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UTAH STATE UNIVERSITY RETURN TO PLAY CRITERIA FOLLOWING ANTERIOR CRUCIATE LIGAMENT SURGERY

by

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A project submitted for partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Health and Human Movement

Approved:

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INTRODUCTION

An injury to the anterior cruciate ligament (ACL) of the knee is a very traumatic experience. Most of these injuries will be a complete rupture of that ligament, and because of the nature of the ligament, the repair process will require surgery; however, a small number of athletes have learned how to successfully stabilize the ACL-deficient knee and return to activity (Hartigan et al, 2010). For the thousands of athletes who undergo surgery to repair their ACL, this is in hopes they can return to physical competition and an active lifestyle. The ACL is also repaired in hopes of preventing joint degradation. Each of these athletes will respond differently to the surgery, and will see post-operative complications such as: amount of swelling, decreased range of motion, muscle loss, and physical pain. This non-exhaustive list of possible complications affects future progress of the athlete and may be indicative of problems to come.

After the ACL is surgically repaired, then the athlete begins the long and hard process of physical therapy. The post-operative complications can lead to the length of time involved in physical therapy and this will vary with each athlete. The athlete's dedication to rehabilitation as well as their mental approach will also affect the time frame. The general consensus that physicians have adopted is a six month minimum return to play, but most athletes are closer to the eight or nine month time frame.

After each ACL repair, the main question on the athlete's mind is, "When can I return to sport and full activity?" There are many factors that play into this loaded question, and an athlete needs to be aware of these before they return to sport and full activity. It is very important to understand that an early return, before an athlete is ready, can lead to major setbacks and even another ACL rupture. After discussing this issue at length with Lori Olsen, Physical Therapist for Utah State University, the decision was made that a return to play criteria was needed for ACL reconstruction. This criteria would inform an athlete on what needs to be

accomplished before they can return to their sport and full activity. Although there is no set return to play criteria, there are different tests and techniques being used, and Utah State University would benefit from a more developed return to play criteria for ACL reconstruction.

Not only would this criteria be beneficial for current athletes, it would also be beneficial for prospective athletes who are planning to transfer or attend Utah State University. If they have had prior ACL reconstructions, they will be evaluated with this criteria to see where they are currently. This will determine how healthy the athlete is and the level of liability they are to Utah State athletics.

In discussion with numerous physicians and faculty, they are excited about the idea of such a criteria and agree that the current situation needs to be changed. This criteria will help to determine readiness to return to sport and lifelong success of the athlete.

PURPOSE

Utah State University has no set return to play criteria for ACL reconstruction. Both the athletes and the university would benefit from this. The physicians who clear the athletes would be able to see the completion of the requirements. The athletes would see the tests they have completed and what tests they still need to complete before they can return to sport and full activity. The purpose of this criteria would be to evaluate and test the athlete in five areas: Quadriceps Size, Biodex, Hop Test, 3PQ, and Single Leg Press. There are goal, target percentages the athlete would need to accomplish. The first two tests would have a target goal of 85% with size and strength versus the uninvolved leg and the last three would be 90% because they are more functional in determining an athlete's readiness. This criteria would also allow room for notes on physical therapy progression, current status, and additional comments.

This return to play criteria is only for return to play testing and is not the extensive protocol and rehabilitation phases following surgery. A brochure was developed to give general information about ACL injuries and physical therapy timelines. One of the most important things to remember is the information in the brochure is generalized, and each ACL reconstruction is unique.

LITERATURE REVIEW

There is an abundance of literature available regarding ACL criterion, return to play, and possible complications from early return. Much of the literature uses the same examples but there are variations in the things they do and recommend. Much of the cited literature in the articles is as early as the 1970s and continues until today. These articles highlight advances in surgical techniques, graft strength, and testing for return to play. These advances have significantly increased overall joint health and stability, as well as quality of life for each individual athlete. The main reason for the literature review in this particular case is to examine return to play criterion, evaluate what methods are being used, and see if any of these want to be adopted by Utah State University.

The ACL is frequently injured and is the most prevalent structure reconstructed in an athlete's knee (Majewski et al, 2006). The mechanism of injury for an ACL tear can be different for each athlete, whether it be during sporting events or everyday activities. Tearing of this ligament can have disastrous effects ranging from complaints of instability and buckling during high level sports participation to reports of giving way while walking down the street or stepping off of a curb (Manal et al, 1996). In 1970 Kennedy stated that "the ACL is the most common cause of the ex-athlete." Significant changes in procedures have changed this outcome but data has also shown that retirement rates are higher in previous ACL injury athletes versus those with a healthy history. Also there is a significant risk of re-injury to the graft and the knee, and even if there is no re-injury, there is also convincing data that shows nearly all athletes will develop osteoarthritis (Mykelbust et al, 2004).

