Anterior Cruciate Ligament Injuries and Their Impact on Physical Performance and Mental Health in Young Amateur Athletes

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Abstract:

Approximately 400,000 anterior cruciate ligament tears occur every year in active people and athletes. For many years, ACL injury has been a prevalent and devastating injury for athletes of all ages and playing levels. It has occurred across many sports and can be especially devastating to younger amateur athletes who may be trying to progress their athletic careers. In addition, research within the past five to ten years has pointed towards a higher risk of injury for young athletes, especially females [1]. The goal of this paper is to explore hypotheses to explain this occurrence and to understand ACL injuries in general. The paper is meant to analyze both the physical and mental effects of ACL injury. A survey was conducted that gathers information about young athletes' ACL injuries, from how they got injured to the end of recovery. In this paper, a combination of literature review of pre-existing research and collected data were used to support or contradict findings.

Introduction:

The driving question for my research asks what the effects of ACL injury are, both physically and mentally, on young athletes? There is a lot of research surrounding this topic, so surgery and recovery is much faster than it was ten years ago. For example, the most common surgery graft types are the hamstring tendon, the quadricep tendon, patellar tendon (BPTB), and cadaver grafts (achilles tendon, quadricep tendon, hamstring tendon) [2]. BTPB has been the gold standard for many years and has a lot of durability, but there is a trend in other grafts being recommended to patients depending on their circumstances [2, 3]. In addition to common surgery types, there are differing and developing opinions on physical therapy and recovery following surgery. When completing PT, it is important to note the sport the athlete plays and the surgery they receive. Depending on what graft the patient receives, it may prevent them from reaching milestones sooner, such as running or jumping [4]. Many doctors and researchers favor the idea of having milestones in recovery because milestones can help an athlete achieve them effectively and on a timeline that will make return to sport (RTS) much faster [4].

Injuries can be divided into two categories: contact and non-contact. Contact means the injury happened when a player collided with another player; non-contact means the injury happened while the player was alone with no other players around [1]. Most commonly, a player will land wrong from a jump or someone will fall on their knee causing the ACL to tear [1]. In addition, that risk increases in female athletes. As talked about in our literature review, there is a higher incidence rate for girls than for boys [1]. An athlete may also have multiple tears occur at once. The most common include: medial collateral ligament (MCL), meniscus, cartilage, or osteoarthritis [5]. When other tears occur, like the meniscus, it can also affect how the athlete

goes about their recovery and PT. Having surgery on the meniscus can delay certain milestones, such as flexion and extension of the knee [6].

Overall, while there is research surrounding ACL injury, it is still a devastating injury that requires a long recovery journey. The long recovery can have a tremendous impact on the athlete's mental and physical health. It is one of the worst injuries an athlete can receive, so the more research conducted, the more likely researchers can reduce recovery time and increase a higher return to sport (RTS).

Literature Review:

Evidence shows a higher incidence rate of ACL injury in young athletes, ranging from 13 to their mid-20s. On top of the high incidence rate, there is a high reinjury rate for the same demographic of athletes [4]. Athletes are four times more likely to reinjure their ACL compared to non-athletes [4]. The high incidence rate among young amateurs increases in female athletes. Much of the higher chance of injury for female athletes is attributed to anatomy, such as wider hips or weaker stabilizing muscles [1]. There has also been evidence that women take longer to activate their trunks/ab muscles, which causes them to land without stability [1]. Because they land without core stability, the energy or blow of the land travels to the lower extremities and eventually to the knee joint [1]. On a mental health side, oftentimes, an athlete is physically ready to return to sport, but they feel pressure to return to the level of play they were at before injury, so they continue to put off playing due to fear, stress, or anxiety [7]. This paper reviews the effects of ACL injury on young athletes, both physically and mentally.

Methods:

Data Collection

This paper was conducted through a literature review and a survey. The literature review was used to gain knowledge of the existing research. It helped identify valuable questions to ask in the survey. All procedures were approved by the Institutional Review Board of Crystal Springs Uplands School. The individuals consented to the form in the survey and were told that their information would be kept anonymous. The survey was created through Google Forms. It contained a mixture of multiple choice and free response questions. The audience for our survey was young athletes, both male and female. The age range was 13 to 25 years old, but there were some responses from athletes who were older. The target audience was athletes who did and did not tear their ACL, which created a control group. Geographically, responses came from the west coast and east coast. There was geographic bias due to the location of the creators of the survey. A complete understanding of the athlete's ACL journey was the goal of the survey, from before the injury to the first game of their sport post-injury.

