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Can the Implementation of a Standardized Hip Adductor Muscle Strengthening Exercise Protocol Reduce Hip Adductor Muscle Strains for Division III Men's Ice Hockey Teams?

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by

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Chapter 1: Introduction

Injuries to muscles are common occurrences and become obstacles for individuals who participate in athletics. Depending on the functional demands of a particular sport or physical activity, specific muscle groups are more susceptible to injury than others. An example of the relationship between the physical demand of a sport and high prevalence of injury sustained by a specific muscle group can be found when examining individuals who participate in ice hockey. Studies have shown that athletes who participate in this sport have a high incidence of injury to the hip adductor muscle group. This muscle group has been defined by Nicolas, Tyler, Campbell, Donellan and McHugh to include the pectineus, adductor longus, adductor brevis, adductor magnus, gracilis, and obturator externus (2002). In Finland, according to Molsa, Airaksinen, Nasman and Torstila, hip adductor muscle injuries accounted for 43% of all muscular injuries in an elite male ice hockey league (1997). Based on such a high documented percentage of injuries, the following question surfaces: why do hip adductor injuries seem to be so prevalent in the sport of ice hockey?

For decades, the unique athletic motion of the ice hockey stride has required the adductor muscle group to endure relatively high forces in an abnormal, biomechanical range of motion. While gliding on a single leg, the adductor muscles contribute to hip and pelvis stabilization. As the athlete's leg moves backwards into the "push" portion of the stride, the hip is forced into the actions of extension, abduction, and external rotation. At this point, the adductors contract eccentrically to counteract these forces. This is followed by a rapid concentric contraction of all six adductor muscles that brings the leg and foot forward in preparation of supporting the athlete's weight as he places his skate down on the ice and returns to the glide portion of the

stride. These forces are increased during turning maneuvers, particularly when the athlete crosses the foot over the midline of his body to develop speed and power while changing direction. According to Chang, Turcotte, and Pearsall, a skater's stride depends on the adductor muscle group during all stride phases (2009). Thus, this overuse eventually leads to injury.

Since athletic injuries are so prevalent in ice hockey, determining which players are at risk of injury and developing prevention strategies are two important categories needing further research. The high rates of adductor muscle strains in ice hockey have led field investigators to develop and test protocols designed to identify individuals that are susceptible to injury. The investigative team of Tyler et al. created a strengthening protocol for at risk athletes (2002). To test the effectiveness of their protocol, 33 NHL players who were determined to be at risk of injury to the adductor muscle group were placed on a specific protocol designed to increase the strength of the adductor muscles. Based on the athletic trainers' 2001 injury reports, it was found that the injury rate decreased from 11 adductor injuries in 2001, the season prior to intervention, to 3 adductor injuries in 2002, the year of intervention.

The high rate of injury reported, and effectiveness of strengthening displayed by Tyler et al.'s 2002 study seems to suggest that all athletes involved in ice hockey would benefit from a strengthening program. Unfortunately, many research studies on this topic have focused on individuals that are already experiencing groin pain or have been identified as "at risk" for injuring the hip adductor muscles. The question remains if implementation of a preventative exercise and strength program specifically targeting the hip adductor muscles can reduce the overall injury rate to these muscles, including those individuals not identified as being "at risk" of injury. The purpose of this study is to examine whether implementing an adductor

strengthening protocol on a new population of Division III male ice hockey players will decrease the risk of hip adductor strains.

Statement of the Problem

Can the implementation of a standardized hip adductor muscle strengthening exercise protocol reduce hip adductor muscle strains for a Division III Men's Ice Hockey Team?

Definition of Terms

Hip Adductor Strain is defined as any injury in which an athlete experiences pain within the origin, tendon, or muscle belly of any of the hip adductor muscles resulting in a decrease in the range of motion and/or strength of the hip. An adductor strain requires assessment and treatment by the team athletic trainer or physician.

Hip Adductor Strengthening consists of a series of exercises that promote hip adductor muscle activation and stability to improve an athlete's strength, flexibility, and functionality.

National Collegiate Athletic Association (NCAA) Division III Men's Ice Hockey is comprised of 76 men's ice hockey teams throughout the United States that are separated into nine conferences. The NCAA and various conferences apply rules and regulations to their teams.

