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Innovative care of individuals in the athletic training room: A case series

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Innovative Care of Individuals in the Athletic Training Room: A Case Series

An Honors College Project Presented to

the Faculty of the Undergraduate

College of Health and Behavioral Studies

James Madison University

by Kathryn E. Young

Accepted by the faculty of the Athletic Training Education Program, James Madison University, in partial fulfillment of the requirements for the Honors College.

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PUBLIC PRESENTATION

This work is accepted for presentation, in part or in full, at the Virginia Athletic Trainers' Association Conference on February 23, 2019.

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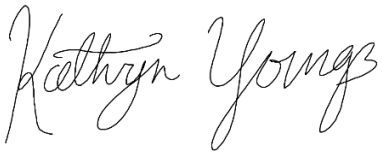
PREFACE

Athletic trainers are healthcare professionals who specialize in the prevention, diagnosis, treatment, and rehabilitation of injuries in an athletic population.[1] Many people think of them of the people that are seen during sports programming running on the field when someone gets hurt, but they are so much more than that. These professionals are vital to the success and risk-management of sports medicine programs of all levels. Athletic trainers can produce an estimated 7 time return on investment for these programs with their preventative care.[1] They have five important domains of their job as defined by the Board of Certification including injury and illness prevention and wellness promotion; examination, assessment, and diagnosis; immediate and emergency care; therapeutic intervention; and healthcare administration and professional responsibility.[2]

This case series focuses on athletic trainers practicing in traditional sports setting and acting in the therapeutic intervention and examination, assessment, and diagnosis domains of the profession. However, athletic trainers are employed in a myriad of different settings from the military to performing arts to industrial profession settings. They provide healthcare for people of all walks of life in conjunction with other healthcare professional.

The following portfolio showcases athletic trainers on the cutting edge of sports medicine. For them, though, it's just another day at the "office." As this portfolio unfolds, I urge to reader to imagine how these patients would feel and where they would be without the services provided by their athletic trainer as well as the time committed and dedication to wellness that the athletic trainer demonstrated in each of these cases.



Kathryn Young, ATS

March 2019

AKNOWLEDGEMENTS

I would first like to thank Dr. Connie Peterson for her incredible dedication to her students' pursuit of intentional education and research. Without her, this project would not have been possible. Thank you for your time, knowledge, and input from the beginning.

I would also like to thank the selfless athletic trainers, physicians, and surgeons who provided the care for these patients. Sports medicine is not an easy or uncomplicated field. Thank you for your dedication to the care of these patients' and the incredible teaching that occurred for the students associated with each case.

Finally, thank you to the James Madison University Athletic Training Education Program faculty for providing the opportunity and resources to create this project.

ABSTRACT

This work follows three unique cases of athletic injuries and/or injuries in patients. These cases were selected because of the innovative nature of the rehabilitation process conducted by the sports medicine team via the athletic training room or the unique nature of the injury/case.

The first is a concussion sustained from a motor vehicle accident in a collegiate female thrower. This is unique because it's a non-sport related concussion handled as an athletic trainer would handle a sports related concussion. It also demonstrates a new unique protocol for concussion management.

The second case is a patient with two complete anterior cruciate ligament tears in contralateral knees sustained at different times with different surgical repair techniques. The patient is a collegiate, female lacrosse athlete. This case is unique because of the dual injuries as the different surgical procedures in the same patient.

The third and final case is a collegiate baseball player who sustained an ulnar collateral ligament tear due to overuse. It was surgically repaired and rehabilitated with the Advanced Thrower's Ten Protocol rather than the Thrower's Ten Protocol which makes this case more unique.

Keywords: concussion, rehabilitation, anterior cruciate ligament, ulnar collateral ligament, surgery, athletic training

Case 1

Concussion: A new model of care.

Kathryn Young

November 2017

Introduction

"Concussion" has recently become a major buzz-word in the medical community as well as households. As many as 3.8 million sports related concussions are estimated to occur every year.[3, 4] Many people, especially athletes, have experienced the negative impacts of a concussion either first-hand or second-hand through a friend, teammate, or colleague. Although there is a high prevalence of this injury, there is not always a high level of understanding about this injury. Even the National Athletic Trainer's Association (NATA) has said that concussions are "one of the most complex injuries sports medicine professionals face."[3] In 2008 at the 3rd International Conference on Concussion in Sport, a concussion was defined as a "complex pathophysiological process affecting the brain" caused by a "direct blow to the head, face or neck or a blow to elsewhere in the body with 'impulsive' force transmitted to the head" that may or may not involve a loss of consciousness and/or amnesia.[5] Basically, there is a force exerted on the body that causes the brain to come into contact with the skull.[3, 5] It is often difficult to diagnose because concussions present differently in different people and the damage they cause often does not show up in brain imaging.[3, 5] The most commonly reported symptoms include headache, dizziness, fogginess, slowed reaction times, drowsiness or fatigue, difficulty concentrating, difficulty remembering or amnesia, and difficulty sleeping.[4, 5, 6] These functional symptoms are thought to be mainly caused by the change in brain metabolism after the force.[3] The brain and its' neurons need more energy to function normally and heal at the same time, but the body still has the same amount of energy. So, it must split time and try to do both. This is why the typically recommended protocol is complete rest until symptoms have resolved.[3, 5] Typically this takes between 7-10 days.[5] Once symptoms have resolved in the athletic population a five-step, graded return to sport protocol is recommended.[3, 5] The suggested protocol and its

goals can be found in Table 1. However, this traditionally recommended protocol has recently been challenged by studies showing that strict rest may be harmful,[7] moderate activity post-concussion may be beneficial,[8] and vestibular therapy may help alleviate symptoms.[9, 10, 11]This case examines these claims in one individual.

Case

The patient, a 19-year-old female thrower for a college track program, presented with immediate headache after hitting her head on a window in a vehicular accident while home during a weekend break. The headache continued throughout the night as well as neck pain. The patient was suspected to have a concussion by the local urgent care the day following the accident. It is unclear whether the urgent care examined the patient with any advance imaging. During a follow-up with the team physician two days after the incident the patient presented with headache, pain with palpation in the posterior and lateral neck muscles, fatigue, poor concentration, photophobia, phonophobia, and visual motor sensitivity all described as moderate. A King-Devick Test, a recognized concussion test that looks mainly at eye tracking by timing a patient's ability to follow and read back an abnormal line of numbers, was administered and showed a 15 second increase from baseline. She reported all 22 symptoms in the Standardized Concussion Assessment Tool Version 2 (SCAT2) with a total reporting intensity score of 78/132 (Table 2). The patient was prescribed modified classwork for 5 days and eye exercises (Figures 1-7). The team's physician and team's athletic trainers worked together from here to monitor symptoms and administer the new rehabilitation protocol that included vestibular therapy and moderate activity. Symptoms were monitored by administering SCAT3 symptom surveys daily. Selected symptoms that line up with the identified symptoms in a Vestibular Oculomotor

Screening (VOMS) test, an identified concussion screening tool used for baseline testing in conjunction with the King-Devick test, and the total symptoms scores from the SCAT3 survey are outlined in Table 2. The treatment protocol combined vestibular oculomotor therapy, light cardiovascular exercise, power-based exertional exercise, and sport-specific functional exercises. The protocol was tailored to the patient and the patient's symptoms as to not exacerbate any symptoms. To this date, the protocol can be separated into 10 distinct progressive programs outlined in Table 3. Each rehabilitation session was accompanied by therapeutic modalities to decrease neck pain and warm-up the neck muscles. This included the use of one or more of the following: moist heat packs, stretching, Graston technique, dry needling, and electrical stimulation.

Discussion

There are two parts to this case that seem to vary significantly from the "normal" sports related concussion (SRC), mostly to the mechanism of injury being a motor-vehicle accident (MVA). The duration of symptoms experienced by the patient were quite longer than the average SRC and the rehabilitation protocol used by the clinicians was different than most typical concussion protocols.

This patient did not return to her baseline Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), a computerized concussion assessment tool also used in the sports medicine department, for 28 days. A normal SRC typically resolves in 7-10 days.[5] However, this was not a SCR. The duration of this concussion is not abnormal based on pre-disposing factors and mechanism of injury in this case. Studies have shown that both the female sex, [4, 5] patients experiencing concussion due to a MVA,[6] and patients with whiplash associated with concussion[9]

(common with MVA) experience more severe symptoms with a longer duration.[5, 6, 9] One study found that 74.5% of males recovered from a concussion in 3 weeks or less, while only 42.2% of females recovered in 3 weeks or less.[6] Due to females having smaller necks on average than their male counterparts, it is hypothesized that more force may be transferred to the impact between the brain and the skull since their smaller necks may not absorb shock as efficiently.[6] Additionally, concussions due the MVA often occur at a much higher velocity than SRC. Because there is more force present in the collision, more force is available to be transferred into the contact of the skull and the brain possibly causing more damage and increasing the duration of symptoms.

Information on duration and symptoms due to non-sport mechanism is extremely important because non-sport concussions are prevalent and possibly debilitating in all populations. Kerr et. all found in a study on middle school athletes that 28% of all concussions from 2015-2016 in nine U.S. middle schools were sustained during non-school sanctioned sporting events.[12] A Massachusetts school nurse reported anecdotally in 2015 that only 7 of 16 concussions managed under the school's care were sport related. The other 9 occurred in other settings such as accidents and recreation activity.[13] Another study found that 1/3 concussions handled in a Connecticut hospital between 2007-2010 were caused by an MVA.[6] Often times these patients don't have access to the everyday care and monitoring of a healthcare provider, such as the care that athletic trainers often provide for theirpatients. It is imperative for the sake of the patient that all affected by concussions have access to adequate information, care, and rehabilitation.

The other piece is the new, quasi-experimental concussion rehabilitation protocol. Although, this exact protocol has not been used before similar rehabilitation strategies and exercises have been used in previous studies showing either a decrease in patients' symptoms or no adverse effects due to the therapy.[4, 9, 10, 11] A study that used similar modalities (stretching, pain free range of motion that did not provoke symptoms, and cervical traction/joint mobilizations) and similar therapeutic exercises (individualized program, gaze stabilization exercises, balance exercises, and dynamic exercises) to the ones used in this case found that patients who participated in the experimental protocol were "10.27 times more likely to be medically cleared to return to sport within 8 weeks" than patients participating in the traditional return to play protocol.[9] This is a major difference in recovery time for patients using the new protocol which means a faster return to the patients' normal lives, whether that includes sport or not. This is also important for students in academic settings. It is important to look at the return-to-learning in addition to return-to-sport in student-athletes and non-athlete students participating in academic activity. School nurses in Massachusetts perceived more benefit to shorter rest and increased academic accommodation in older students compared to younger.[13] Because of this, the new protocol potentially has great clinical importance to clinicians using patient-oriented outcomes because it can significantly decrease the severity and duration of post-concussive symptoms thus improving their overall quality of life. In one study, 75% of patients reported a one level decrease (i.e. severe to moderate or moderate to mild) in perceived disability due to post-concussion dizziness because of vestibular rehabilitation.[10] This also shows improved quality of life due to the new protocol because it increases independence and confidence in patients by decreasing self-perceived disability.

