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# Maintenance of Hip and Core Areas for Ice Hockey Goaltenders- A Video Training Guide

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Abstract

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**Keywords:** ice hockey, goaltending, hip area, maintenance, injury prevention, core, training

The purpose of this thesis was to serve as a manual for off-ice training for ice hockey goaltenders and coaches. The anatomy of the hip and core areas were studied and reflected to the requirements of playing as a goaltender. The research showed that hip and core training are vital for goaltenders' performance and health. The goal for the thesis process for the author was to gain insight in the problems surrounding the hip and core areas. Existing literature showed that there are multiple problems in terms of hip and core areas for goaltenders, and for some of the issues, the mechanism of an injury is slightly unclear. The most vital muscles for goaltenders were identified, both in terms of the hip and core areas, their effect was studied and presented, and then a training plan was created to develop those muscles.
To summarize the literary review, the hip and core area muscles are vital in terms of injury and issue prevention of the hip area. In terms of the most vital muscles, it was found out that when considering the internal rotators, the muscles are the adductors and abductors, the gluteus minimus and medius, the tensor tascia latae. The muscles involved in the external rotation are also vital. Some of them include the gluteus medius and minimus and the lateral rotators. Improvements in core and hip area muscles will prevent an incorrect posture, in which the bottom of a goalie drops towards the ice and their knees spread out. This causes stress to the hip area.

During the thesis process, a wealth of new knowledge was gained by the author. The effect of specific muscles, and mainly the key finding that core area strength and control are a factor in the stress caused to the hip area. The product is a video manual/training routine designed specifically for ice hockey goaltenders. The exercises in the product are chosen because they target the specific, most vital muscles for goaltenders. Training those muscles may reduce the risk of hip injuries. The video manual will serve as a helping tool for goalies and goalie coaches in planning off-ice training.

For future, more extensive studies of the hip and core areas would be extremely beneficial, e.g., the effects of given training methods, ways to recognize weaknesses and warning signs.

Table of contents

# 1 Introduction

Goaltending is widely regarded as the most important position in ice hockey. When compared to the other positions in hockey, it can be considered as being almost like a different sport, due to the drastically different physical and mental demands. However, in the vast majority of junior hockey teams, the goalies perform exactly the same off-ice routines as the players. That is mainly due to the limited resources and knowledge that teams have. One issue can also be the culture. Some coaches are very "old-school". That can be seen as a mindset that every player has to do the same exercises because hockey is a team sport. This is evident in the planning and execution of training.

An issue with goaltender training is the broadness of training that should be conducted. A goaltender should be quick to move and react, in good condition physically and mentally, healthy, and able to stop the puck in multiple ways. The author believes that there should be one or two areas to focus on at a given time. It is inefficient to train all attributes at once, when the total amount of training is high. (Vesterinen 2020), in terms of goalie training it would possibly be ineffective to focus on multiple qualities (for example, speed, strength, hip and core areas). In the thesis, the quality chosen is hip and core areas. That is also the main focus in the off-ice training of goaltenders.

Hip area problems are very common for goaltenders. In Sweden, a study was conducted on 101 goaltenders that played either professional hockey, or the top-level junior hockey. Based on the responses, it turned out that 69% of the goaltenders participating in the survey suffered from hip and groin problems at least once during a hockey season (from September to May). For "significant" problems, the same result was 36%. (Wörner, Clarsen, Thorborg & Eek 2019) Based on these responses, hip area problems can be considered common for goalies, and something that would be very beneficial to prevent.

The plan and aim for the thesis is to serve as a video manual and a workout routine for goalies. Hip and core areas are vital for a goaltender in terms of both performance and injury prevention. These are also areas the author feels that are very neglected in training. Based on the author's own experience as a goaltender, especially the hip area is something that was not focused on enough, even though the author personally has been relatively injury-free in that aspect.

## 2 The commissioning party

The commissioning party for the thesis is TuTo juniorijääkiekko. TuTo (Turun Toverit) is a multi-sport club based in Turku, Finland, which has divisions in multiple sports. (TuTo Ry n.d) The thesis work is done for the junior hockey organization, which the author works for. The organization also includes a co-operative club, Kisurit. The clubs work in very close co-operation, thus nearly everything that is discussed in the thesis about TuTo can apply to Kisurit as well. The goalies in Kisurit are also the target group of the thesis. The thesis was created due to the lack of specific off-ice training plans for the goaltenders within the organization. The video was chosen as the form due to the ease of distribution. The hip and core areas were chosen as the subject due to their importance in goaltending.

# 3 The frame of reference

In the figure one, the frame of reference can be seen. The starting point for the thesis was the frequency of hip area issues that plague goalies, and the possibilities of mitigating those injuries. Playing goalie can be seen as being the hardest sport on the hips. (Miers 2018)

Starting from the top, are the hip area issues in general. There are some specific problems that will be discussed later on in this thesis, but in the frame of reference, the hip area injuries are viewed as a very general, broad subject. When going down the figure, all of the parts connect to the part above, and are dictated by the part above.

The human anatomy of the hip and core areas was studied, and the findings reflected to the requirements of playing goalie. The most vital muscles were identified in terms of goalies.

The training plan was designed and filmed on video. The plan was designed to improve the muscles of the hip and core areas. The most vital muscles for goalies were the focus on the plan.