Hypothesis

Research Hypothesis – The implementation of a standardized hip adductor muscle strengthening exercise protocol will reduce hip adductor strains for Division III men's ice hockey teams.

Null Hypothesis – No significant difference in hip adductor muscle strain frequency will arise between athletes who did not participate in the exercise protocol prior to 2010 and athletes that participated in the 2010 protocol.

Delimitations

1. The participants of the study are members of an NCAA Division III Men's Hockey program. The only truly relevant population that we will have the ability to relate the results to will be limited to other NCAA Division III Men's Hockey Programs that have similarly competitive schedules and training methods.
2. There is potential for bias within the limits of this investigation.
3. The researchers have decided to investigate hip adductor muscle injuries specifically, and not any of the other structures or systems in the body. Time and participation loss, as well as biomechanical compensation because of injuries in other areas of the body can reduce or increase an athlete's risk of sustaining a hip adductor injury.
4. The researchers have outlined a specific strengthening program to utilize for the study that could have included or excluded several different exercises (see Appendix A).

Assumptions

1) All athletes will perform to the best of their ability during the intervention strengthening exercise protocol.
2) If the incidence of injury does fluctuate after implementing the strengthening protocol, it is assumed that the program brought forth the change in injury rate.
3) All athletes adhere to only the treatment protocol and do not perform any extra exercise repetitions outside of their required team lifting schedule.
4) All athletes will report any groin pain to the team's certified athletic trainer (ATC) if they are experiencing it.

Limitations

1) Sample size in this study is relatively small.
2) Each athlete will not have the same number of exposures for injury. This includes time missed from practice or games secondary to injuries or conditions other than a hip adductor muscle strain. Also, because of individual's sport ability or team needs as deemed by the coaching staff, not all players will receive equal exposure during game conditions.
3) Period of observation is limited based on the length of the NCAA Division III ice hockey season. Depending on how successful the team is, the game schedule can differ each year, affecting the number of exposures that each athlete will have.
4) The effect of the length of season and scheduling on injury rates secondary to physiological and psychological fatigue is unknown.
5) Athletes may be more prone to hip or groin injury than others based on anatomical predisposition as well as the position they play in the game of ice hockey.
6) The timing of the study's intervention in reference to time of day, collegiate coursework, and practice and game schedules of the team cannot be completely consistent.

Chapter 2: Review of Related Literature

Adductor muscle injuries are prevalent in the game of ice hockey. This chapter will review publications that involve hip adductor injuries in sport. In recent years, many studies have documented the rate of injury to the groin/hip area. Overwhelmingly, this particular injury has been shown to account for roughly 10% of all documented ice hockey injuries over a regular season by several publications reviewed for this project (Agel, Dompier, Dick and Marshall (2007), Chang et al. (2009), Emery and Meeuwisse (2006), Flik, Lyman, and Marx (2005), Montelpare, Pelletier, and Stark (1996)). The unique biomechanics of the skating stride has been identified as a main factor for the high rate of strain and injury (Chang et al., 2009). This review of literature is divided into two sections, the first being articles that analyzed the motion of the adductor muscles in and the second being sources that focus mainly on injury rate information.

Analysis of the Adductor Muscles in Sport

To gain a broader sense of why the adductor muscle group is injured so frequently, papers that reviewed this muscle group in all sports were also reviewed for this chapter. The first of these articles was written by Lynch and Renstrom in 1999. The main goal of their publication was to educate the reader with regard to the sport and medical fields on how groin injuries originate. They also provide information about different types of injuries to the hip and their specific treatment protocols. Injuries other than adductor strains that they described are stress fractures, avulsion fractures, osteitis pubis, sports hernias and nerve compression. When discussing adductor strains, Lynch and Renstrom mention that many start as small muscle-tendon tears that occur in areas that do not heal quickly due to the lack of blood supply (1999). Soccer is given as an example of a sport with a high rate of adductor injury occurrence.

Similarities to ice hockey injury rates are noted, as the average rate of injury is reported to be 10-18% in soccer players. A slow progressing stretching and strengthening protocol is suggested to return these athletes to sports, as quicker progressions show higher rates of re-injury (Lynch and Renstrom, 1999).