Conclusion

Concussions are a serious and wide-spread injury that can greatly impact the quality of life in both athletes and non-athletes alike by producing symptoms such as headache, dizziness, fatigue, difficulty concentrating, confusion, amnesia, and difficulty sleeping.[3, 4, 5, 6] Any intervention that could decrease the severity and duration of these symptoms should be of high interest to the clinical practice of any medical professional dealing with concussion. Vestibular therapy is an example of an intervention which has been shown in multiple studies to do just that.[4, 9, 10, 11] This is why this non-traditional protocol was chosen as the primary intervention for this case. The patient presented with severe headache, neck pain, and dizziness lasting more than two weeks due to a concussion sustained after an MVA. Even though this case follows a college athlete, technically it was not an SRC. So, the symptoms and their duration were not abnormal when compared to those with similar pre-disposing factors and mechanism of injury/concussion.[5, 6, 9] However, both SRC and concussions due to MVA present similarly and have similar rehabilitation recommendations.[3, 5, 6] Like patients in other studies that used a similar protocol,[9, 10, 11]the patient in this case also saw a decrease in symptom severity (Table 2). This patient also saw no long-lasting negative effects of this treatment up to this point. Although this protocol is still not widely accepted or reccomended,[3, 5] its efficacy is being evaluated in small steps[4, 9, 10, 11] and there is evidence backing the theory behind it. [7, 8]

Table 1. Description of recommended graded protocol for return to sport after concussion. Steps are to be separated by 24 hours. If the patient experiences a return of symptoms at any step, then they must return to the pervious step until symptom free.[3, 5]

Step	**Qualification**	**Objective**
Step 1	No activity, rest only	Recovery
Step 2	Light aerobic activity	Increase heart rate
Step 3	Sport-specific exercise	Add movement
Step 4	Non-contact training drills	Exercise, coordination, and add cognitive load
Step 5	Full-contact practice	Restore confidence and assess functional skills
Step 6	Competition	Return to normal function

Table 2. Self-identification of symptom level by patient using the Standardized Concussion Assessment Tool (SCAT) Survey or Vestibular Oculomotor Screening (VOMS) Test. Nausea not scored 9/25; totals have been altered to reflect this change. Nausea and "don't feel right" not scored 10/11; totals have been altered to reflect this change

Days since injury	Test	Headache	Dizziness	Nausea	Fogginess	Neck Pain	Total Symptoms	Total Score
Pre-injury	VOMS	0/10	0/10	0/10	0/10	n/a	0/4	n/a
4	SCAT2	5/6	3/6	4/6	5/6	5/6	22/22	78/132
5	SCAT2	4/6	4/6	5/6	5/6	3/6	22/22	81/132
7	SCAT2	4/6	4/6	4/6	5/6	5/6	22/22	84/132
9	SCAT3	4/6	3/6	--*	4/6	3/6	19/21*	61/126*
11	SCAT2	5/6	4/6	2/6	3/6	3/6	22/22	73/132
12	SCAT2	5/6	3/6	2/6	4/6	4/6	22/22	72/132
13	SCAT2	4/6	2/6	2/6	4/6	3/6	22/22	62/132
14	SCAT2 Pre-Rehab	5/6	4/6	3/6	4/6	4/6	22/22	67/132
14	SCAT2 Post-Rehab	5/6	4/6	3/6	4/6	4/6	22/22	73/132
17	SCAT2	4/6	2/6	2/6	4/6	3/6	22/22	67/132
18	SCAT2	5/6	3/6	3/6	3/6	5/6	22/22	73/132
19	SCAT2	4/6	2/6	1/6	2/6	3/6	22/22	50/132
20	SCAT2	3/6	2/6	2/6	2/6	3/6	22/22	46/132
21	SCAT2	4/6	3/6	1/6	2/6	3/6	22/22	47/132
24	SCAT2	4/6	3/6	2/6	3/6	2/6	22/22	60/132
25	SCAT2	3/6	2/6	1/6	2/6	2/6	22/22	54/132
26	SCAT2	3/6	2/6	--**	2/6	2/6	20/20**	46/120**

Days since injury	Test	Headache	Dizziness	Nausea	Fogginess	Neck Pain	Total Symptoms	Total Score
27	SCAT2	3/6	2/6	1/6	2/6	3/6	22/22	50/132
28	SCAT2	3/6	2/6	2/6	0/6	4/6	20/22	39/132
31	SCAT2	3/6	1/6	1/6	0/6	2/6	17/22	24/132
32	SCAT2	4/6	3/6	1/6	0/6	3/6	19/22	33/132
33	SCAT2	3/6	1/6	1/6	1/6	3/6	20/22	30/132

Table 3. This table details the rehabilitative exercises and goals of each treatment program used in the exploratory treatment protocol. "Day" column refers to the day that that program was originally started measured in days since the injury occurred. Since the patient is a thrower for a college track program, position-specific functional rehabilitative exercises were incorporated when possible and power-oriented exertional activities were favored over cardiovascular-oriented exertional activities. The traditional return to play protocol was initiated for practices between programs 6 and 7. All programs after program 7 were created with the help of a certified athletic trainer who specializes in this new concussion rehab.

Program Number	Day	Exercises and Activities Included	Goals	Notes:
1	3	• Vision training with binocular string • Corrective Saccades Vestibulo-Ocular Rehab (80bpm) • Vision Training-Extreme Near Motility • Gaze Stabilization Exercise VORx1 (70bpm)	Begin slow corrective activity to begin returning to activities of daily life	Increase Corrective Saccades and Gaze Stabilization Exercise VORx1 by 10 bpm as tolerable up to 120 bpm.
2	7	• Vision training with binocular string • Corrective Saccades Vestibulo-Ocular Rehab (80bpm) • Vision Training-Extreme Near Motility • Gaze Stabilization Exercise VORx1 Vestibular Rehab (70bpm) • Treadmill 10mins @ 3mph	Add in cardio to increase cerebral blood flow.	Increase Corrective Saccades and Gaze Stabilization Exercise VORx1 by 10 bpm as tolerable up to 120 bpm. Increase treadmill incline by 1 degree as tolerable up to 3 degrees.
3	14	• Vision training with binocular string • Corrective Saccades Vestibulo-Ocular Rehab (3x100bpm) • Vision Training-Extreme Near Motility	Increase activity level of athlete with focus on power …	Increase Corrective Saccades and Gaze Stabilization Exercise VORx1 by 10 bpm as …

Program Number	Day	Exercises and Activities Included	Goals	Notes:
3 (cont.)	14 (cont.)	• Gaze Stabilization Exercise VORx1 Vestibular Rehab (3x90bpm) • Treadmill 10mins @ 3mph (3 degrees elevation) • Squats 2x10 • KB Swings 2x10 • Hop ups and step ups • Plank 2x20" • Lunges 2x10	… oriented exercises rather than cardio due to nature of athlete's position.	… tolerable up to 120 bpm.
4	19	• Vision training with binocular string • Corrective Saccades Vestibulo-Ocular Rehab (3x110bpm) • Vision Training-Extreme Near Motility • Gaze Stabilization Exercise VORx1 Vestibular Rehab (3x100bpm) • Treadmill 10mins @ 3mph (3 degrees elevation) • Russian twists (3x10) • Plank (2x30") • Lunges with ball twist 2x10 • Ball toss with twist (3x30") • Step ups with SL balance (B, 2x10) • Kettle bell squats (2x10)	Add in activities involving rotation and multi-planar movements.	Increase Corrective Saccades and Gaze Stabilization Exercise VORx1 by 10 bpm as tolerable up to 120 bpm.
5	20	• Vision training with binocular string • Corrective Saccades Vestibulo-Ocular Rehab (3x120bpm) • Vision Training-Extreme Near Motility • Gaze Stabilization Exercise VORx1 Vestibular Rehab (3x110bpm) • Treadmill 10mins @ 3mph (3 degrees elevation) • Russian twists 3x10 • Plank (2x30") • Step ups with SL balance (B, 2x10) • Lunges with ball twist 2x10 • Level 3 DL jumps (1x10) • 1/4 turns 20x • 180 turns 20x • Wall Squats with ball between knees (2x10)	Begin sport-specific activities.	Sets of planks and step-ups may be alternated to decrease strain on patient.

		• Ball toss with twist (3x30")		
Program Number	Day	Exercises and Activities Included	Goals	Notes:
6	18	• Step-ups with SL balance (B, 2x10) • 1/4 turns (2x20) • 180 degree turns (2x20) • Ball toss with twist (3x30") (1x45bpm, 1x50bpm) • Windmills (B, 1x10) • Line jumps fwd/bwd (2x10) • Line jumps side/side (2x10)	Discontinue vestibular rehab because terminal level was reached. Increase jumping motions with focus.	
7	31	In athletic training room (ATR): • 1/4 turns 1x20 • 180 turns 1x20 • Step-ups with SL balance (B, 2x10) • Ball toss with twist (3x30") (1x45bpm, 1x50bpm) To be done at practice on own: • Windmills (B, 1x10) • Line jumps fwd/bwd (2x10) • Line jumps side/side (2x10)	Progress to combine beginning practice and continuing rehabilitation with the sports medicine team.	
8	39	• Nodding the head up and down while focusing on a dot • Shaking head (in "yes" motion and "no" motion) while walking forward • Tossing a small weighted ball backwards over each shoulder • Focusing on a dot on the wall in the throwing glide position and moving the head up and down/ keeping head straight and moving eyes up and down at 130bpm • Sit ups with weighted ball and toss to partner on finish • Side plank on each side following fingertip in the sagittal plane and in the transverse plane 20x on each side in each plane • Throwing large med ball over shoulder replicating hammer throw motion	Work on functional, sport-specific activities. Progress in multi-planar motions. Focus on weaknesses (areas that provoke symptoms the most).	Created with the advice and expertise of athletic trainer with experience in experimental concussion rehabilitation.

Program Number	Day	Exercises and Activities Included	Goals	Notes:
9	42	• Bike 10' • Walks while moving head in "yes" and "no" (4x each) • Brock string (20x) • Side planks following finger while moving arm in sagittal and transverse planes (20x in each direction) • Focus on post-its with dots on them stuck to window in glide position both with head nodding and with head still while eyes move up and down (x3 at 135 bpm) • 180-degree pivots (3x10)	Focus on working on motions and exercises in ATR that are not isolated during activities at practices.	Rest as necessary between exercises.
10	46	• Hurdle Hops (10x) • Walks "yes" and "no" motions (4x each) • Brock string (x20) • Side planks following finger while moving arm in sagittal and transverse planes (20x in each direction) • Ball toss sit-ups (2x10) • Ball toss overhead over shoulder (x3 at 135 bpm) • 180 turns pivoting and jumping (3x10) • Line hops forward/backward and side/side (3x30')	Increase amount, speed, and intensity of exercises involving jumping.	Rest as necessary between exercises.
11	52	• Walks "yes" and "no" motions (4x each) • Brock string (x20) • Side planks following finger while moving arm in sagittal and transverse planes (20x in each direction) • 180 turns pivoting and jumping (3x10) • Line hops forward/backward and side/side (3x30') • Focus on post-its with dots on them stuck to window in glide position both with head nodding and with head still while eyes move up and down (x3 at 135 bpm)	Continue working on weak and symptom-provoking areas. Begin to progress out of the rehabilitation phase and into full return-to-play.	Combine different exercises from this program to supplement practice activities to continue getting a well-rounded rehabilitation.