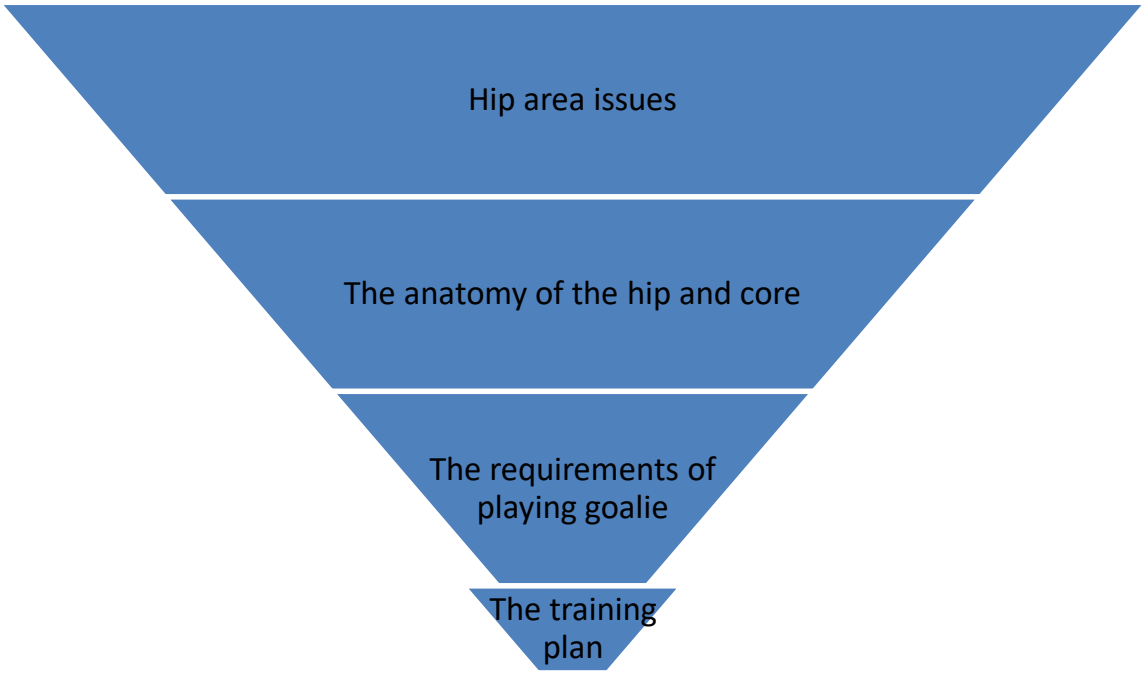


Figure 1. The frame of reference

The main concepts are off-ice training, which is, as the name suggests, training that is done when not on the ice, focusing on all sorts of “supportive” skills for skaters and goalies. Core (and core training) is used when referring to the muscles, and training those in the pelvis, lower back, hips and abdomen. (Mayo Clinic 2020). The term “hip area” is used to refer to the muscles and joints around the hip area. The function of the hip joint is to connect the axial skeleton to the lower extremities. (Physiopedia N.d)

# 4 Existing publications

There are some written publications within the same field as this particular thesis. For example, a goaltenders' manual, which was made for the organization of Tappara. That focuses on mainly the technical, on-ice training, different in-game scenarios, and how the goaltender should play them. That manual also focuses on the mental side of goaltending, which is vital, but will not be the focus in my thesis. In addition to the in-game situations presented in the publication, the different points of focus and requirements for different age groups are presented from the organizational viewpoint. The author also provides information about the basic movements and saves a goaltender is required to make. (Nordman n.d).

# 5 Hip area issues

Over the course of a single season, of the 101 high-level goaltenders studied, 69% of them experienced hip and groin problems at least once, and 36% of the goaltenders suffered from substantial problems, that affected their performance. (Wörner,Clarsen, Thorborg& Eek 2019). During games and practice sessions, a goaltender drops to the ice and moves along the ice multiple times. The stress from the saves and movements done while being on the ice (especially in the "butterfly" position) is mainly focusing on the hip area and the knees. (Suomen Jääkiekkoliitto N.d)

Perhaps the most talked- about condition of goalies is the Femoroacetabular Impingement (FAI). The FAI is caused by abnormal contact during movement of the hip, which is also called "impingement" that occurs between the head-neck junction of the femur, which is the upper part of the thigh bone, below the ball, and the rim of the acetabulum, which is the socket part of the hip joint. (NHS Royal Berkshire 2019).

Even a slight abnormality in the head-neck part of the femoral bone can cause the acetabulum to be under stress. When repeated, this stress will cause the FAI. When junior aged ice hockey players were compared with skiers of similar ages, hockey players were diagnosed with over four times the radiological changes, that fit the spectrum of symptoms of the FAI. Thus, the consensus is that hockey players, especially goaltenders are in danger of developing and suffering from the FAI. It can however be prevented by improving the muscles on the hip and groin areas. (Kallio & Koskinen K 2015)

The cause of stress to the hip joint is the motion of dropping to one's knees and flaring the feet outwards, especially in the butterfly. (Miers, 2018). It is estimated that the amount NHL goalies perform the movement of dropping to the butterfly can be over 300 times per practice, and 28-40 times per game. (Mehta, Nwachukuwu & Kelly 2019). However, the stopping motion has been found to produce greater hip motion than the butterfly. (University Of Michigan 2018). The forementioned" stopping motion" is used to refer to the stop that the goalie does with their leg, after a movement (generally a lateral movement what is called the T-push). The T-push is pictured below, with figure 2 showcasing the pushing phase (the start) of the T-push, and figure 3 showcasing the stopping phase (the end) of the T-push. The push is done vertically in the photos, but the principles of the lateral T-push are the same, the key difference being the rotation of the gliding leg.