In a 2002 study, Tyler et al. also looked specifically at adductor muscle strains in sports. The goal of their paper was to evaluate different grades of injury, sites of injury, and options for treatment mentioned in multiple existing studies on the hip. The authors identify ice hockey and soccer as the two sports carrying the most risk for adductor strain injuries. They also stated, similar to previously discussed studies, that "groin strains accounted for 10% of all injuries in elite Swedish ice hockey players" (Tyler et al., 2002, pp. 340). Risk factors mentioned include loss of range of motion because of previous injury and an imbalance in strength bilaterally.

In addition, a number of additional studies that were the platform for this paper were those that performed experiments on athletes who had previously sustained adductor injuries. First, in 1999, Holmich et al. examined a group of 68 athletes who had suffered from groin pain for an extended period of time. The group was randomly placed in two separate treatment groups, one group receiving active strength training rehabilitation and one receiving physiotherapy treatment, which included modality and stretching treatments. Of the 59 that completed the study, the return to play rate was much higher in the active strength training group, suggesting that including strengthening exercises in the hip adductor treatment protocol promotes full recovery. The difference between groups proved to be statistically significant ($P < 0.04$).

Looking further into experiments involving injured athletes, over a two year period Tyler et al. (2002) performed a study involving 83 professional ice hockey players. All subjects participating in the study had the flexibility of their hip adductor musculature measured as well as the strength of their adductors and abductors of the hip. Strength was measured by a manual muscle-testing device to ensure accuracy. The flexibility and strength of the hip flexors were also measured. All measurements were obtained by the same researcher to maintain reliability (Tyler, Nicholas, Campbell, and McHugh, 2001).

Through the two seasons, the investigators stayed in close contact with team athletic trainers and physicians to identify which players had injured their hip adductors (Tyler et al. 2001, Tyler et al. 2002). From this information, they discovered that the players who suffered from adductor muscle strains had an imbalance in strength between the adductors and abductors of the hip. More specifically, the adductors were less than 80% of the measured strength of the abductors in the injured population. After this discovery, players who fell into the group of having adductor strength of 80% or less of the measured abductor strength were placed into an "at risk" group for adductor muscle strains. In addition, low numbers of hip flexor strains were found. These findings have become the basis of this project. Adductor strains have been identified by Tyler et al.'s 2001 study as a key area of concern when looking at frequent hip injuries of ice hockey players.

After this experiment, Tyler et al. performed a follow up study on the same professional hockey team in 2002. In this experiment, only the 33 players who were in the "at risk" group were used as subjects, and they were all placed in an adductor strengthening program prior to the hockey season. The strengthening program lasted six weeks and was performed three times per

week. In the previous two years, 11 adductor strains were found in these individuals, and in the two years during the intervention phase there were only three instances of adductor strains. The reported incidence of injury pre-intervention was 3.2 strains per 1000 exposures. This was reduced to 0.71 strains per 1000 exposures, which is a significant reduction in risk ($P < 0.05$). This further proves the findings of Holmich et al. (1999) by supporting the idea of strength program implementation being able to return players to full and painless use of their adductor muscle group after injury.

In addition, Chang et al. (2009) studied electromyography (EMG) recordings of the muscles of the upper leg during the skating stride. A group of seven male college ice hockey players participated in the study. The subjects were connected to EMG leads to record the activity of their adductor magnus, vastus medialis, biceps femoris and gluteus maximus while they skated on a skating treadmill. It was reported that the adductor magnus "exhibited disproportionately larger increases in peak muscle activation (compared to other muscles) and significantly prolonged activation with increased speed" (Chang et al., 2009, pp. 212). Their experiment has provided the research community with an evidence based explanation as to why and how the adductor muscle group may be injured so frequently during the skating stride.

These studies have shown how prevalent adductor injuries are in male ice hockey. Although some reviewed studies clashed in their methods or results, the common conclusion is that nearly 10% of all injuries suffered in the game of ice hockey are adductor muscle strains. This leads into the analysis and intervention of the injury. Analysis showed that the adductor muscle produces more force than any other major muscle in the hip region and therefore it bears more force as well upon leg recoil. More recent studies have applied this information and

documented that strengthening programs are an effective tool to decrease risk of and return players from adductor groin strains.