Figure 1. Corrective Saccades Vestibulo-Ocular Rehabilitation. This exercise is used for improving both saccades, quick eye movements, and smooth purists, smoothly moving eyes from one point to another. Follow a cycle of moving eyes then head between each finger to a pre-determined beat from a metronome. [14]

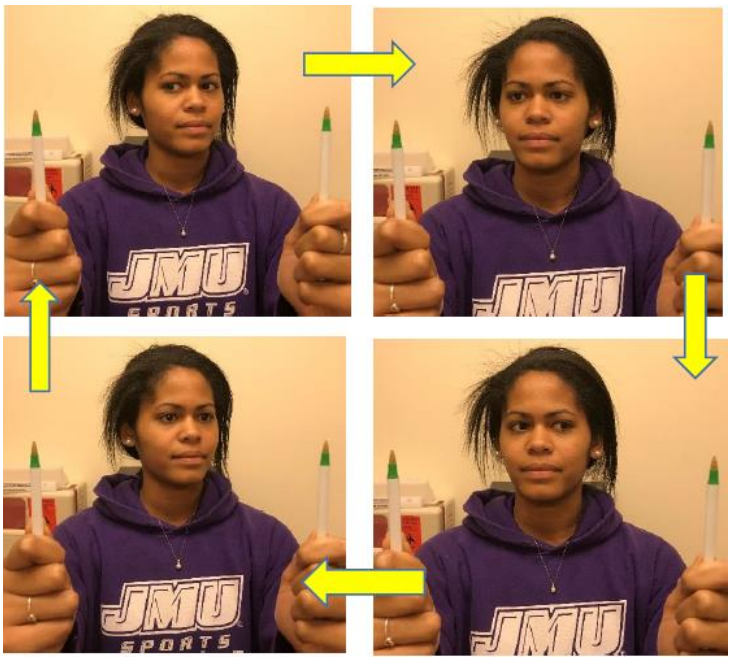


Figure 2. Gaze Stabilization Exercise Vestibular Oculomotor Reflex 1 for Vestibular Rehabilitation. This exercise is used for coordinating the balance system of the inner-ear with eye motion. Turn head while maintaining focus on the chosen object (i.e. pen, thumbs, drawing on paper, etc.)[14]

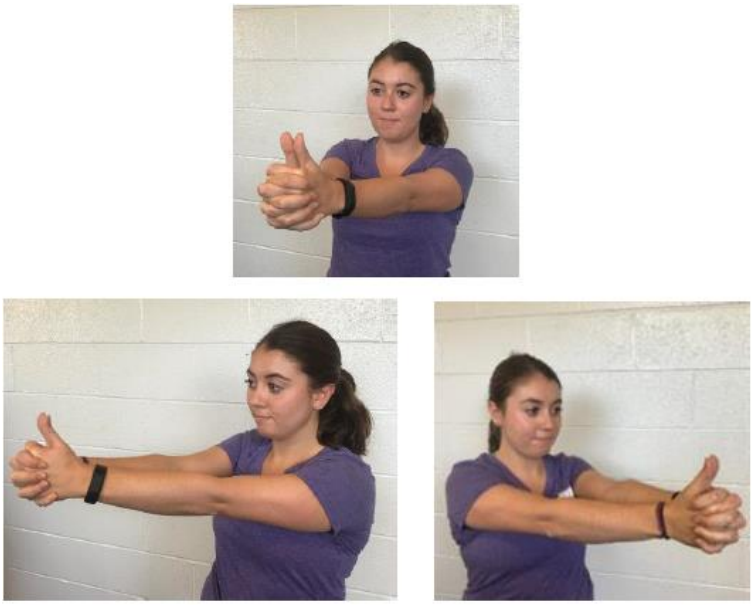


Figure 3. Vision Training: Extreme Near Motility. This exercise is used to improve the eyes ability to focus on and track an object. It uses eye convergence, both eyes coming to one point especially close to the face, to do this. Start with pen approximately 40 cm from face and bring it in towards the nose until double vision occurs. The figure demonstrates the two distances, but not the motion.[14]

Figure 4. Pen Movements. This exercise is used to improve the eyes ability to focus on and track an object. Holding the pen about 40 cm away from the nose and keeping head still, move the pen from left to right briefly pausing when the pen hits the end of vision line on each side. [14]

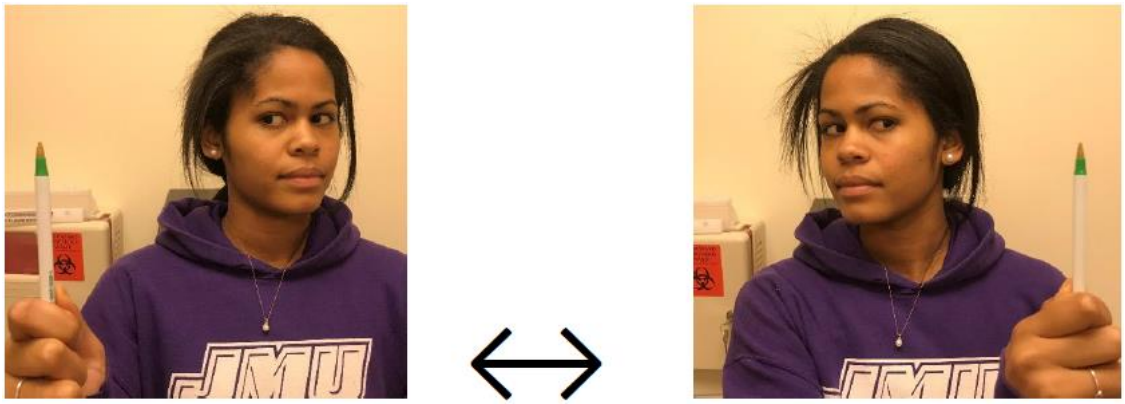


Figure 5. Head Movements. This exercise is used to improve the eyes ability to focus on and track an object. Begin with the pen stationary approximately 40 cm away from the tip of the nose and slowly move head from side to side briefly pausing when the pen hits the end of vision line on each side. [14]

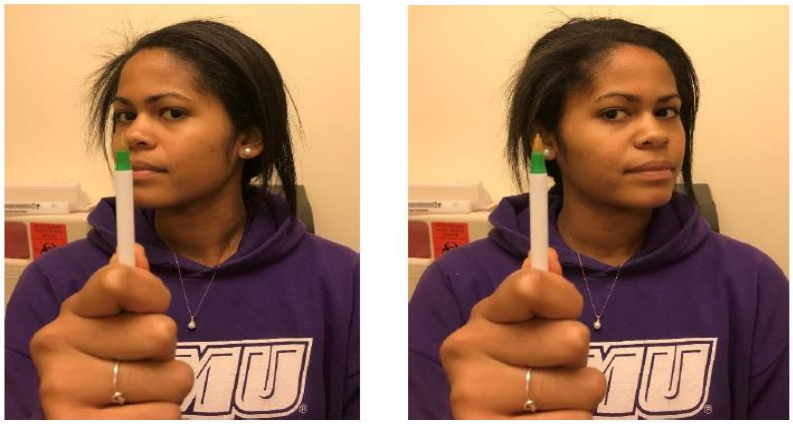
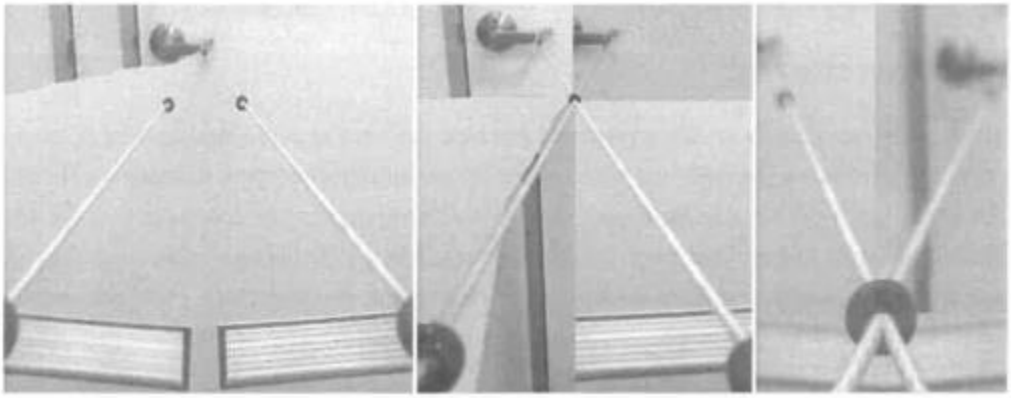


Figure 6. Vision Training with Binocular String. This exercise is used for training eye focus and convergence, both eyes focusing on one point especially close to the face. Secure sting to point at eye level and hold the other end to nose. Move eyes from one bead to the next.[14]

Figure 7. Vision Training with Binocular String 2. This is an image of what the Binocular String will look like to the patient doing the exercises.[14]



Case 2

Kathryn Young

A direct comparison of anterior cruciate ligament repair graft type in a female college athlete.

April 2018

Introduction

Anterior cruciate ligament (ACL) ruptures are a common yet debilitating injury for high level athletes such as those at the Division 1 (D1) collegiate level. College athletes are over twice as likely to sustain an ACL injury as high school athletes.[15] Furthermore, college females have a higher rate of incidence than their male counterparts.[15, 16, 17] Most commonly, these injuries occur in a "non-contact" manner[15, 16] through hyperextension of the tibiofemoral joint or a "plant-cut-twist" mechanism which places the knee in a valgus position. Surgery and rehabilitation are the most common solutions for patients hoping to return to sport or any active lifestyle. The two most common surgical procedures for ACL repair (ACLR) are a patellar tendon graft or a hamstring graft. In a patellar tendon graft procedure, or "bone-patellar tendon-bone" repair, the surgeon will harvest fibers from the middle of the patellar tendon and fix them in the same orientation as the ACL using bone plugs from the tibia and femur to secure the graft.[18, 19] In a hamstring graft, portions of the distal tendon of one or more of the medial hamstrings are harvested, doubled over, and secured in the knee joint in the orientation of the ACL with man-made hardware.[18, 19] Graft type depends on surgeon preference and patient activity level. Researchers have investigated which graft produces "better" clinical outcomes for the patient. The current literature offers a plethora of research on the subject.

Case Presentation

Overview

A female college lacrosse player sustained an ACL rupture to her left knee during the fall of her first year. It was repaired with a patellar tendon graft (PTG) two weeks post injury. Her return to sport was complicated due to a painful cyclops lesion that had to be removed and an unexpected infection which delayed her recovery. Two years after her initial injury she was

cleared for fall participation and full return to sport. During the spring of the patient's third year, 2 months after being fully cleared, she sustained an ACL rupture on the contralateral side. This knee was repaired 4 weeks post-injury with a hamstring graft (HSG).

The First Injury

During a practice the patient fell to the ground after a "plant-cut-twist" mechanism. She felt a "pop" with immediate severe pain "deep" in her knee that slightly resolved (but not completely) shortly after. At this point, the patient had no past medical history of knee injuries. On field the patient presented with extreme muscle tightness of the hamstrings that the athletic trainer (AT) suspected to be guarding and caused the Anterior Drawer and Lachman's Test to appear negative. The patient needed assistance ambulating and was sent home with crutches. The next day, the patient was sent for x-rays and subsequent magnetic resonance imaging (MRI). The MRI confirmed the suspected ACL rupture. A PTG repair procedure was planned within the next two weeks. Prior to the surgery the AT began a pre-surgical rehabilitation program focusing on maintaining knee extension range of motion (ROM) and hip strength through the quadricep and hamstring muscles. For a comprehensive list of rehabilitation exercises preformed, refer to Table 4. Immediately prior to surgery the injured knee had ROM measurements of 0º/9.5º/145.5º (Hyperextension/Extension/Flexion, Table 4) taken three times and averaged.

After surgery she began the post-ACLR (isolated) rehabilitation protocol (Appendix A). The AT followed this protocol using various exercises (Table 5). The therapeutic goals of the protocol and exercises were to control pain and swelling, regain full functional ROM, regain muscular strength, and maintain health of unaffected leg. Cryotherapy and compression were utilized to decrease swelling and manage pain. Manual therapy via patellar mobilizations were also used to maintain patellar mobility and promote healing in the patella tendon from which the

graft was taken. When away from the university for long breaks during and between semesters, the patient attended rehabilitation sessions with a local physical therapist (PT).

The patient progressed normally through 24 weeks. Major milestones included: progressing to single crutch at 2 weeks, beginning hop progression at 15 weeks, beginning jog progression at 18 weeks, BioDex testing at 23 weeks. At 25 weeks, the patient incurred a bout of cellulitis that hospitalized her for two days which had no correlation to graft type. The patient rested for one week then resumed rehabilitation. At 35 weeks, a Cyclops lesion was found and removed. Cyclops lesions are unique to PTG, but not abnormal.[4] The patient was cleared to begin to return to sport progression at 13 months. At this time her ROM measures were 0/0/145º (Table 4) and BioDex measurements were equal to or improved from baseline (Table 6). Girth measurements were within acceptable range compared to the unaffected leg (Table 1). The patient returned to participation without issue until the second injury occurred.