Figure 2 The T-Push pushing phase. (Nordman, n.d)

Figure 3. The T-push stopping phase. (Nordman n.d)

# 6 The anatomy of the hip

The hip joint is what is called a “ball-and socket joint”. It allows motion and provides stability for the lower limbs to bear the weight of the body. The acetabulum, which is the socket area, fits within the pelvis. The top part of the thighbone (femur), which is the ball part of the joint. The femur is connected to the acetabulum to form the hip joint. Some of the parts mentioned can be seen in figure 4. (Johns Hopkins Medicine 2020) The hip joint allows for movement in three directions. Flexion and extension of the hip joint, the internal and external rotation of the hip, and abduction and adduction of the hip. (Gold,Munjal & Varacallo 2020)

The hip joint has a great importance in many sports. Not only does it change the direction of force, from the straight lower limb to the hip, which is in an angle. As a ball-and-socket joint, it also allows for a wide mobility. While jumping or running, the forces going through the hip joint can be up to 3-5 times the amount of one’s body weight. (Kallio & Koskinen K 2015)

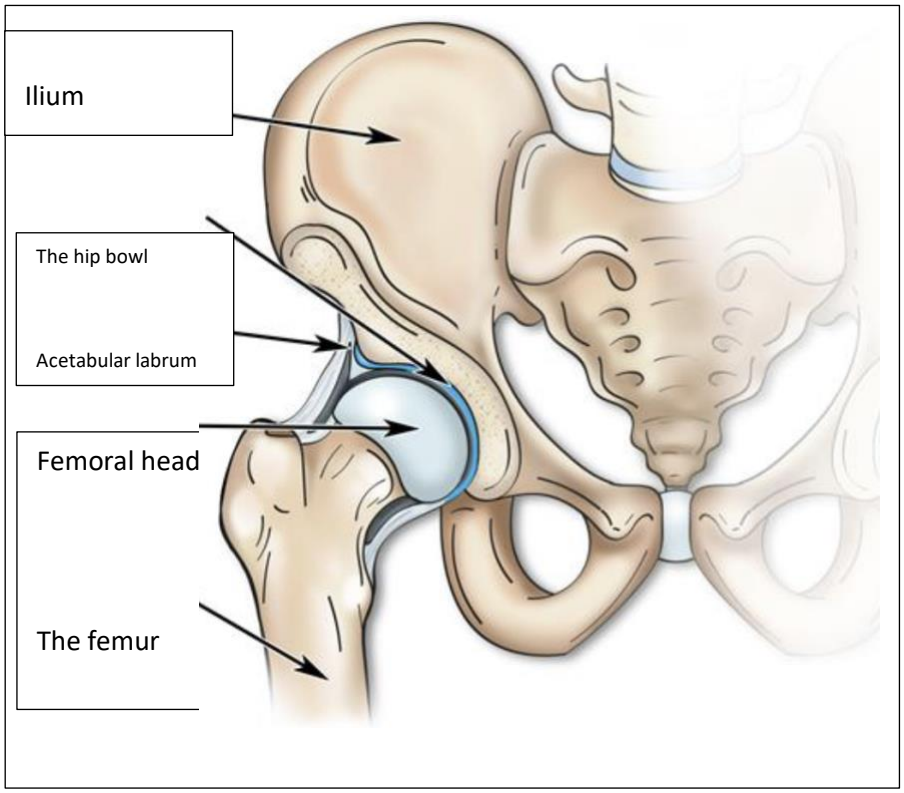


Fig 4. The hip joint, Adapted from (Terveyskylä, 2018)

The most important rotational muscles working in the internal rotation of the hip are the tensor fasciae latae, the gluteus minimus and parts of the gluteus medius. (Kapandji 1995) In addition to the internal rotation, the gluteus muscles (figures 7 and 8) are also important in extension, flexion and external rotation. (Löytynoja 2019). Moreover, together with the tensor fascia latae, some of the muscles involved in the external rotation are the gluteus minimus and medius (seen in figure 8), six small muscles, often referred to as "the lateral rotators", which are: obturator externus (and internus), quadratus femoris, piriformis, and superior and inferior gemelli. (Ocran 2020)

Some other important muscles are the inner and external rotator muscles of the hip, and the hip flexors. (Rämet, Saari& Virkkala N.d) The adductor muscle consists of five muscles: the adductor longus, the adductor brevis, the pectineus, and gracilis muscles. Their main action is the adduction of the thigh. They also work as important stabilization muscles for the pelvis. (Sendic 2020c). The iliopsoas is a muscle that is composed of the illiacus (seen in figure 5) and the psoas major (seen in figure 6) muscles. Those are a part of what are known as the hip flexors. The main function of the iliopsoas is to produce flexion of the thigh at the hip joint. (Sendic 2020b).

