

Tommy John Surgery

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Inside Tommy John Surgery

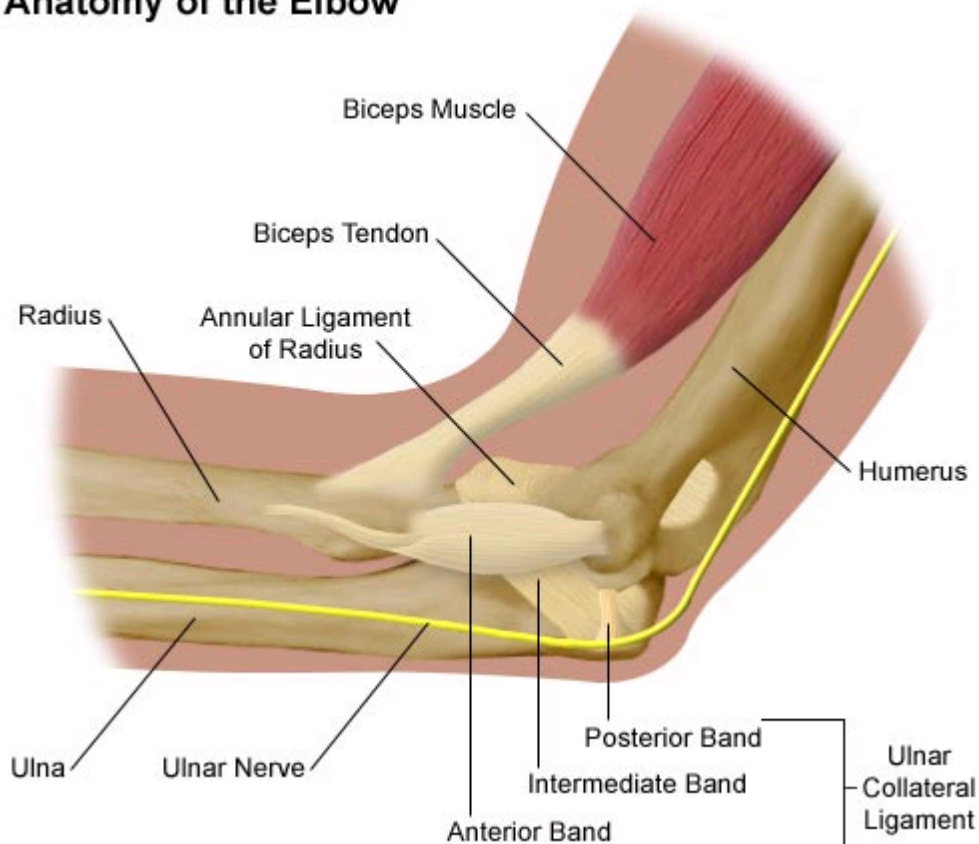
Thirty Years of Fixing Pitchers

by Will Carroll and Thomas Gorman

"Since the invention of the breaking ball, there has been no more significant development in baseball than Tommy John surgery." --Will Carroll, Saving the Pitcher

Kerry Wood. Matt Morris. John Smoltz. Mariano Rivera. Tom Gordon. Eric Gagne. Other than an ability to throw a ball past the best hitters in the world, what these hurlers have in common is a four-inch scar on their pitching arm. They're not the only ones. *USA Today* reports that in the 2002 and 2003 seasons, 75 of the almost 700 pitchers who appeared in the majors were Tommy John surgery survivors. That's approximately one in every nine pitchers.

Anatomy of the Elbow



Tommy John surgery--technically an ulnar collateral ligament replacement procedure--has saved the careers of hundreds of Major League players. It may one day make the Hall of Fame case for its inventor, surgeon Frank Jobe (who was Hollywood enough to trademark the name "Tommy John procedure"). Thirty years after Jobe was told by [his patient](#) to "make something up," we take a closer look at the surgery that changed the game and some of the recent advancements that have made it such a medical wonder.

First some anatomy: the elbow is a hinge joint, moving in only one dimension (flex or extend), making it relatively simple from an architectural and functional standpoint. The humerus bone in the upper arm connects to the two bones of the forearm by means of various connective tissues. For a pitcher, one of the most important of these connections is the [ulnar collateral ligament \(UCL\)](#). The UCL offers much of the stability that is necessary for the elbow to withstand the extreme stresses created by throwing a baseball at high velocity. Its function is to stabilize against lateral forces and to keep the arm connected across the joint space.

Pitching overhand is a particularly stressful motion; the strain it puts on a player's joint is commonly injurious. Sometimes the UCL will weaken and stretch (technically a sprain), making it incompetent. Other times a catastrophic stress will cause the structure to "pop" or blow out. The injury isn't tremendously painful, and it can be incredibly difficult to diagnose without sophisticated imaging (such as an MRI), but incompetent or blown out, a damaged UCL will prevent a player from throwing at full velocity or with effective control.