The Second Injury

At approximately 70 weeks, the patient incurred another knee injury to the contralateral side. While shooting during practice the patient fell to the ground. She described a "plant and twist" mechanism with an associated "deep pop." The patient was in severe pain and did not want to straighten or relax the affected leg. She was able to partial weight bear to the side of the field but described a "looseness" in the affected knee while doing so. Upon evaluation the AT elicited a positive anterior drawer and inconclusive Lachman's. The patient described some tingling in her toes and pain with end range knee flexion and extension. The patient discontinued practice and the AT applied cryocompression and fitted the patient with crutches to ambulate until further evaluation and/or imaging was possible. The next day she was sent to get x-rays and MRI as she presented with considerable intra-articular swelling and continued pain. The

orthopedic surgeon confirmed ACL rupture and suspected an associated tear of the medial meniscus. Surgery was scheduled. The AT began similar pre-surgical rehabilitation routine with patient (Table 5). Four weeks post-injury, orthopedic surgeon completed an HSG repair of her ACL and a 7-stitch meniscal repair. From this point, all time will be expressed in number of weeks since this surgery.

Because of the different graft type and associated meniscal repair, a different protocol for this injury from OrthoVirginia (Appendix B) was used. As OrthoVirginia is in a different hospital system, the UVA Orthopedics protocol that is in the same format as the protocol form the first surgery has also been included for easy comparison and comprehension (Appendix C). At 4 days post-surgery the patient presented with significant swelling and ROM deficits (Table 7), as to be expected at this post-surgical stage. The patient began rehabilitation exercises at 1 week (Table 8). Similar to the first injury, exercises were prescribed to fit the protocol. It is important to note differences in the protocol goals based on graft type. Due to the nature of HSG, there are slightly more limitations placed on strengthening exercises and stretches involving the hamstrings to limit tension on the graft site caused by knee extension to allow for healing of the graft site. It is suggested that in a HSG no hamstring strengthening exercises be performed for 3 months post-surgery while there are no restrictions on hamstring strengthening in a PTG rehabilitation.[18, 19, 22] Also, the associated meniscal injury prevented the patient from progressing her weight bearing and end-range flexion range of motion as quickly as a PTG.

The patient progressed as expected through 11 weeks post-surgery. At this time her care was transitioned to a physical therapist at home due to a long semester break. During this time, at 20 weeks, a knee scope revealed loose meniscal repair stitches which had to be repaired. This delayed further knee rehab for 2 months. Care by the athletic trainer resumed at 23 weeks post-

surgery. At 31 weeks, a team ortho noted significant joint laxity during both a Lachman's test and an anterior drawer test as well as a positive pivot shift test. The ortho also noted slight effusion remaining in the joint. A follow-up MRI was conducted and read by another ortho who noted no abnormalities. It was suggested that she return to her previous level of rehab (before the revised meniscal repair) and would be allowed to begin jogging at 44 weeks post-original surgery. At around 32 weeks post-original surgery, a rash appeared similar to the one noted in the previous injury. It was treated in the same manner as the last one and did not seem to significantly delay progression. Because much of the care was conducted outside of the ATR, most milestones are unknown.

Discussion

ACL ruptures and subsequent repairs in collegiate athletes are not notable on their own. An ACL rupture in a female collegiate lacrosse player is even less notable due to the prevalence of this injury in this population. Collegiate women are more than twice as likely to sustain an ACL injury as their male counterparts.[15] One twentieth of ACL injuries in the National Collegiate Athletics Association (NCAA) occur in female lacrosse players.[17] The sport has one of the highest rates of incidence of this injury compared across all collegiate sports, male and female. Reportedly, the incident rate of ACL ruptures in female lacrosse players is between 0.07-0.23 injuries/1000 exposures.[16, 17] Comparatively, men's lacrosse players have a reported IR of 0.13 injuries/1000 exposures.[16] One study suggests that this could be due to biomechanics of female lacrosse players.[20] Braun et. al. found that women's lacrosse players had significantly less knee flexion upon landing compared to female field hockey players.[20] These statistics show that is the combination of the sport and the gender contributing to the prevalence of injury, not a single isolated variable.

The mechanism of injury in this case is also not unique as 60% of ACL ruptures in female athletes were caused by a "non-contact" mechanism of injury (MOI).[16] It is more unique for the rupture with the same mechanism to occur in both knees, however it is not surprising. A contralateral rupture rate after first ACLR is reportedly between 0.6-29% with an average of 12.5%,[21, 22] meaning approximately one eighth of ACLR patients will sustain a contralateral ACL rupture upon returning after the first injury. Patients who had their first surgery under the age of 20 and patients returning to sports with a high level of cutting and pivoting increase this risk by a factor of 3 and 5 respectively.[23] The patient in this case would be positive for both of those, thus increasing her risk of contralateral knee injury drastically.

One unique portion of this case is the use of two different surgical techniques and grafts in the same patient. Although it is difficult to make any definite statements solely based on this case due to the lack of data at the present time, hypotheses can be concluded from the current literature. Both grafts have their pros and cons. Studies have shown that HSGs take longer to return to sport and often do not return to baseline at all[19, 22] Due to the nature of harvesting an HSG, "the hamstring muscles are considerably more vulnerable than the quadriceps muscles after hamstring ACL reconstruction."[22] This vulnerability could be a factor in the studies that have found HSG patients have decreased knee flexion strength[22, 24] and poorer performance in some single leg hop tests[24] which have been shown to be statistically correlated.[25] In all populations HSG have shown significantly more post-operative laxity than PTG, but especially in females.[18, 22] On average females showed an average of 0.6 mm more laxity in the post-HSG knee than males did.[18] This will directly impact the patient in this case as she is female. HSG patients also have a higher risk of nerve damage due to the surgery. Approximately 53% of HSG patients reported saphenous nerve irritation after surgery.[19] Overall, it seems that PTGs produce

more stable knees that return baseline and to sport faster.[18, 19, 22, 25] On the other hand, PTGs have been shown to produce more anterior knee pain immediately post-surgery,[18] lingering anterior knee pain, higher pain with kneeling,[18, 19] and some deficits during the anterior reach of a star excursion balance test.[24] The patient elected a different surgeon for the second surgery due to the complications incurred during the rehabilitation of the first surgical repair. The second surgeon that was chosen preferred to do HSGs over PTGs. This difference in surgical technique in the knees of the patient was not a personal decision nor medical recommendation, but rather a surgical preference.

It is important to note that in this patient, protocols were slightly different due to the additional meniscal repair in addition to the graft difference in the HSG rehabilitation protocol in the second surgery. Rehabilitation after the second surgery was more limited because the patient was restricted from full weight bearing for 6 weeks due to the meniscal repair and hamstring specific strengthening exercises for 12 weeks due to the graft type. Some ROM limitations were placed on the rehabilitation process as well due to both the graft type and meniscal repair such as avoiding knee flexion beyond 90°(Appendix C). In PTG rehabilitation protocols without associated meniscal repairs, full weightbearing is encouraged as soon as possible as tolerated by the patient and is expected by 2 weeks post-surgery (Appendix A). Aside from restrictions, special care should be implemented based on the type of graph to best target problem areas. HSG patients may benefit from more hamstring strengthening exercises in their rehabilitation plan.[22] Gastrocnemius and soleus strengthening are recommended specifically for PTG patients' rehabilitation. Both types of repairs may benefit from weight bearing between 70-100% rather than a lower percentage of weight bearing, an option which new anti-gravity treadmills (both air-

based and underwater) have now made possible. This is because the thigh muscles begin to deviate from normal firing patterns below 70% weight bearing.[24]

The best outcome for the patient is to not injure themselves at all. The NATA recommends all female athletes in high risk sports that involve cutting and twisting, such as lacrosse, participate in prevention program to decrease the risk of an ACLR.[26] It is suggested that programs include exercises targeting strength, plyometrics, agility, flexibility, and balance. These programs should be administered with proper feedback to improve neuromuscular control, biomechanics, and functional performance in effort to prevent the injury from occurring in a non-contact (seen in this case) or in-direct contact, such as a fall due to contact with another player where the contact did not directly cause the injury as a blow to the knee may, mechanism.[26]

Conclusion

ACL ruptures are one of the most common traumatic sports related injuries in collegiate athletics. It is best to attempt to avoid the injury and resulting surgical intervention completely by implementing a prevention program to decrease the risk of sustaining an ACL injury.[20, 26] Female collegiate lacrosse players are considered a high-risk population for sustaining one of these injuries.[26] Some studies have reported return-to-sport percentages as low as 55%[24] and patients that do are at a higher risk of re-rupture or contralateral rupture.[21, 23] With that said, surgical repair often yields effective and satisfying results for most patients. PTG seem to produce better patient outcomes with less pain and laxity than reported in HSG repair.[18, 19, 22, 25] However, none of these studies have researched both types in a singular patient. With more information, this case could support or refute these findings.

Table 4: ROM and girth measurements of first injury affected knee. Girth distances are in reference to distance from superior pole of the patella. Positive measures indicated distance from full extension (0º).

Timing	Measure Type	Measurement
Pre-Operation	Extension	10º, 9º
	Flexion	146º, 145º
1.5 weeks	Flexion	112º
	Extension	9º
2 weeks	Flexion	116º
	Extension	11º
3 weeks	Flexion	116 º
	Extension	8º
3 weeks	Flexion	120º
	Extension	9º
54 weeks	Flexion	145º
	Extension	0º
	15cm above	59.5 cm
	3in above	49 cm
	3 in below	40 cm

Table 5: Rehabilitation exercises from first injury. A combination of these exercises was prescribed each day in order to reach the goals outlined by the protocol in Appendix 1.

Activity Set	Weeks Post-Operative	Exercises
0	-2 through 0	Bike For ROM (5 Min), Prone Hang (5 Min), Heel Slides (5 Min), Quad Sets (2x30), Short Arc Quad (2x30), 4-Way Single Leg Raise (2x15), Squat To Stool (X20), Double Leg Calf Raise (2x10), Single Leg Balance (3x30s), Clamshells (2x20)
1	0-2	Heel Prop W/ Patella Mobilization , Ankle Pumps (X30), Toe Curls (X30), Prone Hang (5-8min), Continuous Passive Motion (15min, -3° To 60°), Quadriceps Activation With Russian Electoral Stimulation, Calf Stretch W/ Towel, Hamstring Stretch , Quad Sets (X20), Short Arc Quad (2x20), Heel Slides (5min), 4-Way Ankle W/ Band (2x10), Terminal Knee Extensions / Band (2x12), Treadmill Pawing Progress To Walking (5min), Straight Leg Raises (Assisted Or Solo), Mini Squats To Stool (2x10), Double Leg Calf Raises (2x10)
2	2-3	Prone Hang (2lbs, 8min), Quad Sets (2x20), Short Arc Quad Contraction (2x20), 4-Way Straight Leg Raise (2x10), Single Leg Calf Raise (2x10), Single Leg Balance (3x30sec), Terminal Knee Extension W/ Band (2x12), Walk On Treadmill (5min), Stationary Bike (5min), Walk Backwards On Treadmill (5min), Mini Squat W/ Physioball (2x10), Heel Slides (5min), Step Up To Small Box (Forward And Lateral, 2x10), Russian Dead Lift W/O Weight (2x10), Hip Abduction Against Wall (5min), Patellar Mobilization, Scar Massage