The athlete's response to surgical intervention is dependent on individual and genetic intrinsic factors as well as controllable and uncontrollable extrinsic factors. These factors

include the following: preoperative fitness level of the athlete, healing properties, status of the knee joint at the time of injury, the time from injury to surgery, and the presence of concomitant injury that occurred at the time of ACL disruption (Manal et al, 1996). The hope for each athlete is to have the ACL surgically repaired to protect joint degradation and to return to pre-injury activity levels.

Athletes are most concerned about when they can return to sport. It is very difficult to make this decision, and even when they do return to sport, the question is still asked, "Are they really ready?" When the patient's muscle strength is restored and balance and agility are recovering, the return to sport involves uncontrolled factors. A few uncontrolled factors are concurrent knee joint injuries, meniscal pathology, chondral damage, and medial collateral ligament injury. This list is by no means exhaustive (Manal et al, 1996). Return to sport after ACL reconstruction can be a high-risk period for athletes because of the possibility of graft failure and an increased chance of injury to the uninvolved side, which can be higher than the involved. Re-injury to the knee can be as high as 20% for athletes who return to highly competitive activities. However, athletes who perform criterion based protocols have a decreased risk of re-injury (Myer et al, 2008).

Timelines for rehabilitation have been developed to protect the athlete and the healing process. One study that has been done investigates the natural history of a hamstring tendon autograft used for anterior cruciate ligament reconstruction in a sheep model (Goradia et al, 2000). Sheep knees have been shown to be a valid model for study of human cruciate ligaments (Radford et al, 1996). The results from the Goradia study give us a timeline so we can know the different healing stages of the ACL graft. At four weeks a synovial lining had developed around the ACL graft and there was no evidence of graft necrosis. An abundant blood supply was also

noted at this time. At eight weeks central avascular necrosis was apparent in the graft, but collagen began to be more longitudinally oriented. At twelve weeks the granulation tissue was almost completely replace by collagen and the collagen in the central area started to show longitudinal orientation. At twenty-four weeks granulation tissue was no longer found in the graft. There was a continued decrease of vascular response, similar to that of a normal, healthy ACL. At fifty-two weeks the biochemical and histological properties of the ACL graft resembled that of the original ACL. This study was important to develop rehabilitation guidelines because we learn significant events, such as: the blood supply takes at least four weeks to be developed, the weakest time of the graft is around eight weeks, and after one year the graft resembles what once was the original ACL.

Rehabilitation programs should be outlined in a written criteria format. This facilitates communication between the physician, therapist, and athlete and assures that all three parties have the same understanding of the process. A written criteria is valuable because they provide specific guidelines and help give realistic expectations to all parties involved. The guidelines should be definable and this will help to create a goal-oriented rehabilitation which is comfortable for most athletes. Mentally, each athlete will benefit from a return to play criteria because they can see what they have to accomplish before they are cleared to play. Surgeons give a timeline estimate of how long the rehabilitation process will take but this is not specific to each case. Adjustments should be made for each athlete to properly treat them. No one single criteria has been shown to correlate with successful return to sports. Most clinicians will use a combination of criteria to get a well-rounded approach (Cascio et al, 2004).

The most common of the functional tests are the one leg single hop for distance, the one leg triple hop for distance, the one-leg timed hop, and the one leg cross-over hop for distance.

The one-leg single hop is an indicator of power, whereas the other three tests indicate both power and endurance (Cascio et al, 2004). Three of these hop tests are currently used at Utah State to test ACL readiness and return to play. I discussed in length with Todd Brown (personal communication, February 6, 2011), one of my undergraduate professors, the need for a return to play criteria, and what he thought the best testing methods would be. He said that he felt the best test is a single leg hop for distance because it will test power, as well as knee stability and anterior translation of the tibia. Isokinetic/Biodex testing can also aid therapists and physicians when making return to play decisions. In this specific article (Cascio et al, 2004), they state that the general rule is the hamstring should be 70% to 75% when compared to the uninvolved leg, but Utah State sets a target goal of 85% comparable strength. The hamstring to quadriceps ratio should also be one to one. The hamstrings are so important because they act as an ACL agonist and a dynamic stabilizer of the knee.