Until recently, a UCL injury was career-ending or, at the very least, a major detour in a career path. Some believe that [Sandy Koufax's](#) "dead arm" in 1966 was simply a case of a damaged UCL. It is unknown how many pitchers prior to 1974 could have benefited from this type of procedure, but given the rate of surgeries today and what we know about the workloads of the past, it is reasonable to assume that one out of every ten or so pitchers who burned out or simply faded away might have been saved.

Crudely described, what Jobe did was build John a new ligament. Since no artificial tissue can fully approximate the function of the body's own connective tissues, and since the body doesn't have a whole lot of spare ligaments lying around, Jobe began by harvesting a healthy tendon. In most cases the tendon is harvested from the forearm of the patient, one attached to the palmaris longus muscle. This tendon is not crucial for anatomical function, and in fact, 15% of people do not have the tendon. To see your palmaris longus tendon, look at the palm-side of your forearm. Touch your thumb and little finger and then make as much of a fist as possible. 85% of you should be able to see [this tendon](#) running down your arm.

San Francisco Giants team orthopedist Ken Akizuki reports that when the palmaris longus tendon is unavailable, the surgeon will often use the plantaris tendon in the ankle or a small part of the hamstring tendon in the leg. Usually this tendon will be harvested from the leg that is not used as the plant foot in the pitcher's delivery. The removal of either of these tendons has a negligible effect on function.

Next, the surgeon has to open up the elbow. In the original procedure, Frank Jobe used a large incision to get exposure to the joint. For an idea of the size of this incision, hold your right arm out from your body with your palm pointed upwards. With your other hand, feel along the inside of the elbow until you can find what feels like a hard round nub. That's the proximal end of your ulna bone. The incision would have taken place along the inside of the arm, beginning several inches above the elbow and ending several inches below.

More recently, [Kris Benson](#) used his Web cam to document the healing of his own [Tommy John scar](#). In the [first image](#) you can actually see the two incisions in his forearm that were used to remove his palmaris longus tendon. Benson's elbow incision is quite a bit smaller than the scars left by early Tommy John procedures.

As Dr. Akizuki explains, "In order to get exposure to the joint you used to have to detach the entire flexor attachment [the muscles that flex the elbow--you can feel those muscles by feeling along the incision site]. You used to just fillet that open."

Once inside the elbow the [ulnar nerve](#) is recognized, lifted out, and moved to provide greater access to the joint. This is the "funny bone" nerve and it runs inside the ulnar groove.

Dr. Tim Kremchek, Medical Director of the Cincinnati Reds and one of the four doctors who do most of the Tommy John surgeries on major-league pitchers, explains that in early versions of the procedure this was a problematic part of the surgery. "Sometimes the movement of the nerve would cause scarring and you would need to go back in and re-release it." This was the case for Tommy John. A second procedure to correct his nerve problems guaranteed that his DL stint would last the entire 1975 season.

With the muscle separated and the ulnar nerve safely out of the way, the surgeon would then locate the damaged ligament. After scraping out the damaged tissue, the next step is to drill tunnels in the elbow. If you were imagining a Makita with a quarter-inch bit you wouldn't be too far off. Two different drill passes are made through the humerus in a V-shape aimed at the ulna, and one more tunnel runs through the ulna at approximately a perpendicular angle to the humerus. The result is a pattern that allows for the surgeon to loop the harvested tendon through the various holes in a series of figure-eight patterns.

Over time, the transplanted tendon "ligamentizes," which basically means it learns to become a ligament. There is a healthy blood supply from the muscle above the surgery site (the one the surgeon had to cut through), and there is also a hope that the drilling will give the harvested tendon access to the vascular supply of the humerus and ulna. It is not completely clear how it is that a tendon becomes a ligament, although Dr. Akizuki thinks that range of motion exercises help the tendon learn that it is being used as a ligament now and that it needs to adopt. Surgeons don't go back in to biopsy the repaired elbow to see how the tissue has changed, but follow-up MRIs do show that the new tissue is maturing and functioning as a ligament should.

That's basically it. Or at least, that would be it if surgeons and trainers and pitching coaches and GMs weren't a tinkering sort and didn't try to keep one upping each other.

Dr. Kremchek, who does some 120 UCL replacements a year, detailed some of the many improvements in the surgical technique that have been made since the original procedure. After noting that the drill equipment they use is more sophisticated he explained "the entire procedure is less invasive. We leave the ulnar nerve, and we leave the damaged ligament."

Making the procedure less invasive isn't about having a smaller, prettier scar; it's about doing as little damage as possible to the surrounding muscles and tissues. Leaving the ulnar nerve in place reduces the risk of scarring or permanent nerve damage. Scarring would require a second procedure to re-release the nerve, whereas nerve damage could leave a pitcher with permanent numbness or tingling in part of the hand, a condition that would make pitching tricky.