Activity Set	Weeks Post-Operative	Exercises
3	3-5	Prone Hang (2-3lbs, 8min), Quad Sets (2x20), Short Arc Quad W/ Large Bolster (2x20), 4-Way Straight Leg Raises W/ 2lbs (2x15), Terminal Knee Extension (2x20), Prone Or Standing Hamstring Curls W/ 2lbs (2x20), Single Leg Squat (X10), Single Leg Balance On Foam (3x30), Single Leg Calf Off Step On Slant Board (2x10), Heel Touch Off Small Box (2x10), Stationary Bike (8min), Walk Backward On Treadmill (Progress To W/ Band, 5min), Patellar Mobilizations, Scar Massage , Heel Slides (5min), Clamshells W/ Band (2x10), Step Up On Medium Box (Forward And Lateral, 2x10), Star Excursion Balance (X5), Body Weight Squat W/ Pvc Pipe (2x20)
4	5-7	Foam Roll Quads And Hamstrings, Stretch Hamstring And Calf, Prone Hang (3lbs, 5min), Short Arc Quad Contraction 2x20, 4-Way SLR (, 2x20), Body Weight Squat W/ Pvc (2x15), Mini Standing Lunge W/ Pvc (2x10), Heel Touch From Small Box (2x10), Step Up To Med Box (2x12), Wall Sit (3x20sec), Single Leg Balance On Bosu (Blue Up, 3x20sec), Double Leg Russian Dead Lift (2x10), Walk Backwards On Treadmill W/ Band (3min), Bike (7min)
5	7-9	Elliptical (10min), Trigger Point, Stretch Band, Standing 4-Way Hip W/ Band (2x12, Each Way), Monster Walks W/ Band (Lateral, Fwd, Body Weighted X1each), Balance W/ Eyes Closed On Dynadisk (3x30sec), Sl Squat W/ Band (2x8), Ground Ball Pick-Up On Step (2x10), Single Leg Cone Pick Up (X3), Alternating Lunge (2x5), Double Leg Calf Raise W/ Kettle Bell (2x10), Plank (3x20sec), Leg Press (90-30º, 30lbs, 4x10)
6	9-10	Foam Roll/Trigger Point, Fire Hydrants (2x10), Donkey Kickbacks (2x10), Heel Touches (2x10), Lateral Lunges (Both Ways, 2x10), Mini Tramp Balance And Pass (2x10), Goblet Squat W/ Kettle Bell (2x10), Calf Raise (Toes In And Toes Out, 2x8 Each), Swimmer's (2x20s) , Plank (3x30sec), Single Leg Russian Dead Lift (2x12), Leg Press (35lbs, 3x10)
7	14-17	Balance On Bosu W/ Pass (3x10), Quadruped Leg Circles On Bosu (2x30s, Each Way), Single Leg Squat On Ground (3x5), Uneven Squat On Step (2x10), Russian Dead Lift Into Shrug (3x8), Single Leg Russian Dead Lift On Foam (8lbs, 2x10), Trx Lunge (3x12), Star Lunges (X8), Calf Raise On Tramp (3x10), Resisted Step Up Onto Med Box (2x10), Side Planks (2x20s, Each Side), Step Outs (Forward And/or Lateral, 2x8), Fire Hydrant, Kickback, Donkey Kick (30s)
8	17-19	Patellar Mobilizations, Terminal Knee Extension (3x10), Heel Touch (3x10), Single Leg Balance On Foam Eyes Closed (3x30s), Bosu Lunge (Forward And Lateral, 2x10 Each), Step Out Onto Foam (2x10), Eccentric Calf Off Step (2x10), Hamstrings Single Leg Bridge (2x10), Single Leg Trx Squat (3x6), Ladder Walk Or Drills, Planks (Progress To On Bosu, 3x45s), Leg Press , Single Leg Hops (Triple, Single, Crossover), 100 Abdominal Exercises Of Patients Choice
9	19-21	Fast Feet (3x10sec), Skip 20yards (Forward, Lateral, Backward), 3 Step Bound Zig-Zag, Lateral And Forward Lunge Walk, Single Leg Squat Alternating (3x5), Power Step Ups (3x5), Slow Figure (8x5), Slow Circles (X5), Bike (15min) , Heel Touch (3x10), Monster Walk (X2), Treadmill Pushes, Y-Lunge (X8, Each), Single Leg Toe Taps (Back, Side, Front, X5 Each), Pop Hops (Double Leg-To-Single Leg Hold, X10), Broad Jump (2x5), Quarter Turn Broad Jump (X10), 6" Box Jump (X10)

Activity Set	Weeks Post-Operative	Exercises
10	21+	Bosu Fire Hydrant And Kickback (X30), Bosu Double Leg Bridge (2x10), 100 Abdominal Exercises Of Patients Choice , Star Excursion Balance On Foam (X7), Heel Touches (3x10), 180 Degree Jump Turns (2x10), Drop Down And Reaction Turn And Jog (X10), Slide Board (3x20s), Single Leg Squat (1min), Single Leg Triple Hop (X5), Single Leg Crossover Hop (X5), Single Leg For Distance (X5), Hurdle Hop Overs, Terminal Knee Extension (3x10), Single Leg Balance On Bosu (3x30s), Single Leg Russian Dead Lift (10lbs, 2x12), Goblet Squat W/ Kettle Bell (3x10), Tall Box Step Up W/ Kettle Bell (2x10), Walking Lunge (X2), Ground Ball Pickup From Medium Box (2x5), Jog (10min), Ladder Patterns (X8)

Table 6: BioDex testing of affected leg in first injury.

Timing	BioDex Test	Muscle Group	Affected compared to unaffected (Average Torque)
23 weeks	90 degrees/sec	Hamstrings	90%
		Quadriceps	61%
	180 degrees/sec	Hamstrings	97%
		Quadriceps	77%
	Isometric Contraction	Hamstrings	82%
		Quadriceps	51%
54 weeks	90 degrees/sec	Hamstrings	104.2%
		Quadriceps	102.4%
	180 degrees/sec	Hamstrings	105%
		Quadriceps	115%
	Isometric Contraction	Hamstrings	87%
		Quadriceps	80%

Table 7: ROM and girth measurements of second injury affected knee. Girth distances are in reference to distance from pole of the patella. Positive measures indicated distance from full extension (0º). Negative weeks refers to number of weeks prior to surgery. Extreme flexion (>90º) was contraindicated for the first two weeks post-surgery due to the meniscal repair and HSG surgical repair, so it was not measured until 2 weeks post-op. A baseline measurement from first injury has been included at the beginning of measurement chart.

Timing	Measure Type	Measurement
-16 weeks	Flexion	146º
	Extension	0º
	15cm above	63 cm
	3in above	52 cm
	3 in below	41 cm
-1 week	Flexion	127º
	Extension	5º
1 week	Extension	10º
	15cm below	38.1 cm
	3in below	39.4 cm
	3in above	45.7 cm
	15cm above	53.3 cm
1.5 weeks	15cm below	35.6 cm
	3in below	39.3 cm
	3in above	45.7 cm
	15cm above	52 cm
	Extension	8º
2 weeks	15cm below	40 cm
	3in below	39.4 cm
	3in above	47 cm
	15cm above	53 cm
	Extension	5º
	Flexion	76º
4 Weeks	Flexion (affected)	115 º
	Flexion (unaffected)	136 º
5 Weeks	Flexion (affected)	120º
	Flexion (unaffected)	135 º

Table 8: Rehabilitation exercises from second injury. A combination of these exercises was prescribed each day in order to reach the goals outlined by the protocol in Appendix 2.

Activity Set	Weeks Post-Operative	Exercises
0	-2 through 0	Quad Sets (3x25), Prone Hang (5min), Heel Slides (X30), Straight Leg Raise (3x15), 4-Way Hip (3lbs, 2x12, B), Standing Hamstring Curls (2x10), Calf Raises (2x15), Side-Lying Hip Abduction Against Wall (2x10), Mini Squats W/ Ball (2x8), Double Leg Bridge (2x10), Game Ready W/ Heel Prop (20min), Terminal Knee Extensions W/ Band (2x12), Bike For Rom (10 Min), Walk On Alter-G (10min), Prone Hang (3-5lbs, 5-10min)
1	1	Patella Mobilizations, Heel Prop On Bolster(10min), Quad Sets (10x5), Compex Machine (4 Min), Calf Stretch With Towel (3x30 Sec), Ankle Pumps, Gameready, Normatech, Assisted Straight Leg Raise In Brace (Progress To Unassisted, 2x5), Ankle 4-Way (2x10), Heel Slides (Hold For 10 Sec At Top, X15), Sit Off Edge Of Table (3 Min), Hip Hikes On Board (X10), Hip Hikes And Pendulum (X10)

Kathryn Young

The Baseball Epidemic: Ulnar Collateral Ligament Reconstruction

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Introduction

Ulnar collateral ligament (UCL) injuries were first documented in the 1940's in two main throwing sports: javelin and baseball.[27, 28, 29] The first surgical case was documented and performed by Frank Jobe in 1976.[30] Since these initial documentations, studies on UCL injury have readily increased – as well as the incidence of them in high-level baseball.[30] This case presents the experience of one collegiate baseball pitcher and his road to rehabilitation after UCL reconstruction (UCLR).

The UCL is a thick band of connective tissue between the medial humerus and medial ulna. It lays over the elbow's medial joint line in three primary bands: anterior oblique portion, transverse, and posterior oblique portion.[27, 30] The anterior oblique portion primarily resists the valgus stresses of the throwing motion;[27, 30] some reports say it absorbs as much as 54% of valgus force during throwing.[31] This is a significant amount as studies have documented that during a pitch between 60-120 newtons of force stress the medial elbow.[27, 31] However, there seems to be some imbalance as cadaveric studies have shown ultimate UCL failure/rupture at about 34 newtons of force.[27, 31, 32] This is how the UCL gets injured. Repetitive valgus stress alters the UCL to the point where it can rupture or be more susceptible to injury.

Diagnosing these injuries is often difficult. The first step is to get a detailed history. Many times, patients can remember a single throw in which the injury occurred; other times the patient may only note pain and a progressive loss of velocity and accuracy in their throws.[27] The elbow will be tender to palpation over the medial joint line. The most recommended diagnostic field tests are the moving valgus stress test (Figure 8), milking sign/maneuver (Figure 9), and the static valgus stress test (Figure 10) in that order.[32] However, the most accurate way to diagnose this condition and its severity is through advanced imaging. The most recommended diagnostic

imaging technique is an magnetic resonance arthrogram (MRA) in which dye is injected into the joint and magnetic resonance imaging (MRI) is performed.[27] This dye gives the doctors a better view of the joint and allows the radiologist to see if the joint has any leakage where the ligament has torn, called a "T-sign."[27] The MRA has reported sensitives of 86-95% based on the degree of injury.[27] Once diagnosed, the patient must choose which treatment route they would like to pursue: conservative or surgical.

Conservative treatment consists of a relatively brief period of immobilization of the elbow and cessation of throwing followed by intense strengthening program and possible throwing mechanics consultation.[28] Patients typically return to play in about 6 months.[32] Between 42-91% of patients make a full recovery and return to the same level of sport activity depending on level of play and surgical type.[28, 31]

Surgical treatment is slightly more complex. Typically, the higher the grade of sprain to the UCL, the more likely the patient is to require surgery.[27] Many different surgical techniques have evolved since Jobe's first approach. After surgery there is a slightly longer period of immobilization followed by bracing and intense rehabilitation focused on strengthening and mechanics. The documented average return to paly time is between 4-5 months, and the documented average return to competition is around 11 months.[29, 30] Between 87-97% of patients successfully return to the same level of sport.[28, 30] The patient in this case selected an operative route of treatment.

Case Presentation

The patient, an 18-year-old male collegiate baseball pitcher, arrived on campus for pre-season physicals ready to start his first season of college play. However, he did not pass the elbow pre-screening, a series of joint stability tests and patient history questions developed by

the team's head athletic trainer and orthopedic elbow specialist. The patient reported that he had pain with almost every pitch since somewhere in his junior year of high school. Upon screening the patient presented with a positive milking sign and positive static stress test. He was tender to palpation over the UCL area. An MRA was scheduled for two weeks after the encounter which revealed a Grade 3 sprain of his UCL. Surgery, a full UCLR, was scheduled for a few weeks later.

Surgery went as planned and was generally successful. The surgeon used a modified Jobe procedure with an ipsilateral palmaris longus graft, the presence of which was verified prior to surgery. The palmaris longus was harvested via two incisions on the volar surface of the forearm between the radius and ulna. The graft was reinforced with sutures on either end and suture tape the length of the graft. Osseous tunnels were drilled during surgery through the proximal medial ulna and the medial epicondyle of the humerus.[33] The reinforced graft was threaded though these tunnels in a "figure-of-8" pattern,[31] and the free ends were sutured together. An ulnar nerve transposition was also performed in which the ulnar nerve was elevated over the medial epicondyle of the humerus into the cubital fossa area.[33] Following surgical closure, the elbow was laced in an orthoplast splint with the elbow in approximately 90 degrees of flexion. As set forth by the Andrew's UCL Protocol (Appendix D), the patient was instructed to keep his incisions clean and dry and to use the provided sling until the follow-up appointment approximately 2 weeks post-surgery. All times stated from this point forward will be expressed in relation to time since surgery.

