

ACL: The Anatomically Chauvinistic Ligament

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POP. I immediately fell to the ground, my right knee shooting with pain. It happened while I was playing football with my friends. Running a route for a pass, I decelerated and quickly changed direction, making a cutting motion I had made thousands of times playing field hockey in high school. This time, though, when my right foot landed, I felt my knee continue to the left, while my lower leg remained planted to the right. After a few minutes, the excruciating pain settled into a dull, throbbing ache, but my concern did not subside. Later, upon reviewing my MRI, Boston College athletics' orthopedic surgeon, Diane English, confirmed my worst fear: I had torn my anterior cruciate ligament, known more commonly as the ACL. "ACL tears are typical among women your age," she assured me. "This is completely common, even to be expected."

Despite her lack of surprise, as a member of a Division I track and field team, the last thing I had expected was tear my ACL during a pick-up game of football. Even though I was blindsided by my season ending injury, Dr. English was right. The majority of ACL reconstructions each year are performed on "young athletes under age 25 and female athletes," two categories I fall into (Quinn). According to the American Academy of Orthopedic Surgeons, female participation in athletics has grown by seven-fold in the past two decades alone (Young). With the advent of Title IX, it seems now that women have been given an equal playing field in athletics, they are getting injured at an alarming rate compared to men. Knee ligament injuries are especially frequent among females, specifically "the painful pop and tear of the anterior cruciate ligament, or ACL" ("Knee – Plaguing"). Studies have shown that women are anywhere

from three to eight times more likely to suffer from an anterior cruciate ligament injury than men (“Physical”). This alarming statistic prompts one orthopedic surgeon and researcher to pose this question: “why are women’s knees, in a sense, their Achilles heel?” (Bramnick). The New York Times health columnist Jane E. Brody declares, “When it comes to knees, women are indeed the weaker sex. The very design of their bodies makes them more vulnerable than men to serious knee injuries” (Brody). It is apparent that women, due to their anatomy, physiology and consequent behavioral tendencies, are exceedingly more prone to anterior cruciate ligament tears.

The ACL, “is a broad, thick cord the size of a person’s index finger” (Brown). At five centimeters long, the ACL is the smallest of the knee ligaments, and therefore the most commonly torn. The ACL crosses behind the patella, or knee cap, and working with the larger, posterior cruciate ligament, or PCL, “maintains the rotary stability of the knee and prevents the lower leg (tibia) from moving either too far forward or backward on the upper portion (femur) of the leg of the knee” (“Physical”). Together these ligaments bolster the knee during “activities requiring running, jumping, landing, deceleration, twisting, turning, and changing directions quickly” (“Female Athletes More Susceptible”). Female athletes usually injure their ACLs in two ways, either through the “violent planting of the foot during a high-speed, high-impact stop/change of direction,” as I did, or during a “routine jump-stop,” likened to taking a jump shot in basketball, or a dismount in gymnastics. (Brown). Naturally, the ACL is most commonly injured in “bone-jarring, stop and start” sports where these movements are habitual, namely, the aforementioned basketball and gymnastics, as well as soccer, football, field hockey, skiing, and volleyball (“Knee – Plaguing”).

Anatomically, women generally have wider set pelvises in comparison to their shoulders, while men, conversely, have broad shoulders in relation to their narrower hips (“Physical”). This physiological difference directly results in a greater angle formed by the femur, or thigh bone, as it runs from the hip to the knee cap (“Sports Injuries – ACL”). This angle, known as the quadriceps angle, or “Q-angle,” is commonly larger in women due to their wider set pelvises, resulting in increased stress put on females’ anterior cruciate ligament (“Sports Injuries – ACL”). The wider female pelvis also causes the femur to follow a more inward line along the patella, increasing the weight it bears. When fatigued, this inward angle becomes more pronounced upon landing, making the risk of injury even greater for women taking part in athletic activity. Simply, the wider the hips are set, the more severe the angle, and therefore the more stress inflicted upon the knee’s ligaments.

The anterior cruciate ligament “passes through the notch in the lower end of the thighbone that forms part of the knee,” known as the intercondylar notch (Bramnick). Though the ACL itself is approximately the same size in men and women, this notch through which it runs is up to twenty percent narrower in women (Bramnick). Females tend to have an “A” shaped notch, compared to the wider, more “U” shaped notch usually present in males (Garroway). This dramatically “tight[er] fit may cause a ‘shearing’ effect on the ACL by the femur;” that is, the female ACL is more susceptible to tear itself within its own ill-fitting groove (“Physical”). When Dr. English reviewed my MRI, she commented on the size and extreme shallowness of my notch, attributing my ACL tear to this anatomical deficiency. While surgically reconstructing my ACL, Dr. English shaved my intercondylar notch, making it wider and deeper, to prevent future injury to my “new” ACL.