Historical Statistics of Injuries

This section primarily reviews longitudinal studies whose purpose are to examine documented injury data that was recorded for a specific ice hockey team(s) over an extended period of time. The first of these studies reviewed was a study performed by Agel et al. in 2007. This study reported the results of an injury data collection system run by the NCAA on men's collegiate ice hockey called the "Injury Surveillance System" or ISS. Athletic trainers from approximately 25% of all Division I, II and III varsity men's ice hockey teams recorded all injuries into this collection system between the years of 1988-2004. The study reports that pelvis and hip muscle strains were the most common injuries suffered during a practice situation, accounting for 13.1% of all practice injuries. Hip muscle strains also accounted for 4.5% of all game injuries and 6.2% of all injuries requiring 10 or more days of activity time loss suffered in a practice. It must be noted that this study included "hip and pelvis muscle strains" as a single category meaning that some injuries may include the hip flexor and hamstring muscles (Agel et al. 2007).

The next study based on injury statistics was a prospective study performed by Kuzuhara, Shimamoto and Mase in 2009. The researchers documented all injuries in an elite Japanese male ice hockey team (average age 26 years-old) in the Asian Ice Hockey League over a three season period. An injury was defined as "any event that required medical attention and treatment" (Kuzuhara et al., 2009, pp. 209). In contrast to Agel at al. in 2007, it was determined that strains of the medial thigh were much more prevalent in game situations in this group of subjects

compared to practice situations (8.2 injuries per 1000 player-game hours compared to 1.0 injuries per 1000 player-practice hours). It is noted that the two studies mentioned above did not analyze data with the same method, however they are comparable when considering game to practice injury risk, and both identified hip muscle strains as an injury with high prevalence.

A study performed by Emery and Meeuwisse in 2006 examined injury rates of 71 youth hockey teams in Canada (ages 9-16). An injury in this case was defined as "any injury occurring during the regular hockey season that required medical attention, removal from a session, or missing a subsequent session" (Emery and Meeuwisse, 2006, pp. 1960). Weekly injury sheets were collected by certified athletic therapists, who are the Canadian version of ATCs, and brought back to the investigators for further analysis. It was found that about 4% of all injuries were groin/thigh muscle strains. Although this number is lower than many other studies included in this review, it must be taken into account that this is a much younger population of participants than any of the other studies. This may account for the lower injury rate because of the differing anatomy in older ice hockey players who are more developed.

Turning back to a study performed on hockey players closer to the age in question, Flik et al. performed an analysis of injuries in American collegiate men's ice hockey in 2005. The investigators looked at eight NCAA Division I men's ice hockey teams over the period of one season, collecting injury data through an injury reporting form created specifically for ice hockey ATCs. An injury was defined as "an event that caused a player to miss the subsequent practice or game" (Flik et al., 2005, pp. 186). The investigators found that hip/groin injuries accounted for 9% of all injuries recorded. Once again, from the wording one can assume that hip/groin includes hip flexor injuries along with the groin injuries. Compared to other studies reviewed,

this is the only one to use an injury recording system that is specific to ice hockey which is a great strength of the design, however not many teams were observed and they were only observed for one season.

These studies seem to indicate that groin injuries in hockey are prevalent in nearly every age group playing the game. The average percentage of hip/groin strains in ice hockey is around 10%. There was also some conflicting information found in this group of studies. First is the definition of an injury, which some included any injury requiring momentary medical attention. Others included only injuries requiring a player to miss a practice or game session. Also, none of the studies reported adductor/groin injury rates by themselves as the hip muscles were always included in this statistic.

Chapter 3: Methods

Subjects

Subjects will not be chosen randomly for convenience. Subject demographics include: Ages: 18-24 years old. All subjects have excelled in high school hockey, and the majority have played transitional junior level hockey before coming to the National Collegiate Athletic Association (NCAA) Division 3 level. The subjects have no specific training outside of general off-ice weight lifting and dry-land workouts in relation to hip flexor strengthening exercises.