Two weeks after surgery, the patient returned for a follow-up with the orthopedic surgeon. The orthoplast splint was removed and the patients surgical closing sutures were removed. The patient was placed in a dial brace (Figure 11) set to 90 degrees of extension and

120 degrees of flexion. The patient was instructed to wear this brace constantly for the next few weeks until full range of motion (ROM) was achieved. Each week the patient gained 5 degrees of extension and 10 degrees of flexion each week as set forth by the Andrew's Protocol (Appendix D). The patient progressed through the first two weeks of rehabilitation without issue. At a 1-month post-surgery follow-up appointment with the patient, the orthopedic surgeon noted full healing of the surgical incision with only mild thickening and recorded the patient's range of motion at 15 degrees extension and 120 degrees of flexion. He also noted full ulnar nerve function. The surgeon instructed the Athletic Trainer and patient to continue with ROM exercises and edema control and to plan to remove the brace in about 6-8 weeks, 10-12 weeks post-surgery. Detailed rehabilitation is listed in Table 1.

The patient progressed well over the next 7 weeks. At 6 weeks post-surgery, he achieved full extension on his own in the brace and as much flexion on his own as the brace allowed. He progressed from isometric exercises and began adding weight (1lb) to his wrist exercises. As the patient was progressing through his rehabilitation, an unexpected illness removed him from the athletic training room and rehabilitation exercises for about a week and a half (weeks 7-8 post-surgery). This stunted his rehab slightly. When he returned (roughly 8 weeks post-surgery) he had lost about 5 degrees of elbow extension but had not lost any elbow flexion. Some rehabilitation exercises needed to be modified as the patient returned with a PIC line of antibiotics in his contralateral arm. This was removed at approximately 10 weeks post-surgery, and rehabilitation exercises were progressed more freely.

At 9 weeks post-surgery, the patient regained full elbow extension and the dial brace was removed. This is slightly delayed from the Andrew's protocol due to the patient's illness. At this time the patient also progressed his rotator cuff strengthening rehabilitation program by adding

weight (1.5 lbs.). The weight of each exercise and the following exercises was progressed as tolerated by the patient at approximately 1lb per week since starting the exercise. At 10 weeks post-surgery, these exercises were progressed by beginning to do them seated on a physio ball to increase core engagement. At 11 weeks post-surgery, the patient added bicep curls and band-resisted internal and external rotation of the glenohumeral joint while seated on a physio ball. These progressions move the rehabilitation program towards the well-documented "Advanced Thrower's 10" program.[34] At 11 weeks post-surgery, he began a modified running and lifting program with the team's strength and conditioning coach. At 16 weeks post-surgery, the patient began the Advanced Thrower's 10 program (Figure 12) as his primary form of rehabilitation in addition to the modified versions of other team activities (running, lifting, condition, etc.).

In addition to rehabilitation exercises, various modalities were utilized to manage symptoms. Cryotherapy in the form a bagged ice for management of pain and swelling. Compression in the form of cotton and elastic compression sleeves were used to control edema through 10 weeks post-surgery. Continuous ultrasound with light massage was used to remove edema and bruising.

This case study concludes at 16 weeks post-surgery due to academic deadlines. The patient has progressed well this point, and it is expected that he will continue to do so.

Discussion

This case is not unlike those of thousands of other high-school collegiate baseball players around the country. One study found that 10% of professional baseball players surveyed had previously had one or more UCLR before entering the professional league,[30] which means they had the procedure as a high-school or collegiate baseball player. One surgeon noted an 11-fold increase in the number of UCLR performed in his operating room on high school athletes

between 1988 and 2003.[30] In one study of 155 D1 collegiate baseball programs, over 55% of participating teams had at least one surgical case.[32] This is a significant problem for collegiate athletes as the probability of a collegiate baseball player sustaining a UCL injury is 1.12/10000 athletic exposures, which means any time an athlete participated in a practice or game – any baseball activity.[31] What is even more alarming is that it has increased by 0.18 in the past decades.[31] For reference, counting only games (a maximum of 56 games, not including post-season play)[35] with an average roster (capped at 35 by the National Collegiate Athletic Association),[35] this one team could reach 1,960 athletic exposures in games alone.

This patient, a freshman pitcher, fits the stereotypical patient well in age and position. In one study of collegiate baseball players, freshman athletes accounted for 27% of all UCL injuries.[31] Another found that underclassmen were 1.6 times more likely to sustain a UCL injury than their upperclassmen counterparts.[32]

Pitchers incur these injuries at even more alarming rates. The same study found that pitchers had UCLR at a rate 5.9 times higher than position players.[32] In a study of one professional program, 32 of 43 (74%) UCLR cases were pitchers.[28] In this same study, all 8 of the complete or grade 3 UCL sprains documented were in the elbows of pitchers.[28] Study after study finds that over half of UCL cases occur in pitchers.[29] This could be due to the nature of their position as these players throw significantly more and are encouraged to throw significantly harder than their position-player counter-parts. Erickson et. all states that pitch count is a "well-established cause of UCL injury."[31] Half of little league pitchers studied who routinely exceeded pitch counts required UCLR, while only 1.7% of those pitchers following recommended pitch counts required UCLR.[31] Now, little league is a very different ballgame than collegiate baseball literally and figuratively. Currently, the NCAA doesn't regulate the number of pitches thrown in-

season or out-of-season. Could this be a factor in the increasing number of injured pitchers? Would regulation help or is it just the nature of the position?

As stated before, surgery, as in this case, is a fairly typical route of treatment of UCL injury. However, conservative treatment is also common. Both have high return to play (RTP) rates. Surgical cases have a RTP rate of 87-97%, and conservative cases have a RTP rate of 42-93%.[28, 30] It should be noted here that conservative treatment is typically only an option in the cases of partial UCL tears/sprains.[28] Conservative treatment is much more variable in their RTP, although they typically return faster because they require less recovery time. It has been reported that conservative cases can return to competition in an average of 8 months[31] and 91% in one study returned to competition by the next season.[28] Surgical case take slightly longer averaging 7-11 months to return to competition respectively. [29, 30] However, in one study 17% of partial tears had surgery after beginning or completing conservative treatment,[28] nullifying any time benefit gained from conservative treatment. Long-term, surgical cases have very limited negative impacts, if any. Ninety-eight percent of surgical cases at 10-year follow-up were able to still participate in throwing activities.[29] Only 3% had any elbow pain and only 5% felt they had limited function at 10-year follow-up.[29] In fact, the patients' Disabilities of the Arm, Shoulder, and Hand Scores (DASH Scores) were all better that those of the general population.[29]

Unfortunately, there are currently no long-term prospective controlled research studies comparing these forms of treatments or comparing variations in surgical techniques. Further research into these would be beneficial in finding the best outcomes for the many UCL injuries. Also, further research into the stress on pitchers' elbows in college and before via pitch count or other methods may give insight into disproportionate amount of UCL injuries in pitchers and young players.

Figures and Tables

Table 9. Rehabilitation documentation of this patient.

Phase of Rehabilitation and Goals of Phase	Duration of Phase (Weeks Post-Surgery)	Rehabilitation Exercises	Therapeutic Interventions	Notes (Throughout phase)
Phase 1: -edema control -pain management -wrist and hand ROM	0-4	-Wrist ROM w/o weight	-Compression sleeve -Cryotherapy in form of ice bags	-Monitor incisions and healing process -Monitor edema and bruising
Phase 2: -forearm strength -elbow ROM	4-9	-Seated Y's and T's w/o weight -Isometric IR/ER -1lb wrist ROM	-Continuous ultrasound -Light massage -Cryotherapy in form of ice bags or cryo-compression -Compression sleeve	-Add prone hang (possibly with weight) to achieve full elbow extension -Watch elbow for edema with increased activity. Take a step back if necessary. -d/c isometrics as soon as pain-free IR/ER achieved
Phase 3: -maintain elbow ROM -strengthen rotator cuff -well body activity	9-11	-Seated Y's and T's w/ weight -2lb wrist ROM -2 lb. bicep curls -Band resisted IR/ER on PB	-Continuous ultrasound -Light massage	-Some bruising noted and some pain reported (hx of medial epicondylitis), reintroduce US and possible massage
Phase 4: -introduce functional and sport-specific activity -strengthen rotator cuff	12+	-Modified cardio/running and lifting program -Progress modified AT10 to full AT10	-Cryotherapy in form of ice bags or cryo-compression	

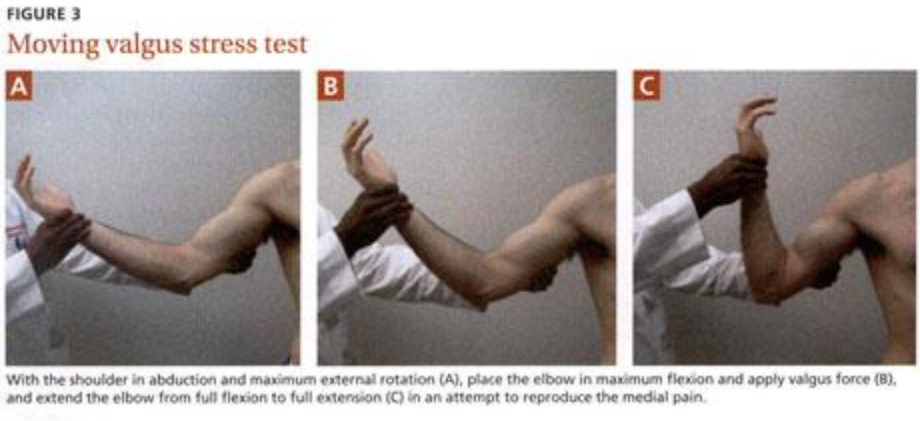

Figure 8. Demonstration of moving valgus stress test from Madden CC, Putukian M, McCarty E, et al. Netter's Sports Medicine. Philadelphia, PA: Saunders Elsevier; 2010: 360-367.

Figure 9. Demonstration of milking maneuver from James Madison University ATEP306A.

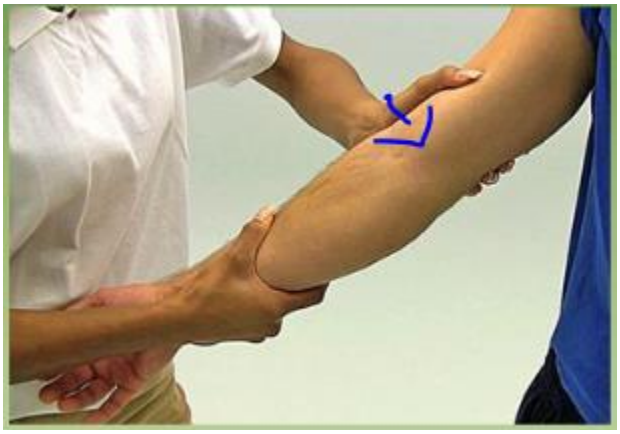

Figure 10. Demonstration of the static valgus stress test for the elbow.

Figure 11. Photo of dial brace excerpted from Orthomen Inc. at https://www.orthomen.com/products/rom-arm-elbow-brace

Table 2. Advanced Throwers Ten Exercise Program

- –IR/ER tubing at 0° of abduction seated on stability ball[a]
- –Full can seated on stability ball[a]
- –Lateral raise to 90° of abduction seated on stability ball[a]
- –Side-lying external rotation[a]
- –T raises prone on stability ball[a]
- –Y raises prone on stability ball[a]
- –Prone row into ER on stability ball[a]
- –Lower Trapezius 5 Series
  - • Shoulder extension in ER seated on stability ball
  - • Shoulder extension at 45° in ER seated on stability ball
  - • Standing wall circle slides
  - • Standing low row
  - • Standing table press-downs with scapular depression
- –Biceps curls/triceps extensions seated on stability ball
- –Wrist flexion/extension and supination/pronation

[a]Exercises in which sustained holds are utilized. Exercises are performed incorporating 3 sets of 10 repetitions. Exercises are performed (3-set sequence) 2 times.
Abbreviations: ER, external rotation; IR, internal rotation.