The specialized core and hip area training may help prevent these injuries for goalies later on. Goalies perform a variety of skating movements, that require as much, or even more mobility from the hip area as the butterfly. (Mehta, U. Nwachukuwu & T. Kelly 2019)

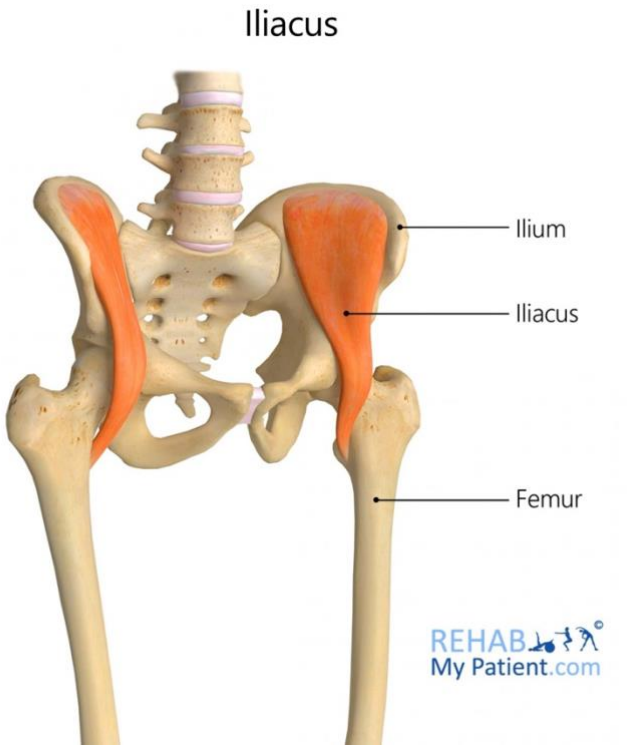


Fig 5. The Illiacus muscle (Rehab my patient, 2020a)

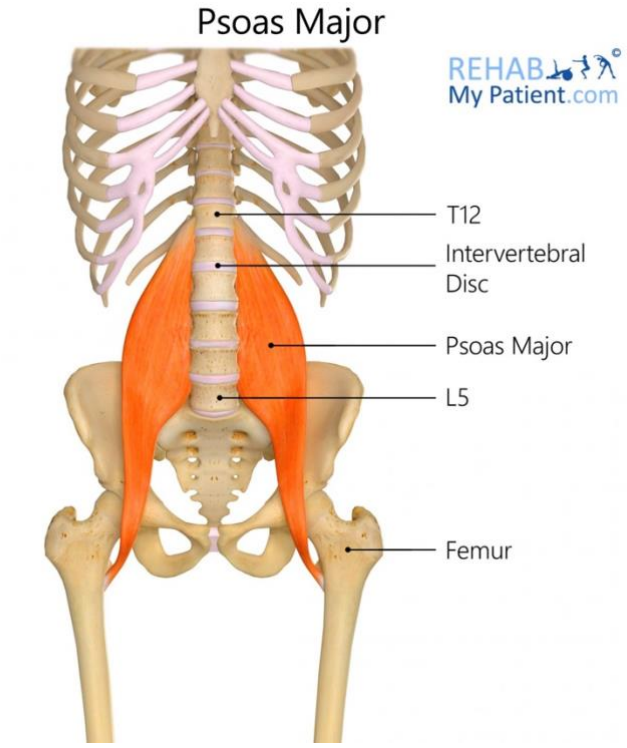


Fig 6. The Psoas Major muscle (Rehab my patient, 2020f)

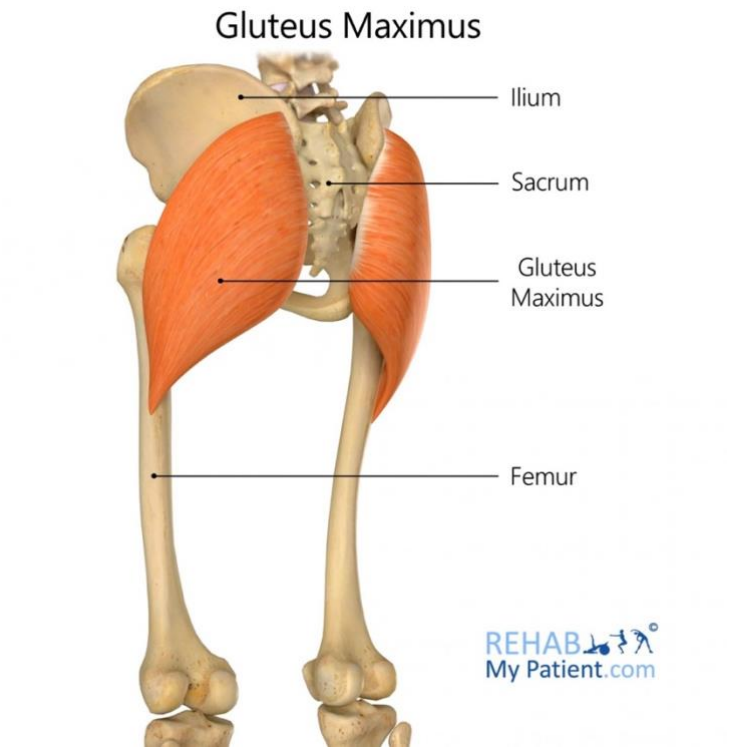


Fig 7. The gluteus Maximus muscle (Rehab my patient, 2020c)