Link to survey: https://forms.gle/aB7GQfbjSpCaFNLB6

Demographic Information

The individual was asked their age, the sport the individual plays or played, the highest level they played at, their sex and gender, race, ethnicity (Latino or Not Latino), socioeconomic status, zip code, body mass index (BMI), their history of smoking and comorbidities.

ACL Injury

The individual was asked if they had ever completed any ACL prevention exercises. Additionally, whether the individual had ever torn their ACL. If they answered yes, they would continue on to section three. If they answered no, the survey would end.

Injury Accident Background

The factors assessed were when the accident occurred and whether it was non-contact or contact as well as the degree of the tear and if there were any additional tears. Possible additional tears include: meniscus, MCL, cartilage, and osteoarthritis. They were asked how long after initial injury did they wait to seek medical help and who they saw first. If they did not go to a specialist first, they were asked if they eventually saw a specialist. Finally, the gender of the provider the person saw was asked.

Surgery Background

The individual was asked to be specific with the options presented by their provider or specialist, such as different grafts and surgical approaches. The reason the individual chose the specific surgery/treatment plan was asked, as well as if they completed any pre-surgical rehab. The specific graft they chose and whether that graft was an allograft or autograft was asked. It is possible for complications, so the individual was asked to provide any post-surgical complications and how long after injury they received surgery.

Post-Surgery Background

Finally, information was gathered about recovery and rehabilitation. The individual was asked if they completed physical therapy (PT), and how long after surgery they started PT. If possible, the individual was asked to provide specific examples of what rehabilitation they completed, such as open kinetic chain exercises (OKC), closed kinetic chain exercises (CKC), or acupuncture. Then, certain milestones and how long it took the individual to achieve them were evaluated. The milestones were: knee flexion and extension, level-ground walking with crutches, walking without crutches, squatting without resistance, knee brace removal, single-leg squat on injured leg, barbell squatting, single-leg hop on injured leg, use the muscle/tendon that was used for the graft during surgery, jogging/running, and a single-leg landing on the injured leg from a running stop. Following PT, the individual was asked when they first returned to non-contact activity for their sport. If their sport is a contact sport, when they first return to contact activity for their sport followed. If they played a non-contact sport, this did not apply. Finally, evaluation of the time after surgery until they played their first game was completed.

Post-Surgery Background: Mental Health

The mental factors and pressures that the individual may have experienced during this process were evaluated. The athlete was asked if they felt any mental/self-pressure to return to their sport or return to the level of play pre-injury. They were asked if they felt any external pressures, and if so, what external pressures (ex: parents, coaches, friends, etc.) If the individual did feel pressure, they were asked if it delayed their RTS. Next, the individual was asked to rank their anxiety levels at five different checkpoints throughout their ACL journey: pre-injury, post-injury, pre-surgery, post-surgery, and 1-2 weeks proceeding to return to play. The individual had to rank their anxiety on a scale from 1 to 5 (1 being no anxiety, 5 being the most extreme anxiety). Finally, the individual was asked if there were any mental health concerns the individual experienced/was diagnosed with related to their ACL injury or surgery.

Statistical Analysis:

Statistical analysis was conducted in R (v. 4.2.1). Differences in outcomes of interest between groups were assessed by chi-squared or fisher's ($n<10$) test for categorical variables and by Wilcoxon Mann-Whitney-U test for continuous variables. Separate analyses were conducted for various comparisons of interest including: ACL tear vs. no ACL tear, hamstring vs. no hamstring, BPTB vs. no BPTB, quadricep vs. no quadricep, OKC vs. no OKC, stress vs. no stress, depression vs. no depression, and anxiety vs. no anxiety.

Results:

Overall, individuals who tore their ACL were significantly younger than those who did not tear their ACL (No ACL Tear = 20, ACL Tear = 22.053, p-val = 0.036).