The 85% and 90% target strength ratios adapted by Utah State have been chosen by both the therapists and surgeons to be the goals for the criteria. The majority of clinicians use these target goals and they have been developed by consensus but there is research to support these numbers. Noyes et al have described a limb symmetry index of 85% or higher to be within normal ranges for both males and females, regardless of limb dominance or sports activity level. Utah State has chosen 90% as the target goal for the last three tests because they are considered more functional when return to activity is concerned.

In the Manal, Hartigan, and Myer articles, they each used return to play criteria that varied one from the other, but each had three things that were similar: jump testing, isokinetic testing, and quadriceps strength testing. The articles used different varieties of the tests but there were also some tests that were the same, such as the hop test. In the Myer article, they even used

an IKDC subjective knee evaluation form with questions of knee pain during performance, frequency of pain, knee stiffness, highest level of activity with no swelling, any locking or catching, and regular activity.

3PQ stands for plyo, press, power, quotient. Utah State is fortunate to have a 3PQ system available to use for ACL testing. The system is in the Athletic Republic department at Logan Regional Hospital. The system has been there for five years but has only been functional since the beginning of Summer 2010 due to the limited availability of parts. I have been working with Justin Cox, (personal communication, February 2011), to get more information on the 3PQ system and important components involved. 3PQ focuses on power, strength, endurance, and agility. Athletic Republic has used the 3PQ system for strength programs but has not done research specifically tailored to an ACL reconstruction. Because of this, available research regarding ACL reconstruction and rehabilitation with 3PQ is limited. The research Athletic Republic has done is in regards to strength training programs for healthy athletes.

Utah State also wants to incorporate a single leg press test on the return to play criteria. Research has shown there is clinical relevance to having a single leg press involved when making the return to play decision for ACL reconstruction. There is a need to have a more detailed strength assessment of the injured limb. This particular assessment would measure quadriceps strength and endurance. The quadriceps muscle group is particularly important because weakness now may lead to knee osteoarthritis in the future (Neeter et al, 2006). This is why significance is placed on the quadriceps muscle group immediately following surgery. In the Neeter study, results supported the leg press and its ability to discriminate strength in the injured versus the non-injured leg, and they also suggested how important it is to have a combination of specific tests for ACL return to play. The battery of tests improves sensitivity by

placing greater demands on the athlete and muscle function. No single test is able to do this and that is why the recommendation is made to have a battery of tests or a return to play criteria.

The mental aspect for this return to play criteria for athletes will be very important. They will be able to see, on paper, what they need to do before they can return to sport. Under the current standards, they hear rumors of what they are suppose to do, but when those requirements are written on paper, then they truly know what needs to be done. The current standard also causes unrealistic expectations for some of the athletes which can cause them to lose their motivation, well-being, and cause to action (Podlog et al, 2007). This is one of the reasons a target percentage was set and not a specific percentage requirement. Athletes will still be nervous when they return to full activity, but they need to understand the ACL was healthy when it failed. Their preparations in physical therapy and other return to play exercises will prepare them for sport but do not guarantee prevention of re-injury. They will need to take the necessary precautions but should be confident in the rehabilitation process and return to play criteria.

METHODS

The design of this project is to determine what methods will be best to test an athlete after ACL surgery to determine if they are ready to return to sport. As mentioned, there are numerous different tests and battery of tests that are being used, but the five that Utah State Athletics have chosen are the Quadriceps Size, Biodex, Hop Test, 3PQ, and Single Leg Press. These five things will allow us to compare strength, power, endurance, speed, and agility.

The athlete will begin the return to play criteria testing at the 4 to 6 month mark depending on their progress in physical therapy. The athlete will see improvements in the uninvolved leg during physical therapy so percentage measurements will be taken for both legs when they reach the 4 to 6 month mark. An athlete will not be allowed to use the measurements of the uninvolved leg at the beginning of physical therapy and compare that to the measurements of the involved leg at the end of physical therapy. The athlete also needs to remember the 4 to 6 month mark is variable and each ACL reconstruction is unique.

The quadriceps size will have a target goal of 85 % when compared to the uninvolved leg. This will be a single circumference measurement of the upper leg, six inches above the middle of the patella. Muscle atrophy is a concern that all athletes will deal with after ACL surgery because of the limited use they have initially with their knee and upper leg. As they begin physical therapy, they will start to see strength gains and muscle hypertrophy once more, and this is one of the first tests they will pass on their way to return to sport. Not only will this measure quadriceps size but it will also measure some hamstring size as well, which can give information about the muscle and what gains it has had.