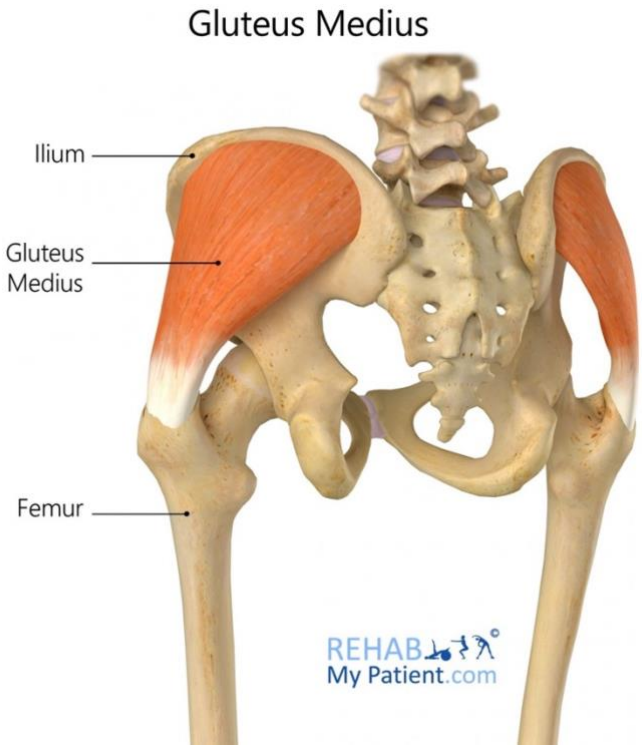


Fig 8. The gluteus Medius muscle (Rehab my patient, 2020b)

# 7 Anatomy and importance of the core

Core control can be defined as the ability to control the position of the body and the pelvis, the balance, along with the isometric and dynamic movements. The weakness of core muscles is a common cause to lower back pains. In addition, improved support from the core decreases the risk of lower-body injuries significantly. (Aho 2016)

Core muscles act in three ways. By stabilizing the lumbar spine, by extending and by rotating. The core muscles can be divided into “local” and “global” muscles. The local stabilators’ effect is limited to a single joint. These muscles work to control movements eccentrically. The effect of the global muscles is on multiple joints, that are more superficial than the local muscles. The global muscles act concentrically by providing movement and power. (Rintasalo & Turpela 2018) The local muscles are deep muscles, that have attachment points either on or near the vertebrae. The global muscles are typically superficial muscles, and they connect the extremities to the trunk, thus providing power for movements. Some examples of the global muscles, which are also considered stabilizers are the internal and external obliques (figures 9 and 10) and spinalis. (Huxel Bliven & Anderson 2013)

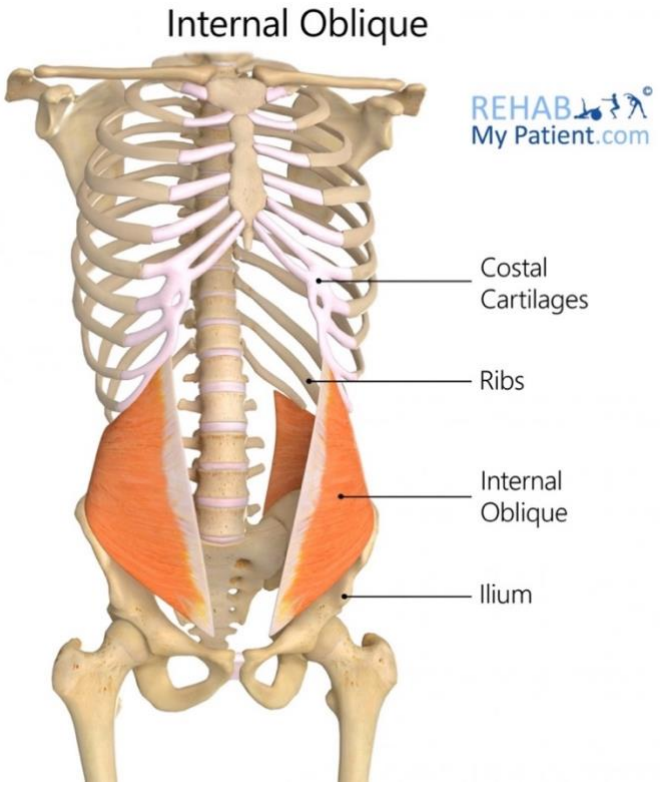

Fig 9. Internal oblique (Rehab my patient, 2020d)

Thus, the forementioned global and local muscles must all be trained. Increased movement control for a goalie can mean a better opportunity to make the save after movement, and a better opportunity to perform another movement. The global muscles, as mentioned, provide the power for movements. A goalie is required to use their upper body to direct movements and make saves.

The external abdominal oblique (figure 10) is a muscle, that is located on both sides of the abdominal wall. It is one of the muscles comprising the lateral abdominal muscles. The others are the internal abdominal oblique and transversus abdominis. The movements to the spine are produced by the external abdominal oblique muscle. (Vaskovic 2020)