Surgical Graft Data Results

To start, the different graft types were analyzed along with every variable the survey evaluated for (see Table 1). Individuals who received a BPTB graft took significantly less time to begin using the tendon following surgery (No BPTB = 5.829, BPTB = 0.928, p-val = 0.048). Individuals who chose a BPTB graft were also more likely to choose an autograft as well (No BPTB = 23.08%, BPTB = 75%, p-val = 0.032). Individuals who chose a hamstring graft for surgery were more likely to experience post-surgical range of motion loss (No hamstring = 7.14%, hamstring = 71.43%, p-val = 0.006), but were able to barbell squat much sooner than those who did not select a hamstring graft (No hamstring = 22.833, hamstring = 12.5, p-val = 0.028). Individuals who chose a quadricep graft were significantly less likely to be of higher income (No quadricep = 88.24%, quadricep = 25%, p-val = 0.028). The individuals who chose a quadricep graft also took significantly less time to return to non-contact activity for their sport (No quadricep = 35.333, quadricep = 10, p-val = 0.033). In addition to the different graft types, individuals who chose an autograft took significantly less time to start jogging and running post surgery (No Autograft = 26.286, Autograft = 16, p-val = 0.037). Individuals who chose an autograft were more likely to choose their treatment plan for the reason of a lower retear and

reinjury rate (No Autograft = 29.41%, Autograft = 100%, p-val = 0.021). The individuals who choose their treatment plan for the reason of a lower retear and reinjury rate also experienced increased anxiety levels post-injury (No = 3.529, Yes = 4.75, p-val = 0.035), pre-surgery (No = 3, Yes = 4.5, p-val = 0.024), and post-surgery (No = 3, Yes = 4.5, p-val = 0.034).

Table 1: Graft vs. All Variables Evaluated

Variable	Hamstring	Quadricep	BPTB
Age	18.571	18.25	19.625
Soccer	3 (42.86%)	0 (0%)	4 (50%)
Volleyball	1 (14.29%)	0 (0%)	0 (0%)
Lacrosse	1 (14.29%)	0 (0%)	3 (37.5%)
Tennis	0 (0%)	0 (0%)	1 (12.5%)
Water Polo	1 (100%)	0 (0%)	0 (0%)
Basketball	2 (28.57%)	0 (0%)	0 (0%)
Golf	0 (0%)	0 (0%)	0 (0%)
Track/XC	0 (0%)	1 (25%)	1 (12.5%)
Football	1 (14.29%)	0 (0%)	0 (0%)
Baseball	0 (0%)	0 (0%)	0 (0%)
Field Hockey	0 (0%)	1 (25%)	1 (12.5%)
Softball	0 (0%)	1 (25%)	0 (0%)
Ultimate Frisbee	0 (0%)	0 (0%)	1 (12.5%)
Gymnastics	0 (0%)	2 (50%)	1 (12.5%)
High School	0 (0%)	2 (50%)	0 (0%)
Club/Outside of School Team	5 (71.43%)	0 (0%)	3 (37.5%)
College	1 (14.29%)	2 (50%)	4 (50%)
Amateur	0 (0%)	0 (0%)	1 (12.5%)
Professional	1 (14.29%)	0 (0%)	0 (0%)
Female/Woman	5 (71.43%)	4 (100%)	7 (87.5%)
Asian/Asian American	3 (42.86%)	4 (100%)	3 (37.5%)
White	4 (57.14%)	**0 (0%) ^**	**8 (100%) ~**
Hispanic/Latino	0 (0%)	1 (25%)	0 (0%)
Middle Eastern/Northern Africa	0 (0%)	1 (25%)	0 (0%)
Black/African American	0 (0%)	0 (0%)	0 (0%)
American Indian/Alaska Native	0 (0%)	1 (25%)	0 (0%)
Multiracial	0 (0%)	2 (50%)	3 (37.5%)