Figure 12. The Advanced Throwers Ten Exercise Program excerpted from Wilks et. all.[34]

Appendix 1: UVA Orthopedics Isolated ACLR Rehabilitation Protocol

UNIVERSITY of VIRGINIA HEALTH SYSTEM

UVA SPORTS MEDICINE

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Post-operative Rehabilitation Protocol

ACL Reconstruction

Phase I: Immediate post-operative (weeks 1- 4)

Goals:

- Protect graft and graft fixation
- Control inflammation/swelling
- 0-120 flexion AROM as tolerated first 4 weeks.
    - Caution: avoid hyperextension greater than 10 degrees.
- Educate patient on rehabilitation progression
- Restore normal gait on level surfaces

Weight bearing Status:

- Weight-bearing as tolerated immediately post-op with crutches
- Wean from crutches for ambulation by 2 weeks as patient demonstrates normal gait mechanics and good quad control.

Exercises:

- Patellar mobilization/scar mobilization
- Delay hamstring strengthening for 12 weeks. (for hamstring tendon autograft procedure only)
- Hamstring curls – add weight as tolerated (for patellar tendon autograft procedure only)
- Heel slides (to 90° only for hamstring tendon autograft procedure)
- Quad sets (consider NMES for poor quad sets)
- Gastroc/Soleus stretching
- Hamstring stretches (very gentle for hamstring tendon autograft procedures)
- Gastroc/Soleus strengthening (for patellar tendon autograft procedures)
- SLR, all planes. Add weight as tolerated to hip abduction, adduction and extension.
- If available, deep-water jogging for ROM and swelling.

For patellar tendon autograft procedures only:

- Closed Kinetic Chain Quadriceps strengthening activities as tolerated (wall sit, step ups, mini squats, leg press 90-30 degrees)
- Quadriceps isometrics at 60° and 90°
- If available, aquatics for normalizing gait, weight bearing and strengthening
- Balance/Proprioception
- Stationary Bike – initially for promotion of ROM – progress light resistance as tolerated

Criteria for advancement to Phase II:

- Full PROM flexion/extension
- Good quad set, SLR without extension lag
- Minimal swelling/inflammation

- Normal gait on level surfaces

PHASE II: Post-operative weeks 4 to 10

Goals:

- Restore normal gait with stair climbing
- Maintain full extension, progress toward full flexion range of motion
- Protect graft and graft fixation
- Increase hip, quadriceps, hamstring and calf strength
- Increase proprioception

Exercises:

- Continue with range of motion/flexibility exercises as appropriate for the patient
- Continue closed kinetic chain strengthening as above for patellar tendon autograft procedures, progressing as tolerated – can include one-leg squats, leg press, step ups at increased height, partial lunges, deeper wall sits, lunge walks.
- Initiate CKC quad strengthening and progress as tolerated for hamstring tendon autograft procedures (wall sits, step-ups, mini-squats, Leg Press 90o-30o, lunges)
- Stairmaster (begin with short steps, avoid hyperextension)
- Nordic Trac or elliptical machine for conditioning.
- Stationary bike- progress time and resistance as tolerated
- Continue to progress proprioceptive activities for patellar tendon autograft procedures, initiate for hamstring tendon autograft procedures – ball toss, balance beam, mini-tramp balance
- Continue hamstring, gastroc/soleus stretches
- Continue to progress hip, hamstring and calf strengthening as tolerated
- If available, begin running in the pool (waist deep) or on an unweighted treadmill at 8 weeks.

Criteria to advance to Phase III include:

- No patellofemoral pain
- Minimum of 120 degrees of flexion
- Sufficient strength and proprioception to initiate running.
- Minimal swelling/inflammation

PHASE III: Post-operative weeks 10 to 16

Goals:

- Full range of motion
- Improve strength, endurance and proprioception of the lower extremity to prepare for sport activities
- Avoid overstressing the graft, for hamstring tendon autograft progressively increase resistance of hamstring strengthening.
- Protect the patellofemoral joint
- Normal running mechanics
- Strength approximately 70% of the uninvolved lower extremity per isokinetic evaluation (if available)

Exercises:

- Continue flexibility and ROM exercises as appropriate for patient
- Initiate OKC Knee extensions 90°-30°, progress to eccentrics
- If available, isokinetics (with anti-shear device) – begin with mid-range speeds (120o/sec- 240o/sec)

- **Progress toward full weight bearing running at 12 weeks for BTB autograft (16 weeks for hamstring tendon autograft procedures).**
- Begin swimming if desired
- Recommend isokinetic test with anti-shear device at 12 weeks (14-16 weeks for hamstring tendon autograft procedures) to guide continued strengthening.
- Progressive hip, quadriceps, hamstring, calf strengthening
- Cardiovascular/endurance training via Stairmaster, elliptical, bike
- Advance proprioceptive activities

Criteria for advancement to Phase IV:

- No significant swelling/inflammation.
- Full, pain-free ROM
- No evidence of patellofemoral joint irritation
- Strength approximately 70% of uninvolved lower extremity per isokinetic evaluation
- Sufficient strength and proprioception to initiate agility activities
- Normal running gait

PHASE IV: Post-operative months 4 through 6

Goals:

- Symmetric performance of basic and sport specific agility drills
- Single hop and 3 hop tests 85% of uninvolved lower extremity
- Quadriceps and hamstring strength at least 85% of uninvolved lower extremity per isokinetic strength test

Exercises:

- Continue and progress flexibility and strengthening program based on individual needs and deficits.
- Initiate plyometric program as appropriate for patient's athletic goals
- Agility progression including, but not limited to:
  Side steps
  Crossovers
  Figure 8 running
  Shuttle running
  One leg and two leg jumping
  Cutting
  Acceleration/deceleration/sprints
  Agility ladder drills
  Continue progression of running distance based on patient needs.
  Initiate sport-specific drills as appropriate for patient
  Assessment of running on treadmill

Criteria for advancement to Phase V:

- No patellofemoral or soft tissue complaint
- Necessary joint ROM, strength, endurance, and proprioception to safely return to work or athletics

PHASE V: Begins at 6 months post-op

Goals:

- Safe return to athletics/work
- Maintenance of strength, endurance, proprioception
- Patient education with regards to any possible limitations

Exercises:

- Gradual return to sports participation
- Maintenance program for strength, endurance

Appendix 2: OrthoVirginia Hamstring Graft ACLR Rehabilitation Protocol

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ACL HAMSTRING AUTOGRAFT RECONSTRUCTION REHABILITATION PROTOCOL

	WEIGHT BEARING	BRACE	ROM	THERAPEUTIC EXERCISE
PHASE I 0-4 weeks	As tolerated with crutches*	**0-2 week**: locked in full extension for ambulation and sleeping **2-4 weeks:** unlocked for ambulation, remove for sleeping**	As tolerated	Heel slides, quad sets, patellar mobs gastroc/soleus stretch***, SLR with brace in full extension until quad strength prevents extension lag****
PHASE II 4 - 6 weeks	Gradually discontinue crutch use	Discontinue use when patient has full extenstion and no extension lag	Maintain full extension and progressive flexion	Progress to weight bearing gastroc/soleus stretch and closed chain activities, begin hamstring stretching
PHASE III 6 weeks - 4 months	Full, without use of crutches and with a normalized gait pattern	None	Gain full and pain-free	Begin hamstring strengthening, advance closed chain strengthening, progress proprioception activities, begin Stairmaster/Nordic Trac, begin running straight ahead at 12 weeks
PHASE IV 4 months - 6 months	Full	None	Full and pain-free	Progress flexibility/strengthening, progression of function: forward/backward running, cutting, grapevine, etc., initiate plyometric program and sport-specific drills
PHASE V 6 months and beyond	Full	None	Full and pain-free	Gradual return to sports participation, maintenance program for strength and endurance. At patient's discression, a functional ACL brace can be used from 6 mo to 1 yr post-op.

*Modified with concomitantly performed meniscus repair/transplantation or articular cartilage procedure

**Avoid open chain quadriceps strengthening for first 4 months

***This exercise is to be completed in a non-weight bearing position

****NO hamstring stretching until 4 weeks post-operative

Appendix 3: UVA Orthopedics ACLR with Associated Meniscal Injury Rehabilitation Protocol

UNIVERSITY of VIRGINIA HEALTH SYSTEM

UVA SPORTS MEDICINE

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Claire Denny, PA-C, Jennifer Hart, PA-C, Michelle Post, PA-C

Post-operative Rehabilitation Protocol

ACL Reconstruction with Meniscus Repair or Microfracture

Phase I: Immediately postoperative (weeks 0- 4)

Goals:

- Protect graft and graft fixation
- Minimize effects of immobilization
- Control inflammation/swelling
- ROM: 0-90 when supine (such as heel slides).
    - **Caution: avoid squatting and flexion for leg press beyond 90 degrees until 4 months post-op.**
- Brace 0-90 degrees for ADLs until 6 weeks post-op
- Educate patient on rehabilitation progression

Weight bearing Status:

- TTWB (25%) for 2 weeks, 50% until 6 weeks post-op, then advance to full weight bearing.

Exercises:

- Patellar mobilization/scar mobilization
- Delay hamstring strengthening for 12 weeks. (for hamstring tendon autograft procedure only)
- Hamstring curls – add weight as tolerated (for patellar tendon autograft procedure only)
- Heel slides (to 90° only for hamstring tendon autograft procedure)
- Quad sets (consider NMES for poor quad sets)
- Gastroc/Soleus stretching
- Hamstring stretches (very gentle for hamstring tendon autograft procedures)
- Gastroc/Soleus strengthening (for patellar tendon autograft procedures)
- SLR, all planes, with brace in full extension until quadriceps strength is sufficient to prevent extension lag – add weight as tolerated to hip abduction, adduction and extension.

For patellar tendon autograft procedures only:

- Closed Kinetic Chain Quadriceps strengthening activities as tolerated (wall sit, step ups, mini squats, leg press 90-30 degrees)
- Quadriceps isometrics at 60° and 90°
- Balance/Proprioception
- Stationary Bike – initially for promotion of ROM – progress light resistance as tolerated

Criteria for advancement to Phase II:

- Full PROM flexion/extension
- Good quad set, SLR without extension lag
- Minimal swelling/inflammation
- Normal gait on level surfaces

PHASE II: Post-operative weeks 4 to 10

Goals:

- Restore normal gait with stair climbing after brace is discontinued at 6 weeks
- Maintain full extension, progress toward full range of motion at 6+ weeks
- Protect graft and graft fixation
- Increase hip, quadriceps, hamstring and calf strength
- Increase proprioception

Exercises:

- Continue with range of motion/flexibility exercises as appropriate for the patient
- Continue closed kinetic chain strengthening as above for patellar tendon autograft procedures, progressing aa tolerated – can include one-leg squats, leg press, step ups at increased height, partial lunges, deeper wall sits, lunge walks.
- Initiate CKC quad strengthening and progress as tolerated for hamstring tendon autograft procedures (wall sits, step-ups, mini-squats, Leg Press , lunge at 90° -30°
- Stairmaster (begin with short steps, avoid hyperextension)
- Nordic Trac or elliptical machine for conditioning.
- Stationary bike- progress time and resistance as tolerated
- Continue to progress proprioceptive activities for patellar tendon autograft procedures, initiate for hamstring tendon autograft procedures – ball toss, balance beam, mini-tramp balance
- Continue hamstring, gastroc/soleus stretches
- Continue to progress hip, hamstring and calf strengthening as tolerated
- If available, begin running in the pool (waist deep) or on an unweighted treadmill at 8 weeks.