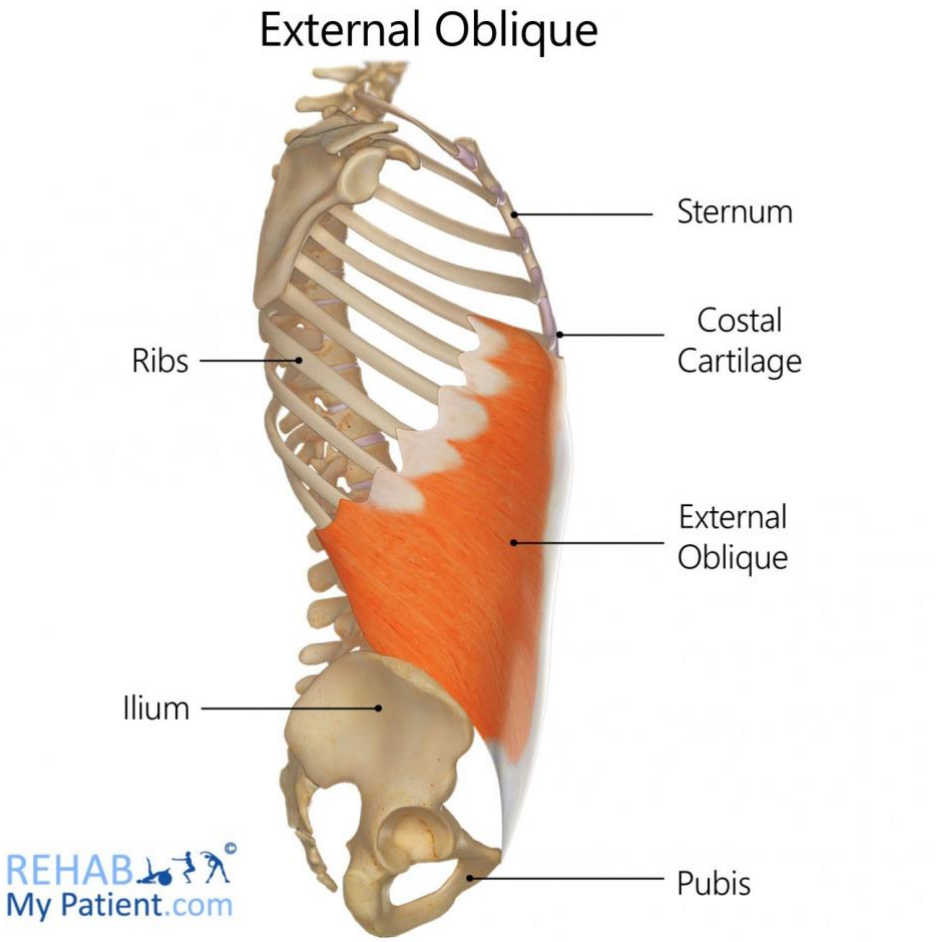


Fig 10. External oblique (Rehab my patient, 2020e)

A vital component in maximizing efficient athletic function is core stability. (Kibler,Press& Sciascia 2006). It is proven, that insufficient strength and endurance of the trunk-stabilizing muscles is associated with injuries to, for example knees and hips. When a weakness of any trunk-stabilizing muscle is identified and corrected, it decreases an individual's risk for joint and muscle injury. (Hibbs, Thompson, French,Wrigley & Spears 2008). Thus, the role of core training cannot be neglected. The plan will implement exercises to train the core muscles.

As mentioned previously, the impact of core training is beneficial to also preventing hip area injuries. For hip area, the most strain occurs when a goalie drops to the butterfly and their knees slip wider and their rear end drops down towards the ice. Core muscle training is an efficient way in preventing this type of strain. (Kallio & Koskinen 2015)

The previously mentioned hip area strain is very evident in young goalies. It can be seen while observing them on the ice. For many goalies, their rear end drops down while making the butterfly save. That can be due to for example (but not limited to) the lack of muscle strength and mass in their hip and core areas. One other sign for coaches to observe can be the lack of control of the upper body while the goaltender is performing a quick change in direction. When a goaltender's body is moving to one side, and they quickly have to stop and change the direction, it is vital for the goaltender to have a strong core, thus preventing the upper body from rotating to the opposite direction. The opposing movement can cause the loss of power for the following push. Also, when a goaltender's hands and feet are not in the positions they are supposed to be, holes for the puck to squeak past the goaltender are created.

When discussing sports injuries in children and youth, many of the non-contact injuries are caused by for example incorrect technique, or poor movement control. Typical injuries are caused by rotations to joints, and muscle sprains. They are most prominent in sports, which require fast-accelerating movements, sudden and repetitive changes of direction and stops. (Pasanen 2015)

# 8 Background

A goalie is considered by many to be the most important position in ice hockey. Goalies are considered to be an individual athlete within a team. Playing as a goalie places special challenges to the athlete in regard to for example mobility, core control, speed, strength and endurance. The mental challenges are different to other players too. A goalie plays the entire length of the game (60 minutes), while a player is on the ice for a fraction of that time and for short bouts at a time. (Kilpivaara 2011)

Mitch Korn, one of the most respected goaltender coaches in the NHL described goaltending so that it can be broken up into three main components. The physical, the mental, and the emotional part of the game. Each of them is more demanding than the majority of professions on the planet. (Korn 2015). This thesis will focus on only the physical demands, and especially focusing on the hip and core areas.

The vast majority of goalies today play with a style, that relies heavily on a save called the "butterfly save". The butterfly save requires flexibility, control and power from the muscles of the core, hip area, and lower limbs. (International Ice Hockey Centre of Excellence). The butterfly save can be considered to be a vital part of a modern goaltender's playing style. Virtually every goaltender in any competitive level uses the save. (InGoal Magazine 2015) Thus, it can be considered an essential part of goaltending. However, that places stress on many areas of the body. It is crucial for a goaltender to maintain a high hip position and the knees close to each other, to limit the stress on the hip area. These are enabled by training the hip and core area muscles. (Kallio & Koskinen 2015). It has been studied that men with higher Hip Osteoarthritis had significantly lower muscle strength in terms of abduction, adduction and flexion. The muscle strength of the Osteoarthritis patients was 67-68% compared to the strength of the healthy group. One suggestion is that strong muscles in the hip area may prevent the Hip Osteoarthritis. (Arokoski, et al., 2002)