All returning athletes will have an injury record on file from the previous year. This information will be recorded prior to starting this study. During the initial preseason training of the intervention season, all potential subjects will be informed about the study, and given a choice to participate or not. All details will be placed in an informed consent form that the athlete will sign (see Appendix B).

Instruments

One outside instrument will be used in this study. The instrument is the groin strengthening program that the subjects will be subject to during the intervention phase. For a detailed version of this program, see Appendix A.

Procedures

1. A meeting with the head coach of the team will be held to explain how the strength exercises will be implemented and how they will affect his athletes.

2. The subjects of the study will perform the strengthening protocol twice per week. The program will be monitored by the researcher in the team weight room to ensure that the subjects complete the program and perform the exercises properly. The intervention will be scheduled to

coincide with the team's workout schedule. For the first six weeks of the regular season, each subject will be put through the same exercise session prior to their lifting or cardio workout session two times per week. For a detailed description of the strengthening program, refer to Appendix A.

3. All injuries during the team's season will be recorded. All adductor strains recorded as part of this data set will become data in the study.

Data Analysis

Data will be analyzed based on the amount of injuries that are found and in which groups the injuries occurred. The amount of subjects injured in the pre-intervention season will be compared to those of the intervention season to provide insight into the effectiveness of the protocol. The amount of injuries per 1000 exposures will be calculated for pre and post intervention and the chi-square method analysis will be used to determine significance.

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Appendix A: **Hip Flexor and Adductor Muscle Strengthening Program**

This program is to be performed twice per week under the supervision of the researcher during the NCAA Division III ice hockey season. Each individual session will consist of four exercises. The list below describes each exercise and how often each exercises should be performed

- **Skaters** – with a resistance band around one ankle that is attached to the wall, the subjects will begin with the involved hip extended to their maximum comfortable active range of motion and abducted 45 degrees. They will then actively flex and adduct at the hip, bringing the leg into a neutral position against the resistance of the band. They will three sets of 15 repetitions on each leg. This exercise is to be performed during every session.
- **Ball Squeezes** – Lying supine with their knees bent at 90 degrees and feet on the floor, the subjects will place a soccer ball between their knees. They will isometrically contract their adductors in an attempt to squeeze the ball between their legs, holding this contraction for three seconds per repetition. This exercise will consist of two sets of 25 repetitions. This exercise is to be performed during every session.
- **Forward Lunges** – The subjects will step forward with the right leg and lower their body until the right knee is at a 90 degree angle. From here, they will push back off of the right foot to the starting position which is one repetition. They will perform three sets of 10 repetitions on each leg. This exercise is to be performed during the first session of every week. Beginning one month into the program, the subjects will hold a 20 pound dumbbell in each hand while performing the exercise to increase the intensity.

- **Lateral Lunges** – The subject will step with their right leg as far laterally as they can, lower their body until the right knee is at a 90 degree angle, and then push back off the ground to the starting position. Perform three sets of 10 repetitions on each leg. This exercise is to be performed during the first session of each week. Beginning one month into the program, the subjects will add a 45 pound bar held across the back of the neck and top of the shoulders to increase the intensity.
- **Hip Adduction** – Standing with a resistance band that is connected to the wall around one ankle, the subjects will begin in complete hip abduction. The leg will be pulled into adduction all the way across the midline of the body, consisting of two sets of 15 repetitions during the second session of each week.
- **Sumo Squats** – Standing with feet shoulder width apart and the hips in slight external rotation, the subjects hold a 10 pound medicine ball. They will squat down until their knees are either at or just past 90 degrees of flexion and then push back up to the starting position, consisting of three sets of 15 repetitions during the second session of each week.

Appendix B: Pre-Season Hip Injury Questionnaire

This questionnaire is designed to better understand information regarding your previous history of hip injuries. In particular, we will be trying to identify if you have ever sustained muscular injuries to your groin and/or hip flexor. Through identifying which players have had certain types of hip injuries, it will allow us to categorize our data at the end of this study more efficiently.

Your answers, like all other data in this study, are completely confidential and voluntary. Please answer all questions and provide as much information as possible. Every piece of information is helpful. Thank you!