Criteria to advance to Phase III include:

- No patellofemoral pain
- Minimum of 120 degrees of flexion
- Sufficient strength and proprioception to initiate running.
- Minimal swelling/inflammation

PHASE III: Post-operative weeks 10 to 16

Goals:

- Full range of motion
- Improve strength, endurance and proprioception of the lower extremity to prepare for sport activities
- Avoid overstressing the graft, for hamstring tendon autograft progressively increase resistance of hamstring strengthening.
- Protect the patellofemoral joint
- Normal running mechanics
- Strength approximately 70% of the uninvolved lower extremity per isokinetic evaluation (if available)

Exercises:

- Continue flexibility and ROM exercises as appropriate for patient
- Initiate OKC Knee extensions 90°-30°, progress to eccentrics
- If available, isokinetics (with anti-shear device) – begin with mid-range speeds (120o/sec- 240o/sec)
- **Progress toward full weight bearing running at 12 weeks for BTB autograft (16 weeks for hamstring**

tendon autograft procedures).

- Begin swimming if desired
- Recommend isokinetic test with anti-shear device at 12 weeks (14-16 weeks for hamstring tendon autograft procedures) to guide continued strengthening.
- Progressive hip, quadriceps, hamstring, calf strengthening
- Cardiovascular/endurance training via Stairmaster, elliptical, bike
- Advance proprioceptive activities

Criteria for advancement to Phase IV:

- No significant swelling/inflammation.
- Full, pain-free ROM
- No evidence of patellofemoral joint irritation
- Strength approximately 70% of uninvolved lower extremity per isokinetic evaluation
- Sufficient strength and proprioception to initiate agility activities
- Normal running gait

PHASE IV: Post-operative months 4 through 6

Goals:

- Symmetric performance of basic and sport specific agility drills
- Single hop and 3 hop tests 85% of uninvolved lower extremity
- Quadriceps and hamstring strength at least 85% of uninvolved lower extremity per isokinetic strength test

Exercises:

- Continue and progress flexibility and strengthening program based on individual needs and deficits.
- Initiate plyometric program as appropriate for patient's athletic goals
- Agility progression including, but not limited to:
  Side steps
  Crossovers
  Figure 8 running
  Shuttle running
  One leg and two leg jumping
  Cutting
  Acceleration/deceleration/sprints
  Agility ladder drills
  Continue progression of running distance based on patient needs.
  Initiate sport-specific drills as appropriate for patient
  Assessment of running on treadmill

Criteria for advancement to Phase V:

- No patellofemoral or soft tissue complaint
- Necessary joint ROM, strength, endurance, and proprioception to safely return to work or athletics

PHASE V: Begins at 6 months post-op

Goals:

- Safe return to athletics/work
- Maintenance of strength, endurance, proprioception
- Patient education with regards to any possible limitations

Exercises:

- Gradual return to sports participation
- Maintenance program for strength, endurance

Appendix A. Andrew's Protocol

UVA HAND CENTER - THERAPY

ANDREW'S PROTOCOL
POST-OPERATIVE REHABILITATION PROTOCOL FOLLOWING
ULNAR COLLATERAL LIGAMENT RECONSTRUCTION
USING AUTOGENOUS PALMARIS LONGUS GRAFT

1. **IMMEDIATE POST-OPERATIVE PHASE (0-3 WEEKS)**

Goals:

- Protect healing tissue
- Decrease pain/inflammation
- Retard muscular atrophy
- Protect graft site-allow healing

WEEK 1

Brace: Posterior splint with elbow at 90° flexion

Compression: Elbow Compression dressing (first 2-3 days)
Wrist (graft site) compression dressing 7-10 days as needed

Cryotherapy: To elbow joint and graft site at the wrist

Range of Motion: Wrist AROM (flexion & extension) immediately postoperatively

Exercises:

- Gripping exercises
- Wrist ROM
- Supination/Pronation
- Shoulder isometrics (no shoulder internal rotation)
- Biceps isometrics

POST-OPERATIVE WEEK 2

Brace: Elbow ROM 30°-100°

Cryotherapy: Continue ice to elbow joint and graft site

Exercises:

- Continue all exercises listed above
- Elbow ROM in brace (-30° to 100°)
- Initiate isometric elbow extension
- Initiate wrist isometrics
- Continue wrist ROM exercises
- Initiate light scar mobilization over the distal graft incision

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POST-OPERATIVE WEEK 3

Brace: Elbow ROM 15°-110°
(Gradually increase ROM by 5° extension and 10° flexion per week after this point)

Exercises:

- Continue all exercises listed above
- Elbow ROM in brace
- Initiate light wrist flexion stretching
- Initiate AROM shoulder
  - Full can
  - Lateral raises
  - ER/IR tubing
- Continue wrist ROM exercises
- Initiate light scar mobilization over the distal graft incision

PHASE II. INTERMEDIATE PHASE (WEEKS 4–8)
Goals:

- gradual increase in range of motion
- promote healing of repaired tissue
- regain and improve muscular strength

POST-OPERATIVE WEEK 4

Brace: Elbow ROM 10°-120°

Exercises:

- Begin light resistance exercises for arm (1 lb):
  - wrist curls and wrist extension
  - pronation/supination
  - Elbow extension/flexion.
- Progress shoulder program, emphasizing rotator cuff and scapular strengthening (avoid ER until week 6)
- Initiate shoulder strengthening with light dumbbells

POST-OPERATIVE WEEK 5

Brace: Elbow ROM 5°-130°

Exercises:

- Continue all exercises and progress all shoulder and UE exercises (progress 1# weight)

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UVA HAND CENTER - THERAPY

POST-OPERATIVE WEEK 6

Brace: Elbow ROM 0°-145° (without brace, or full AROM)

Exercises:

- Initiate Thrower's Ten Program
- Progress elbow strengthening exercises
- Initiate shoulder external rotation strengthening
- Progress shoulder program

POST-OPERATIVE WEEK 7

Exercises:

- Progress Thrower's Ten Program (progress weights)
- Initiate PNF diagonal patterns (light)

ADVANCED STRENGTHENING PHASE (8-14 WEEKS)

Goals:

- increase strength, power, endurance
- maintain full elbow ROM
- gradually initiate sporting activities

POST-OPERATIVE WEEK 8

Exercises:

- Initiate eccentric elbow flexion/extension
- Continue isotonic program; forearm and wrist
- Continue shoulder program—thrower's ten program
- Manual resistance, diagonal patterns
- Initiate plyometric exercise program
  - (2 hand plyos close to body)
  - Chest pass
  - Side throw close to body

POST-OPERATIVE WEEK 10

Exercises:

- Continue all exercises listed above
- Progress plyometrics to 2 hand drills away from the body
  - Side to side throws
  - Soccer throws
  - Side throws

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POST-OPERATIVE WEEK 12-14

Exercises:

- Continue all exercises
- Initiate isotonic machines strengthening exercises if desired
  - Bench press (seated)
  - Lat pull down
- Initiate golf, swimming
- Initiate interval hitting program

RETURN TO ACTIVITY PHASE (14-32 WEEKS)

Goals:

- Continue to increase strength, power and endurance of upper extremity musculature
- Gradual return to sports activities

POST-OPERATIVE WEEK 14

Exercises:

- Continue strengthening program
- Emphasis on elbow and wrist strength and flexibility exercises
- Maintain full elbow ROM
- Initiate one hand plyometric throwing (stationary throws)
- Initiate one hand wall dribble
- Initiate one hand baseball throws into wall

POST-OPERATIVE WEEK 16

Exercises:

- Initiate Interval Throwing Program (Phase I) [long toss program]
- Continue Thrower's Ten program and plyos
- Continue to stretch before and after throwing

POST-OPERATIVE WEEKS 22-24

Exercises:

- Progress to Phase II throwing (once successfully completed Phase I)

POST-OPERATIVE WEEK 30-32

Exercises:

- Gradually progress to competitive throwing and sports

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UVA HAND CENTER - THERAPY

Interval Throwing Program for Baseball Players: Phase I

45' Phase

Step 1: A) Warm-up Throwing
B) 45' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 45' (25 Throws)

Step 2: A) Warm-up Throwing
B) 45' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 45' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 45' (25 Throws)

60' Phase

Step 3: A) Warm-up Throwing
B) 60'(25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 60' (25Throws)

Step 4: A) Warm-up Throwing
B) 60' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 60' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 60' (25 Throws)

90' Phase

Step 5: A) Warm-up Throwing
B) 90' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 90' (25 Throws)

Step 6: A) Warm-up Throwing
B) 90' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 90' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 90' (25 Throws)

120' Phase

Step 7: A) Warm-up Throwing
B) 120' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 120' (25 Throws)

Step 8: A) Warm-up Throwing
B) 120' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 120' (25 Throws)
F) Rest 5-10 min.
G) Warm-up throwing
H) 120' (25 Throws)

150' Phase

Step 9: A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 150' (25 Throws)

Step 10:A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 150' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 150' (25 Throws)

180' Phase

Step 11: A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)

Step 12: A) Warm-up Throwing
B) 180' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 180' (25 Throws)

Step 13: A) Warm-up Throwing
B) 150' (25 Throws)
C) Rest 5-10 min.
D) Warm-up Throwing
E) 180' (25 Throws)
F) Rest 5-10 min.
G) Warm-up Throwing
H) 150' (25 Throws)
I) Rest 5-10 min.
J) Warm-up Throwing
K) 15 throws progressing from 120 → 90'

Step 14: Return to respective position or progress to step 14 below.

All throws should be on an arc with a crow-hop

Warm-up throws consist of 10-20 throws at approximately 30 feet

Throwing Program should be performed every other day, 3 times per week unless otherwise specified by your physician or rehabilitation specialist.

Perform each step ____ times before progressing to next step.

Flat Ground Throwing for Baseball Pitchers

Step 14:
A) Warm-up Throwing
B) Throw 60 ft. (10-15 throws)
C) Throw 90 ft. (10 throws)
D) Throw 120 ft. (10 throws)
E) Throw 60 ft. (flat ground) using pitching mechanics (20-30 throws)

Step 15:
A) Warm-up Throwing
B) Throw 60 ft. (10-15 throws)
C) Throw 90 ft. (10 throws)
D) Throw 120 ft. (10 throws)
E) Throw 60 ft. (flat ground) using pitching mechanics (20-30 throws)
F) Throw 60-90 ft. (10-15 throws)
G) Throw 60 ft. (flat ground) using pitching mechanics (20 throws)

Progress to Phase II – Throwing Off the Mound

45 feet = 13.7 meters
60 feet = 18.3 meters
90 feet = 27.4 meters
120 feet = 36.6 meters
150 feet = 45.7 meters
180 feet = 54.8 meters

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UVA HAND CENTER - THERAPY

Interval Throwing Program: Phase II – Throwing Off the Mound

STAGE ONE: FASTBALLS ONLY

Step 1: Interval Throwing
15 Throws off mound 50%*

Step 2: Interval Throwing
30 Throws off mound 50%

Step 3: Interval Throwing
45 Throws off mound 50%

Step 4: Interval Throwing
60 Throws off mound 50%

Step 5: Interval Throwing
70 Throws off mound 50%

Use Interval Throwing 120ft (36.6m) Phase as warm-up

ALL THROWING OFF THE MOUND SHOULD BE DONE IN THE PRESENCE OF YOUR PITCHING COACH OR SPORT BIOMECHANIST TO STRESS PROPER THROWING MECHANICS

(Use speed gun to aid in effort control)

Step 6: 45 Throws off mound 50%
30 Throws off mound 75%

Step 7: 30 Throws off mound 50%
45 Throws off mound 75%

Step 8: 10 Throws off mound 50%
65 Throws off mound 75%

STAGE TWO: FASTBALLS ONLY

Step 9: 60 Throws off mound 75%
15 Throws in Batting Practice

Step 10: 50-60 Throws off mound 75%
30 Throws in Batting Practice

Step 11: 45-50 Throws off mound 75%
45 Throws in Batting Practice

STAGE THREE

Step 12: 30 Throws off mound 75% warm-up
15 Throws off mound 50% BEGIN BREAKING BALLS
45-60 Throws in Batting Practice (fastball only)

Step 13: 30 Throws off mound 75%
30 Breaking Balls 75%
30 Throws in Batting Practice

Step 14: 30 throws off mound 75%
60-90 Throws in Batting Practice (Gradually increase breaking balls)

Step 15: SIMULATED GAME: PROGRESSING BY 15 THROWS PER WORKOUT (Pitch Count)

* Percentage effort

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