Similar results were found in the study by (Harris-Hayes, et al., 2014); muscle strength of adults suffering from symptomatic FAI was assessed, and it was found out that there were weaknesses in the hip abductors and external rotators. Patients with chronic hip joint pain were also found out to possess reduced hip muscle strength. Weakness of hip flexors and adductors in patients suffering from the FAI was also found to exist. (Harris-Hayes, et al. 2014)

# 9 Productization

Productization is defined by Cambridge Dictionary in the following way: “To make something into a product which can be sold” (Cambridge Dictionary)

A service that is well productized can be easily duplicated. It is not dependent on a single person. Imagine a company that is bought by a foreign investor. They lay off every worker in the restaurant, replacing them with new workers. If the new workers are able to produce the same service as before, the service is well productized. (Parantainen 2013)

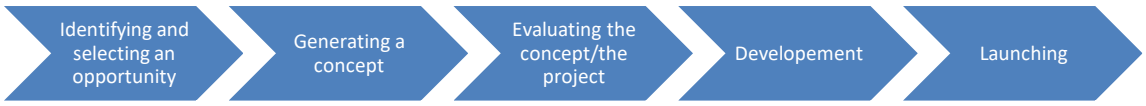


Fig 11. New product process. Adapted from (Suominen;Kantola;& Tuominen)

For this thesis, the process is the following:

- Identifying and selecting an opportunity was done in the spring of 2019 when the author did his practical training at the same company the thesis is commissioned to. The idea for making the thesis this way came from one of the coaches in the organization.
- Generating a concept: This is the foundation of the thesis. The heart of the work will be creating a concept (the video manual) for the commissioning company.
- Evaluating the concept/project will be done throughout the project. It will be evaluated in the writing stage, and throughout the implementing stage as well.

- Development is continuous as well. It is done based on my own observations and feedback from other coaches.

- Launching is done in the beginning of 2021.

# 10 The thesis process

## 10.1 Objectives of the thesis

The objective of the thesis is to study the anatomy of the hip and core areas and design a training routine to improve the muscles and mobility of the areas, thus possibly and hopefully decrease injury risk further down the road. As mentioned before, hip and core training can be considered vital for goalies. It is also an area of training that is often neglected. That can be seen in the study mentioned before. (Wörner,Clarsen,Thorborg& Eek 2019). The thesis process is based on theoretical background that is introduced in the thesis.

## 10.2 Background

Goalie coaching has been a neglected area in the organization. The author did his practical training in the organization in the spring of 2019, and the idea for writing the thesis for the organization came up then by one of the coaches. The original plan was to create a goalie coaching system, but that proved to be too difficult to create in thesis form. Thus, the thesis got its current form. The thesis, especially the product will be another resource for the organization to use in the planning of the off-ice practice sessions.

## 10.3 The implementation

The thesis was published in the beginning of 2021. The initial work began in the autumn of 2019 with the thesis plan. The spring of 2020 was spent working on the thesis, and the beginning of

2021 was spent with finalizing the thesis and the product. The thesis and the product were published in the beginning of 2021, and the product was implemented right away.

The process for choosing the exercises for the video was the following, seen in figure 12:

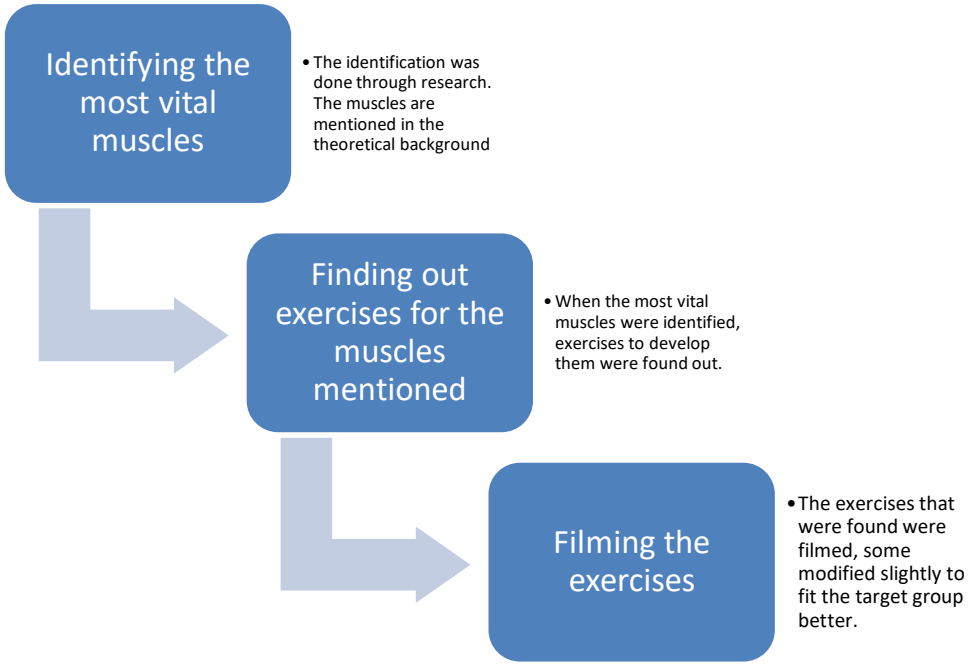


Fig 12. The process of filming the exercises

First, the most vital muscles for goaltenders were identified through the literary review. Then, exercises for the most vital muscles were gathered through research, from various exercise websites. The final part was filming the exercises. Some of the exercises were modified slightly to fit the primary target group (goaltenders of TuTo and Kisurit) better.