The major muscles around the knee, the quadriceps and the hamstrings, are meant to work together to bolster the knees' ligaments. When the quadriceps are relied upon more than the hamstrings, however, the result is anything but bolstering. The function of the quadriceps is to “pull the bones of the lower leg forward and the hamstrings [are] to pull them back. . . . When the pulling power is out of balance to the rear, the knees suffer” (Bramnick). An experiment performed by Dr. Edward Wojtys, professor of orthopedic surgery and head of the Sports Medicine Department at the University of Michigan, Ann Arbor, discovered that the females' unusual order of muscle recruitment is especially detrimental to the ACL (Brody). The experiment “demonstrated that 31% of female athletes recruited the quadriceps first, whereas only 17% of the males did” (Brody). Meaning, upon landing in a bent-knee position, women “rely more on the quadriceps – the muscles in the front of the thigh – to stabilize the knee” rather than “the stronger hamstrings behind the thigh” (Brody). In most females, the quadriceps muscles are much more developed than the hamstrings. This common imbalance of muscle strength results in disorderly muscle recruitment in females, and therefore a “heightened pressure on the ACL” (Saint Michel). Prior to my right ACL injury, I had suffered from a level three tear in my right hamstring. Though it was fully, albeit recently, healed, my hamstring was still much weaker than usual, and not nearly as strong as my quadriceps. This combination most likely caused me to rely too heavily on my quadriceps, therefore compromising my ACL.

As a result of their generally weaker hamstrings relative to their quadriceps, females also tend to bend too slightly at the knee. This tendency, when paired with improper muscle recruitment, proves enough to cause immediate damage: “Many female athletes use their quadriceps muscle when they are changing direction rapidly. This can put enough force on the shinbone to tear the ACL if the knee is not bent enough” (Young). Women athletes should

attempt to participate in a more 'flexed-knee' positions, like our male counterparts. By simply flexing the knee, the females can significantly reduce the stress on their ACLs.

Body composition is yet another area where men have an anatomical advantage over women. Females' average body fat content is "approximately twenty-six percent, compared with that of the male at fourteen percent" ("Sport Injuries – Estrogen"). Extra weight in itself incapacitates knees: "When walking, every extra pound of body weight adds four pounds of pressure to the kneecap. When climbing, that pound adds 20 pounds of stress; when running or doing high-impact aerobics, that pound places up to 25 extra pounds of stress on the knee" (Brody). This difference in body composition is a direct result of the hormones specific to males and females. Males have approximately ten times more testosterone than females, resulting in the fact that they are generally 33 percent stronger than women ("Sport Injuries – Estrogen"). In addition to having a greater lean muscle mass and overall less body fat, testosterone "is very anabolic, which means that it stimulates the growth or repair of tissues" ("Sport Injuries – Estrogen"). The fact that females have under ten percent of this injury-healing hormone is conclusive evidence that women are unable to recover as easily as men are. The male triumvirate of extra muscle, greater strength, and decreased healing time, especially in the aforementioned quadriceps and hamstrings, is proven to "improve knee function and decrease an injury to the ACL," proving males are naturally more resistant to ACL injuries ("Female Athletes More Susceptible").

The hormones inherent to women, namely estrogen and relaxin, are not only responsible for females' comparative lack of lean muscle tissue, but for the overall debility of females' ligaments as well. Estrogen is a "known vasodilator," meaning it widens blood vessels, simultaneously allowing more blood and water within ligaments, both of which "lead to

weakened tissue structure, and ultimately, failure” (“Knee – Plaguing”). Additionally, estrogen coupled with relaxin results in increased joint laxity in women. Greater joint laxity drastically affects the likelihood of a ligament injury. Dr. Wojtys proclaims, “Female athletes are two to eight times more likely to tear their anterior cruciate ligament because they may not be able to achieve the same muscle stiffness across the knee joint” (Brown).

The presence of estrogen and progesterone in the anterior cruciate ligament itself can also affect the overall strength of the ligament. In a 1996 study, orthopedic surgeon Dr. Stephen Liu performed an experiment proving that receptor proteins for both estrogen and progesterone are present within the fibroblasts of the anterior cruciate ligament (Plaguing). Fibroblasts are cells within connective tissues, such as ligaments, that produce protective collagen. Doctor Bing Yu, assistant professor of allied health sciences at University of North Carolina, then carried out a follow-up experiment, testing the effect estrogen and progesterone had on fibroblasts in the anterior cruciate ligament. The experiment determined that increasing levels of estrogen resulted in a decrease in collagen within the ACL, while increasing levels of progesterone resulted in an increase of collagen (“Knee – Plaguing”). Dr. Yu and his associates concluded that “the alternating effects of the hormones may lead to a decrease in collagen strength,” thus concurring that the fluctuating nature of a woman’s menstrual cycle effects the overall strength of ligaments, specifically the ACL (“Sports Injuries – Estrogen”).