Low Income	0 (0%)	0 (0%)	0 (0%)
Middle Income	0 (0%)	2 (50%)	0 (0%)
High Income	7 (100%)	**1 (25%) ^**	7 (87.5%)
BMI	22.714	22.2	23.512
Yes Smoking	1 (14.29%)	0 (0%)	1 (12.5%)
Asthma	1 (14.29%)	1 (25%)	3 (37.5%)
Hypertension	0 (0%)	0 (0%)	1 (12.5%)
ACL Prevention	4 (57.14%)	2 (50%)	5 (62.5%)
Contact	3 (42.86%)	0 (0%)	1 (12.5%)
Non-Contact	3 (42.86%)	4 (100%)	6 (75%)
Full Tear	7 (100%)	4 (100%)	8 (100%)
Partial Tear	0 (0%)	0 (0%)	0 (0%)
Cartilage	0 (0%)	0 (0%)	0 (0%)
MCL	2 (28.57%)	0 (0%)	0 (0%)
Meniscus	4 (57.14%)	2 (50%)	4 (50%)
Time from Injury to Help (Days)	1.833	46.125	1.625
ER/Urgent Care	4 (57.14%)	2 (50%)	4 (50%)
Orthopedic/Sports Medicine Doctor	3 (42.86%)	1 (25%)	4 (50%)
Athletic Trainer	0 (0%)	1 (25%)	0 (0%)
Male Specialist	7 (100%)	3 (75%)	7 (87.5%)
Female Specialist	0 (0%)	1 (25%)	1 (12.5%)
Low Retear/Reinjury Rate	1 (14.29%)	0 (0%)	3 (37.5%)
Best Choice for Sport/Level	1 (14.29%)	0 (0%)	1 (12.5%)
Faster Return to Play/Return to Sport	3 (42.86%)	1 (25%)	4 (50%)
Faster Recovery	3 (42.86%)	2 (50%)	2 (25%)
Guaranteed Recovery/Best Long Term	0 (0%)	2 (50%)	1 (12.5%)
Pre-Surgical Rehab	5 (71.43%)	4 (100%)	8 (100%)
Autograft	1 (14.29%)	2 (50%)	**6 (75%) ~**
Allograft	0 (0%)	1 (25%)	0 (0%)
Complications	**5 (71.43%) ***	0 (0%)	2 (25%)
Nerve Damage	2 (28.57%)	0 (0%)	0 (0%)
Second Incision	0 (0%)	0 (0%)	1 (12.5%)

Range of Motion Loss	**5 (71.43%) ***	0 (0%)	1 (12.5%)
Time From Injury to Surgery (Weeks)	3.316	3.072	4.326
Rehab/PT	7 (100%)	4 (100%)	8 (100%)
Time From Surgery to PT (Weeks)	2.51	0.428	0.653
Knee Flexion/Extension (Weeks)	1.286	0.32	0.91
Ground Level Walking with Crutches (Weeks)	2.238	0.285	0.41
No Crutches (Weeks)	6.286	4	2.938
Squatting Without Resistance (Weeks)	8.071	5.5	6.75
Remove Brace (Weeks)	6.333	9	5.875
Single Leg Squat (Weeks)	13.4	12	11
Barbell Squatting (Weeks)	**12.5 ***	21.333	21.429
Injured Leg Single Hop (Weeks)	14.2	22.667	19.143
Muscle/Tendon Used for Surgery Graft Used Post-Surgery (Weeks)	4.4	6.072	**0.928 ~**
Jogging and Running (Weeks)	22.4	18.667	16.8
Single Leg Landing from Running Stop (Weeks)	30	36	25.2
Return to Non-Contact Activity for Sport (Weeks)	42	10	32.667
Return to Contact Activity for Sport (Weeks)	56.4	N/A	52
First Game Post-Surgery (Weeks)	60.8	60	52.8
Mental Self-Pressure to Return to Sport	5 (71.43%)	3 (75%)	8 (100%)
Anxiety Level Pre-Injury	1.571	1.25	1.375
Anxiety Level Post-Injury	3.857	3.5	3.625
Anxiety Level Pre-Surgery	3.429	3.5	3.375
Anxiety Level Post-Surgery	3	3.75	3.625
Anxiety Level 1 to 2 Weeks Before Return to Sport	3.286	2.75	**4 ~**
Post-Surgical Stress	0 (0%)	1 (25%)	**4 (50%) ~**
Post-Surgical Depression	1 (14.29%)	1 (25%)	2 (25%)
Post-Surgical Anxiety	0 (0%)	1 (25%)	**4 (50%) ~**

Post-Surgical Eating Disorder/Body Dysmorphia	0 (0%)	0 (0%)	2 (25%)
Post-Surgical PTSD	0 (0%)	1 (25%)	0 (0%)
Post-Surgical Fear	0 (0%)	1 (25%)	1 (12.5%)
Post Surgical Panic Attacks	1 (14.29%)	0 (0%)	0 (0%)

* = p-val <0.05 (Hamstring to Other)
^ = p-val <0.05 (Quadricep to Other)
~ = p-val <0.05 (BPTB to Other)