Leaving the damaged ligament in place can help in a couple of ways. First, like any ligament, the UCL has nerve receptors. These receptors allow for proprioception, which is a fancy name for the body's ability to sense the position, location, orientation and movement of its parts. If you close your eyes, you can still tell what position your body is in due to proprioception. A damaged ligament can no longer serve its stabilizing function, but its nerve receptors can still contribute to the elbow joint's combined ability for proprioception. If the damaged ligament is removed completely, the new ligament must develop its own proprioception, a long and complicated process that physicians don't completely understand.

Another reason for leaving the damaged ligament in place is that the structural attachments of the old ligament are still there. As Dr. Akizuki explained, "If you look at a biomechanics study, the number of loops you put in is not as important as fixation at each end." (Someone tell Billy Koch to quit yapping about his six loops!) Dr. Akizuki detailed the way he uses the old ligament structures: "I split the old ligament longitudinally, peel it open from top and bottom--the attachments at the top and bottom are still intact, even though they might be loose. I free it up distally and proximally, pass the new ligament across and suture it. The priority is on the new ligament first. You may have to debride out some of the old ligament but if it's just loose you can overlap it."

No one is exactly sure whether the proprioception advantage or the structural advantage is more important. What the surgeons do know, though, is that leaving in the damaged ligament doesn't make the procedure any harder. After leaving the damaged ligament in place, what some have called an "overlay Tommy John," the cutting edge is probably the use of bio-absorbable screws instead of drilling tunnels through the bone for attaching the harvested tendon, but the use of such screws is still experimental.

Yet Dr. Kremchek is adamant that we understand that surgery is not the most important part of the equation. In fact, he says that post-surgical rehab makes up at least 55% of the solution for an elbow injury and that the "difference maker is the rehab people, not the surgeon." Shocking words from a man whose profession is not well known for deferring credit or modesty.

Kremchek explains, "The crucial element is communication between the surgeon, therapist, trainer and pitching coach... When you diagnose a UCL injury you don't want to waste a ton of time with the rehab. Go straight into surgery." BP's Injury Database concurs. Surgery produces a much higher success rate than just straight rehab. "Keep the communication lines open. Everyone gets my cell phone number: players, agents, coaches, GMs. Progress safely and if everything falls into place, these ultra-fast returns are possible."

As a case study consider [Ryan Dempster](#). Dempster was placed on the DL on August 1, 2003, a Friday, and on the following Monday he was under Dr. Tim Kremchek's knife in Cincinnati. The Reds released Dempster in November; by January his agent was talking with the Chicago Cubs.

Cubs GM Jim Hendry was involved in negotiations with [Jon Lieber](#) before George Steinbrenner's pocketbook knocked him out of the picture, so the idea of signing a pitcher with a serious arm injury was not completely foreign. As Hendry explained it, "We had a good relationship with Dr. Kremchek. We've had him look at our guys before. Our staff liked him. We called him in the past for other players and our medical team thought his diagnosis was dead on. I don't think we assumed a lot of risk. We felt comfortable with our talks with Dr. Kremchek. We felt Dempster was on or ahead of schedule in the winter."

All throughout Dempster's rehab, Dr. Kremchek was in constant communication both with Dempster and with Larry Rothschild, the Cubs pitching coach who was helping to manage Dempster's progress. Available by cell phone, Kremchek could help the team make quick decisions about advancing the hard-tossing righty. Dempster was throwing in extended Spring Training and Class A ball in May; he was in Triple-A in June and July; and on August 1, exactly a year to the day from when was first put on the DL, he was called up to the Cubs' 25-man roster.

Hendry, for one, says he wouldn't be surprised to see more and more teams regularly signing guys with elbow injuries. "Our situation in our minor league system is that we've had a lot of success with rehab from elbow surgeries."

There are always surgeons working on more advances as well. Several teams are working on techniques that would allow the operation to be performed arthroscopically, reducing the stress on the arm. There are amazing advances in the rehabilitation process, most notably by Kevin Wilk and his team from ASMI. Even the material used is being re-considered with "cloned" ligaments, built from stem cells and grown in a dish being considered as an alternative to the harvested tendons used today.

That Tommy John surgery seems all too common is perhaps the best measure of its success. While there is still a failure rate of 10 to 15%, most of these happen on younger subjects. It would be more accurate to say that the pitcher fails himself in most cases, rather than the surgery being the problem. Some think the procedure is becoming too common, with younger and younger patients. Others want to have their "prospect" son given the procedure when young so as to avoid it later.

While there are faults, the surgery and the team behind the procedures have made baseball better. One in nine pitchers would not be on the field without it, further diluting the pitching population. Frank Jobe's experiment on a desperate pitcher has become a part of America's game, a routine procedure taken for granted. That alone is pretty amazing.

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Special thanks to Dr. Tim Kremchek of the Reds, Dr. Ken Akizuki of the Giants, and Jim Hendry of the Cubs for their interviews.

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