Not only are women are more prone to knee injuries than men for anatomical and physiological reasons, but because of their behavioral tendencies as well. This disadvantage centers on the fact that most women do not typically start participating in sports until their teenage years. Boys, however, usually begin participating in athletic activity sooner, therefore conditioning their bodies to adopt injury-resisting habits at a young age: “Their training includes

footwork drills, eye-hand coordination skills, [and] catching and throwing balls which develop their neuromuscular systems” (“Physical”). Young girls, in general, are not as athletically-oriented as young boys are, and therefore “are not exposed to this early motor learning, . . . putting them at a distinct disadvantage when they decide to get involved in sports” (“Physical”). This lack of early conditioning alone puts women in general at a greater risk of a sports related injury.

The most knee-debilitating behavioral difference between the sexes is how men and women jump. This difference stems from the “simple fact that women’s bodies are different than men’s bodies. . . . As a result, females tend to land and react differently when jumping and pivoting, resulting in more stress on the knee” (Young). The University Of North Carolina School Of Medicine concluded that female athletes “perform running, crosscutting, and side-cutting maneuvers in a more upright posture” than their male counterparts (Brown). This tendency to not bend at the knees or hips results in greater impact, and therefore greater stress inflicted on the ligaments of the knee. The anatomically greater Q-angle, typical of most women, causes females to land differently than males. As a result of this increased angle, women commonly land jumps in a “knock-kneed” position, incorrectly pivoting their knees like a ball-and-socket joint (Young). The term “knock-knees” refers to “an abnormal curve of the legs that causes the knees to touch or nearly touch while the feet are apart;” essentially, it is the knee’s equivalent of being “pigeon toed” (“Definition – Knock-Knees”). Landing in such an awkward position puts excess strain on the ACL. Men, conversely, land in a straighter, more upright position, correctly bending their knees like hinges, as they are intended to, due to their aforementioned increased hamstring strength.

This tendency can be corrected by “teaching females to jump – not higher, faster – but straighter” (“Epidemic”). Dr. Tim Hewett, a Sports Medicine professor at the University of Cincinnati, adds that, “The untrained girls were five to six times more likely to blow out their knees” (“Epidemic”). A study performed in 1998 “of 1,200 indoor soccer players, 400 girls who spent six weeks working on jumping without caving in at the knees and other stability and balance exercises saw their injury rate drop to that of untrained boys” (“Epidemic”). This kind of “jump training” is based on a “combination of stretching, weight training, and jumping exercises” shown to increase hamstring strength and correct women’s dangerous behavioral tendencies (“Young Female Athletes”). Such exercises minimize debilitating side-to-side motion of the knees and additionally helps females “develop balance and hamstring strength” (“Epidemic”). Easy preventative exercises such as these are so successful in preventing ACL tears, “a few hundred schools and colleges in the U.S. now use similar programs, as do the Chicago Bulls and Toronto Raptors basketball teams, because the drills are also useful for males,” as well (“Epidemic”). Another ACL tear prevention program focused on plyometric exercises, which consists primarily of jumping, quickness, and agility training, consequently “led to an 88 percent decrease in ACL injuries” (Brown).

Due to anatomical and physiological differences, women are innately more prone to ACL tears than men. Despite the genetic deck being stacked against women, studies have shown that simple defensive exercises can trump female anatomical shortcomings, effectively dropping their heightened chance of injury to the level of their male counterparts. Active women and those training them, from elementary physical education teachers to elite coaches, should be conscious of this tendency and therefore take preventative measures to lessen women’s likelihood of an

ACL injury. Only with increased awareness of this propensity and appropriate defensive conditioning can this epidemic of ACL injuries in women end.

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Process Notes: Bernadette Gaffney

Immediately after tearing my ACL, I scoured the Internet, wanting to learn everything I could about the injury, surgical procedure, and recovery. My orthopedic surgeon, Dr. Diane English, commented that it was an extremely common injury for young women involved in athletics to sustain, and I wondered why females were more susceptible to ACL tears. This initial question became the basis for my essay. I had already broadly researched the topic for personal reasons, but now with a definitive direction, was able to delve deeper into the subject matter. I was astonished with amount of information and research conducted on such a specific subject. The numerous texts contained several overlapping theories, and I wanted to condense the most relevant information into one all-encompassing analysis. Because of the scientific nature of the topic, the texts were riddled with medical terminology, and therefore “translating” this information into an easily understood, yet engaging, essay was challenging. My teacher’s assistant was especially helpful in this aspect of the essay, pointing out sections that needed further clarification. While writing this essay, I underwent the initial tear, consequent diagnosis, surgery, post operative rehabilitation, and physical therapy. Every day, I learned more about the topic. My doctor and physical therapists provided invaluable insight on ACL tears and their effects on young women involved with athletics. Having suffered from the injury, I was able to add somewhat of a first-hand account to the essay, hopefully adding to both its interest and credibility. Additionally, it provided me with a cathartic outlet, therefore making this essay truly meaningful on a personal basis.