "He's scared to death every time Strasburg pitches."

He should be. Tommy John surgery isn't nearly as successful the second time. ■