1. Have you ever had a major hip or lower extremity injury? (i.e. birth defect, car accident, fall, fracture, or surgery) If yes, please explain.
2. Have you ever had any type of lower back pain or injury? If yes, please explain.
3. Have you ever experienced numbness or tingling in your hip or lower extremities? If yes, where?
4. Have you ever had a muscular injury at the hip (Adductor, groin, hip flexor, quadriceps, glutes, or hamstring)? This includes any pain that you have had in muscles that could not be attributed to "normal soreness."

    If YES:

    a. Where was the pain/injury? (Can be multiple places)
    b. Which side(s) was involved?
    c. How did it begin? (Sudden or gradual onset)

d. Did you see a doctor for this injury?

e. Did you ever experience pain or discomfort while playing ice hockey because of this injury? If yes, during what parts of the game or skating stride?

f. How much time did you take off from sports or physical activity because of this injury?

g. Are you currently experiencing complications from this injury?

Appendix C: Informed Consent

You are invited to participate in a research study titled "Can the Implementation of a Standardized Hip Adductor Muscle Strengthening Protocol Reduce Hip Adductor Muscle Strains for Division III Men's Ice Hockey Teams?". This study will involve you participating in a workout program to strengthen your hip muscles. This study will compare the rate of hip muscle strains sustained in last year's season to the upcoming season. You were selected because you are a member of the St. John's University men's ice hockey team. This research project is being conducted by:

Dr. William Picconatto, a faculty member in the Athletic Training Department at St. Cloud State University;

Benjamin St.Martin to satisfy the requirements of a Master's Degree in Sports Management at St. Cloud State University.

Background Information and Purpose

The purpose of this study is to test the theory that increasing the strength in adductor and hip flexor muscles decreases the rate of injury in ice hockey players.

Procedures

If you decide to participate, you will be asked to perform three to four extra exercises that are specific to hip strength during your normal workout sessions scheduled for your team.

Risks

Potential risks of this study include all normal risks of exercise during your workout sessions. These exercises will not be as physically demanding as most exercises that you are used to, but will target your leg muscles in a way that you may not be used to. This may lead to quicker rates of fatigue, muscle soreness, and lightheadedness. You may not participate if you have any

known abnormal cardiopulmonary conditions without previously being cleared by a physician. To minimize risk, a certified athletic trainer will be present at all workout sessions.

Benefits

Benefits of this study will be the normal benefits seen in resistance exercise. Your strength, proprioception, and flexibility may increase in the hip muscles that are being targeting with these workouts.

Confidentiality

Your confidentiality will be maintained throughout the study. When reporting this data in this thesis, names will not be used as you will be assigned numbers. The only people who will have access to the data as it is connected with your name will be Benjamin St.Martin, Dr. William Picconatto, and all staff athletic trainers at St. John's University, which is standard practice in the athletic training profession. The raw data obtained will be stored securely and will be destroyed in seven years, which is standard practice for maintenance of medical records in an athletic training office.

Research Results

At your request, you will be provided a summary of the results of this study at the completion of data analysis. This starred paper will be placed on file at St. Cloud State University's online Repository.

Additional Resources

If you are interested in the theory behind and/or previous research on this subject, you will be given all research obtained for this paper upon request.

Contact Information

If you have questions right now, please ask. If you have additional questions later, you may contact Benjamin St.Martin at (860) 508-6332 or bstmart@bridgeport.edu or Dr. William Picconatto at wjpicconatto@stcloudstate.edu

You will be given a copy of this form for your records.

Voluntary Participation/Withdrawal

Participation is voluntary. Your decision whether or not to participate will not affect your current or future relations with St. Cloud State University, the researchers, or St. John's University. If you decide to participate, you are free to withdraw at any time without penalty.

Your signature indicates that you have read the information provided, and have decided to participate. You may withdraw from the study at any time without penalty after signing this form.

Compensation

No monetary compensation will be provided for participating in this study.

Medical Treatments Available

If an injury should occur, you will be able to report to your assigned certified athletic trainer for injury evaluation, treatment, and rehabilitation free of charge as normal athletic training protocol at St. John's University. You are also free to go to any other medical professional for advice and treatment at your own expense.

New Information

You will be informed of any significant data during the course of this research that could influence your willingness to continue participating.

_____
Subject Name (print)

_____
Subject Signature Date