Recovery Data Results

In addition to the importance of treatment, there were some results in relation to open kinetic chain (OKC) exercises (see Table 2). Individuals who completed OKC exercises during recovery were more likely to have additionally completed closed kinetic chain (CKC) exercises (0 = 6.25%, 1 = 100%, p-val = 0). However, individuals who completed OKC exercises took significantly longer to achieve a single leg hop on the injured leg (0 = 16.692, 1 = 26, p-val = 0.036), a single leg landing from a running stop (0 = 26.571, 1 = 36, p-val = 0.044), and a single leg squat on the injured leg (0 = 11.692, 1 = 19, p-val = 0.034).

Table 2: OKC vs. All Recovery Variables

Variable	OKC
CKC	**5 (100%) ***
Strength Training	1 (20%)
Range of Motion Exercises	0 (0%)
Running/Jumping	0 (0%)
Stretching	1 (20%)
Technology Recovery Devices	2 (40%)
PT	0 (0%)
Knee Flexion/Extension (Weeks)	0.892
Ground Level Walking with Crutches (Weeks)	2.686
No Crutches (Weeks)	7.658
Squatting Without Resistance (Weeks)	9
Remove Brace (Weeks)	15.8
Single Leg Squat (Weeks)	**19 ***
Barbell Squatting (Weeks)	28

Injured Leg Single Hop (Weeks)	**26 ***
Muscle/Tendon Used for Surgery Graft Used Post-Surgery (Weeks)	7.75
Jogging and Running (Weeks)	26
Single Leg Landing from Running Stop (Weeks)	**36 ***
Return to Non-Contact Activity for Sport (Weeks)	20
Return to Contact Activity for Sport (Weeks)	56
First Game Post-Surgery (Weeks)	60

*** =** p-val <0.05 (OKC to Other)

Mental Health Data Results

Mental health is commonly seen post-surgery and can affect an athlete's ability to return to sport quickly (see Table 3). Individuals who experienced post-surgical stress had significantly higher levels of anxiety post-injury (No Stress = 3.5, Stress = 4.6, p-val = 0.047) and pre-surgery (0 = 2.938, 1 = 4.4, p-val = 0.022). The individuals who experienced post-surgical stress were more likely to have chosen a BPTB graft (0 = 25%, 1 = 80%, p-val = 0.047) and were more likely to have played sports at the college level (0 = 25%, 1 = 80%, p-val = 0.047). Additionally, individuals who experienced post-surgical stress took significantly longer to receive help after injury (0 = 1.367, 1 = 38.6, p-val = 0.031).

Individuals who experienced post-surgical depression were more likely to experience co-current post-surgical anxiety (0 = 11.76%, 1 = 75%, p-val = 0.028). The individuals were also more likely to be multiracial (0 = 11.76%, 1 = 75%, p-val = 0.028) and had significantly higher BMIs (0 = 22.853, 1 = 26.75, p-val = 0.044).

Individuals who experienced post-surgical anxiety were more likely to be multiracial (0 = 6.25%, 1 = 80%, p-val = 0.004). They were also more likely to have played at the college level in their sport (0 = 25%, 1 = 80%, p-val = 0.047).

Individuals reporting having experienced an eating disorder or body dysmorphia post-surgery had extremely high levels of anxiety pre-surgery (0 = 3.105, 1 = 5, p-val = 0.042) and post-surgery (0 = 3.105, 1 = 5, p-val = 0.042). Those individuals were also more likely to experience co-current anxiety (0 = 15.79%, 1 = 100%, p-val = 0.048) and stress post-surgery (0 = 15.79%, 1 = 100%, p-val = 0.048).

Finally, individuals who experienced post-surgical fear were more likely to also have asthma as a comorbidity (0 = 15.79%, 1 = 100%, p-val = 0.048).