The Biodex is the second test that will be used to evaluate the athlete and has been one of the most commonly used objective tests to evaluate upper leg strength after an ACL surgery. The Biodex evaluation will have a target goal of 85% when compared to the uninvolved leg.

The machine is open chain with flexion and extension at the knee, and tests at two different speeds, one at 60 degrees per second, five repetitions, and one at 180 degrees per second, 10 repetitions. This tests both hamstring and quadriceps strength, compares the two muscle groups to one another, and then compares the involved to the uninvolved leg. Based on body weight, the machine gives a goal peak torque percentage to compare the results with.

The Hop Test is the third test that will be used to evaluate the athlete's readiness to return to sport after ACL surgery. The Hop Test values will have a target goal of 90% when compared to the uninvolved leg. This test can be very subjective and requires proper training to get correct results; however, has become a widespread test that is used after ACL injuries. There are three different tests for the hop test: single leg 15 feet hop down and back, single leg jump test for distance, and single leg crossover jump test, 3 hops. The first test is timed as the athlete jumps 15 feet in one direction and then back to the original starting point. The second test is measured for distance as the athlete takes one large jump. The third test is measured as well as the athlete takes three hops in a single direction while alternating each hop over a line in the middle of the floor. The Hop Test deals most with proprioception as the athlete needs to maintain balance but also power and strength are also important factors.

The 3PQ is the fourth test that will be used to evaluate the athlete before they return to sport. The 3PQ test values will have a target goal of 90% when compared to the uninvolved leg. The 3PQ test is performed with the athlete sitting on a semi-recumbent leg press. Their body weight is recorded and then 75% of their body weight is added to the weight to be lifted. There is a force plate where the feet are placed, and a linear displacement device attached to the sled, to measure the power and height of each jump. The athlete then undergoes two trials, one on each leg. They push off and land repeatedly, jumping as high as they can, for twenty seconds.

The 3PQ output gives eleven comparisons but only five of them will be used for the criteria. These are the five comparisons that will be used: max force, average peak power, average negative power, average rate of power development, and average push height. Max force will record the largest force output in the twenty second testing period. Average peak power measures the maximum power of each concentric contraction in the twenty second test and gives you the average peak power. The concentric contraction begins when the athlete starts to push up on the sled and ends when the foot leaves the force plate. Average negative power measures the maximum negative power of each eccentric contraction in the twenty second testing period and gives you the average negative power. The eccentric contraction begins when the foot comes in contact with the force plate and ends when the athlete starts to push off again. Rate of power development measures the time it takes from the beginning of the eccentric contraction to the end of the concentric contraction of each jump. More simply described, this measures how long it takes from the bottom of the jump squat to the apex of the jump. Average push/jump height measures each of the jumps and takes the average. The push/jump height is especially important to make sure the athlete is jumping the same height with each leg. The 3PQ test deals mainly with power, but also involves strength and endurance components.

The Single Leg Press is the fifth test that will be used to evaluate the athlete before they return to sport. The Single Leg Press test values will have a target goal of 90% when compared to the uninvolved leg. The athlete will do a leg press of his or her own body weight to fatigue on the uninvolved leg and then repeat on the involved leg. This test is simple and takes little time but will give the athlete an opportunity to gauge where they are at without having to do the other tests.

RECOMMENDATIONS

The return to play criteria will make a significant impact on how ACL injuries are handled at Utah State University. There will be records kept of the testing completion and athletes will be more informed of requirements. In the future, Utah State can explore the possibility of incorporating the muscle lab with the criteria. The muscle lab can be used to evaluate the hop test, while measuring proprioception and hop height. Also it will be important to conduct a study, evaluate the five tests on the criteria being used, and determine if they are the best evaluations possible. The discussion has also been made that time should be involved with the Single Leg Press test. For example, an athlete could do twenty repetitions on both legs but the involved leg takes one minute longer to complete than the uninvolved. This opens the door for more research studies and testing in the future to see what the best way to use the Single Leg Press would be. For the time being, the Single Leg Press will be on the criteria and updated according to new research findings. With each of the tests, minus the Quadriceps Size measurement, there is a learning curve involved. Consideration needs to be made in regards to this learning curve, because test scores can increase dramatically from one day to the next.

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