Table 3: Mental Health vs. All Variables Evaluated

Variable	Stress	Depression	Anxiety
Age	19.2	21.75	20.2
Soccer	1 (20%)	0 (0%)	2 (40%)
Volleyball	0 (0%)	0 (0%)	0 (0%)
Lacrosse	2 (40%)	0 (0%)	0 (0%)
Tennis	1 (20%)	1 (25%)	1 (20%)
Water Polo	0 (0%)	0 (0%)	0 (0%)
Basketball	0 (0%)	0 (0%)	0 (0%)
Golf	0 (0%)	0 (0%)	0 (0%)
Track/XC	1 (20%)	0 (0%)	1 (20%)
Football	0 (0%)	1 (25%)	0 (0%)
Baseball	0 (0%)	0 (0%)	0 (0%)
Field Hockey	0 (0%)	0 (0%)	0 (0%)
Softball	0 (0%)	0 (0%)	0 (0%)
Ultimate Frisbee	0 (0%)	0 (0%)	1 (20%)
Gymnastics	1 (20%)	2 (50%)	2 (40%)
High School	0 (0%)	0 (0%)	0 (0%)
Club/Outside of School Team	1 (20%)	0 (0%)	1 (20%)
College	**4 (80%) ***	3 (75%)	**4 (80%) ~**
Amateur	0 (0%)	0 (0%)	0 (0%)
Professional	0 (0%)	1 (25%)	0 (0%)
Female/Woman	4 (80%)	3 (75%)	4 (80%)
Asian/Asian American	2 (40%)	3 (75%)	4 (80%)
White	4 (80%)	3 (75%)	4 (80%)
Hispanic/Latino	0 (0%)	0 (0%)	0 (0%)
Middle Eastern/Northern Africa	1 (20%)	1 (25%)	1 (20%)
Black/African American	0 (0%)	0 (0%)	0 (0%)
American Indian/Alaska Native	0 (0%)	0 (0%)	0 (0%)
Multiracial	2 (40%)	**3 (75%) ^**	**4 (80%) ~**
Low Income	0 (0%)	0 (0%)	0 (0%)
Middle Income	1 (20%)	1 (25%)	1 (20%)
High Income	3 (60%)	3 (75%)	4 (80%)
BMI	24.18	**26.75 ^**	24.56
Yes Smoking	1 (20%)	1 (25%)	1 (20%)

Asthma	1 (20%)	0 (0%)	2 (40%)
Hypertension	1 (20%)	0 (0%)	1 (20%)
ACL Prevention	3 (60%)	4 (100%)	3 (60%)
Hamstring	0 (0%)	1 (25%)	0 (0%)
Quadricep	1 (20%)	1 (25%)	1 (20%)
BPTB	**4 (80%) ***	2 (50%)	**4 (80%) ~**
Contact	1 (20%)	1 (25%)	1 (20%)
Non-Contact	4 (80%)	3 (75%)	4 (80%)
Full Tear	5 (100%)	4 (100%)	5 (100%)
Partial Tear	0 (0%)	0 (0%)	0 (0%)
Cartilage	0 (0%)	0 (0%)	0 (0%)
MCL	0 (0%)	1 (25%)	0 (0%)
Meniscus	3 (60%)	2 (50%)	4 (80%)
Time from Injury to Help (Days)	**38.6 ***	46.75	38
ER/Urgent Care	2 (40%)	1 (25%)	1 (20%)
Orthopedic/Sports Medicine Doctor	2 (40%)	2 (50%)	3 (60%)
Athletic Trainer	1 (20%)	1 (25%)	1 (20%)
Male Specialist	4 (80%)	0 (0%)	4 (80%)
Female Specialist	1 (20%)	4 (100%)	1 (20%)
Low Retear/Reinjury Rate	**3 (60%) ***	1 (25%)	2 (40%)
Best Choice for Sport/Level	0 (0%)	0 (0%)	0 (0%)
Faster Return to Play/Return to Sport	1 (20%)	3 (75%)	3 (60%)
Faster Recovery	1 (20%)	1 (25%)	2 (40%)
Guaranteed Recovery/Best Long Term	2 (40%)	1 (25%)	1 (20%)
Pre-Surgical Rehab	5 (100%)	4 (100%)	5 (100%)
Autograft	4 (80%)	3 (75%)	**5 (100%) ~**
Allograft	0 (0%)	0 (0%)	0 (0%)
Complications	1 (20%)	1 (25%)	0 (0%)
Nerve Damage	0 (0%)	0 (0%)	0 (0%)
Second Incision	1 (20%)	0 (0%)	0 (0%)
Range of Motion Loss	0 (0%)	1 (25%)	0 (0%)
Time From Injury to Surgery	4.742	3.038	4.43

(Weeks)			
Rehab/PT	5 (100%)	4 (100%)	5 (100%)
Time From Surgery to PT (Weeks)	1.035	0.605	0.742
Knee Flexion/Extension (Weeks)	0.8	0.927	0.97
Ground Level Walking with Crutches (Weeks)	0.428	1.57	0.484
No Crutches (Weeks)	4.5	5.75	4
Squatting Without Resistance (Weeks)	8.4	7.75	7.4
Remove Brace (Weeks)	8.6	9.75	8.6
Single Leg Squat (Weeks)	13.5	12	11.5
Barbell Squatting (Weeks)	23.2	26.5	24.4
Injured Leg Single Hop (Weeks)	**25 ***	22	20
Muscle/Tendon Used for Surgery Graft Used Post-Surgery (Weeks)	2.785	4.75	2.41
Jogging and Running (Weeks)	19	19	15.2
Single Leg Landing from Running Stop (Weeks)	28.667	26.667	**22.5 ~**
Return to Non-Contact Activity for Sport (Weeks)	32	34	**20.8 ~**
Return to Contact Activity for Sport (Weeks)	64	92	**30 ~**
First Game Post-Surgery (Weeks)	74	64	42.667
Mental Self-Pressure to Return to Sport	5 (100%)	4 (100%)	5 (100%)
Anxiety Level Pre-Injury	1.8	1.75	1.6
Anxiety Level Post-Injury	**4.6 ***	3.75	3.6
Anxiety Level Pre-Surgery	**4.4 ***	4	4
Anxiety Level Post-Surgery	4.2	3.75	3.8
Anxiety Level 1 to 2 Weeks Before Return to Sport	4	4	4
Post-Surgical Stress	N/A	3 (50%)	3 (60%)
Post-Surgical Depression	2 (40%)	N/A	**3 (60%) ~**
Post-Surgical Anxiety	3 (60%)	**3 (75%) ^**	N/A
Post-Surgical Eating Disorder/Body Dysmorphia	2 (40%)	1 (25%)	2 (40%)

Post-Surgical PTSD	1 (20%)	1 (25%)	1 (20%)
Post-Surgical Fear	0 (0%)	0 (0%)	1 (20%)
Post Surgical Panic Attacks	0 (0%)	0 (0%)	0 (0%)

* = p-val <0.05 (Stress to Other)
^ = p-val <0.05 (Depression to Other)
~ = p-val <0.05 (Anxiety to Other)

Limitations/Analysis/Conclusion:

Limitations

Limitations to the study were evident in the results. There was a geography bias due to where and who the survey was sent out to. Many of the participants in the survey were from the west coast and the east coast. In addition to geography, there was a very small sample size. Only a certain amount of responses were able to be gathered in a limited amount of time, so the sample size is quite small for many of the results to be comparable to the current literature. There was also a bias in the demographic of individuals who filled out the survey. Individuals who have torn their ACL are more likely to be willing to fill out the survey than those who have not. People who have not torn their ACL were encouraged to fill out the survey, therefore creating a control group. Approximately 51% of individuals who filled out our survey were individuals who have torn their ACL.

Analysis

There was no correlation or higher incidence rate in young female athletes. This finding may be attributed to our small sample size.

The results showed an increased number of complications for individuals who received a hamstring graft for ACL reconstruction. 71.43% of the individuals who received a hamstring graft experienced range of motion loss after surgery (Table 1). As seen in recent studies, there has been a trend of reduced active knee flexion while standing and passive knee flexion range in hamstring tendon groups compared to quadricep tendon groups [6]. There is an indication that taking an autograft from the patient's hamstring can cause some range of motion loss in the reconstructed knee [6]. The hamstring helps to bend the knee and provide flexibility to the knee, so when the flexibility of the hamstring is impacted, it can affect knee flexion and extension. As the field of ACL reconstruction progresses, there may need to be more rehabilitation measures put in place to prevent worsening knee range of motion. Earlier stretching or exercising measures may reduce this problem. In addition, taking time to evaluate different surgical grafts and understanding their pros and cons can help avoid this problem.

Another finding in our results shows individuals who received a BPTB graft were able to utilize the tendon much faster post-surgery, averaging 0.928 weeks (Table 1). Individuals who received a hamstring or quadricep graft had to wait longer before utilizing the muscle

post-surgery, averaging 4.4 and 6.072 weeks, respectively (Table 1). In recent literature, results have pointed to a necessity for more time for the tendon to heal and regenerate [8]. Hamstring tendon regeneration is important for future use of the muscle, and sometimes there are complications in the regeneration of the tendon. If the tendon is not regenerated properly, it can cause complications, such as range of motion loss at the knee joint [8, 9]. Unfortunately, it is still unclear why individuals who received a hamstring tendon ACL reconstruction experience a range of motion loss [6]. A BPTB tendon may take less time to heal considering the graft is not coming from a major muscle in the leg. Although it may seem as though the waiting time to utilize the tendon post-surgery may set hamstring tendon and quadricep tendon patients back, they still make full recoveries returning back to full strength [8]. BPTB graft patients were also seen to be more likely to have post-surgical stress and anxiety compared to non-BPTB graft patients (Table 1). This is a more novel finding and may be related to the bias of a small sample size. Because of the small sample size, it is inadequate to determine if these findings are relevant or important.

Individuals who completed OKC exercises were highly likely to complete CKC exercises during physical therapy (Table 2). It is interesting that the individuals in this study completed both OKC and CKC exercises because in the literature, these two types of PT are often compared to each other. The purpose of OKC and CKC exercises are to reduce range of motion loss, increase muscle strength, and maintain overall functionality of the knee joint. In recent literature, there has not been much of a difference in outcomes for doing either OKC or CKC [10, 11]. In addition to CKC exercises, individuals who completed OKC exercises were seen to take longer to reach certain milestones in ACL rehabilitation. For single leg exercises on the injured leg, they took significantly longer to single leg squat, single leg hop, and single leg landing from a running stop (Table 2). This finding may be a more novel discovery considering recent literature has pointed to benefits from OKC exercises in rehabilitation [11]. Early use of OKC and CKC exercises post-surgery have shown an increase in correction of strength deficits for the hamstring and quadricep. Our findings may have been due to small sample bias, and it may be inadequate to use these findings to make a claim towards the use of OKC.

In the last section of our results, there was an increase in prevalence of mental health issues in college athletes. College athletes suffering from ACL injury were more likely to experience post-surgical stress and anxiety (Table 3). This is not unheard of, especially at the collegiate level. In recent years, there have been trends of high levels of mental health problems for collegiate level athletes [12]. Mental health problems increase with athletes who have experienced injuries, such as tearing their ACL [12]. In our study, 80% of the college athletes experienced anxiety and stress related to ACL injury, which is quite a high percentage. Oftentimes, this stress and anxiety can be related to a pressure to return to the level of playing the athlete was at before injury [7]. While many colleges try to implicate mental health resources, mental health problems are still a widely common issue among collegiate athletes. Continuing to increase efforts for mental health services, specifically for collegiate athletes, can help reduce the risk for mental health issues.

Our results also showed high levels of anxiety post-injury and pre-surgery for individuals who had ACL injury related stress (Table 3). Individuals who experienced ACL injury related depression were also more likely to experience co-current anxiety and vice versa (Table 3). In recent literature, there has been a high link between ACL injury and anxiety, depression, and stress [13]. It has been seen that individuals who undergo ACL reconstruction are subject to depression within the first 6 weeks of ACL reconstruction [13]. However, in the literature, anxiety levels were not alarmingly high. This observation does slightly contradict the findings of our study. However, our sample size may be too small for the findings to be adequate for comparison to the current literature. Similarly, increased efforts to help athletes who have suffered from ACL injury, not just collegiate athletes, can help reduce the levels of mental health issues. In recent literature, there has been an increase in the time it takes to RTS due to self pressure. Mental health resources may help athletes be able to return to their sport much quicker and help their overall recovery.

Conclusion

There were no gender disparities between males and females in ACL injury. Individuals who received a hamstring graft were more likely to experience complications, specifically range of motion loss. BPTB graft patients were able to utilize the tendon much quicker post-surgery than individuals who received a hamstring or quadricep graft. Individuals who completed OKC exercises were highly likely to also complete CKC exercises in physical therapy. However, athletes who used OKC exercises had more difficulty achieving certain physical therapy milestones. College athletes experienced higher levels of stress and anxiety related to their ACL injury. Many individuals experienced multiple mental health issues related to their injury. Overall, my research provides more insight into how physically and mentally demanding the ACL injury process is, but it explores possible ways to improve surgical and rehabilitation efforts.

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