## 10.4 The usefulness of the thesis

For the author, the work will give an additional resource to use in the planning of the training. Writing the thesis will also force the author to gather more information and process it, thus giving new tools and information to use when coaching. For the organization, it is another resource that can be used in training, for both goaltenders and skaters. Hip and core area training could be very

beneficial for skaters too. It can also be seen as an “image enhancer” for the organization. As discussed previously, goaltending is a vital part of today’s ice hockey, and thus important for an organization.

## 10.5 The stages of the project and the thesis process

The original plan was, as mentioned before, to create the goalie coaching system, but that proved to be too difficult to create in thesis form, as there were not enough sources, and the author personally felt that subject to be slightly intangible. Then, as the plan changed radically, research was directed more towards the anatomy of hip and core areas. That made the process significantly easier. The product is the training routine/manual for goalies. The manual was in video form. It will provide the viewer with exercises that are beneficial for a hockey goalie in terms of hip and core area maintenance and strengthening. As mentioned before, the exercises in the product are based on theoretical background that is introduced in the thesis.

## 10.6 A description of the product

The product is a training video, designed for ice hockey goaltenders. The exercises chosen were from mixed sources. Some of them were from the author’s own experience that were done during his hockey career. Some of them were from different exercise websites and sources.

The exercises in the video are designed to improve the most vital muscles for goaltenders. The muscles and exercises are: **Tensor Fascia Latae**. Standing next to a wall, pushing the outer leg to the side, into what is called a “skating angle”, which can be considered to be an angle of approximately 45 degrees. (Lefkowith) The gluteus maximus. The goalie is lying on their back, with their knees bent. The goalie starts to push their hip upwards, working the gluteus maximus. This is also done with both legs separately. **The gluteus medius**: The goalie is lying on their side, with their knees bent, and legs on top of each other. The leg that is higher, is raised up from the

knee. **The gluteus minimus**: the goalie is standing on their knees, with hands on the floor. One leg is raised to the side, with the knee being kept at a 90-degree angle. (Kenler 2021) **The hip flexors:** the goalie sits on the ground, hugging one knee to their chest. The leg that is straight, is raised off the floor and upwards. (Coast performance rehabilitation 2019) **The external rotators of the hip (see chapter six for details):** The goalie is lying on the floor, with one elbow on the ground, and their upper body is off the floor. One knee is bent, and on the floor. The leg that is higher, is raised, while being kept straight. **Hip abductors:** The goalie is standing facing a wall. The other leg is raised off the floor, and to the side. This exercise resembles closely the Tensor Fascia Latae exercise. However, in the abductor exercise, the leg is raised directly, laterally to the side. (Cronkleton & Robinson 2020) **Hip abductors:** the goalie starts in a high squat position, closely reminding that of a goalie's ready stance. The goalie has a stick behind their neck, and does a side lunge, until the knee is at a 90-degree angle. The goalie then gets up, and performs a side lunge the other way. This can also be done by maintaining a position slightly wider than the ready stance all the time and shifting one's weight from leg to leg. **Hip adductors:** This is recommended to do using a resistance band. The band is looped around the goalie's ankle, while the other end is secured. The goalie performs and maintains a slightly squatting position and moves the leg from outwards towards the middle of their body. **Hip adductors:** The goalie is lying on their side, with the higher leg crossed over in front of the body. The leg that is lower is straight and lifted up slightly. (Fox 2014)

The video also features exercises for improving the core muscles. They are: **The Transversus abdominis:** The goalie is lying on their back, with all four limbs facing upwards. The goalie lowers the opposite limbs, for example their right leg and left hand, while the two other limbs stay facing upwards. (Lau, N, d) **The transversus abdominis:** The goalie is lying on their side, with their body nearly straight. The goalie lifts their legs off the floor, while keeping the upper body parallel to the floor. **The erector spinae:** The goalie is lying face-down on the floor. First, the goalie lifts their upper body off the floor, while keeping their legs touching the floor, while performing 10 repetitions this way. Then, the goalie lifts their legs off the floor, while keeping their upper body on the floor. Then, the two previous exercises are combined. The goalie lifts both their upper body and legs off the floor, maintaining the posture for one second, then lowering their limbs. Adapted from (Set For Set 2020) **The erector spinae (among many others):** The goalie is kneeled on the floor, with their palms on the floor. The goalie lifts and straightens one leg, and the opposing hand. Then, the leg and hand are returned to the kneeling position and repeated using the opposing limbs. (Horschig 2018)

**External abdominal oblique:** The goalie is sitting on the floor, with their knees bent, and feet on the floor. The goalie's upper body is flexed slightly, thus the upper back and shoulders are off the floor. The goalie starts rotating to one side, while maintaining the position of the upper body. The goalie tries to touch the heel of that side, and then returns back. Then exercise is then repeated to the other side. (Davis 2020) **External abdominal oblique (among many other muscles):** The goalie is sitting on the floor, with their feet off the ground and upper body straight. The goalie rotates their hands and upper body to either side, while maintaining the position of the feet. Then the rotation is centered and performed to the other side. During the exercise, the eyes should track the hands, thus forcing the upper body to rotate. (Marturana Winderl N, d)

# 11 Discussion

The goal for the thesis was to design a video training manual for goaltenders. A literary review was conducted on the most common problems and issues for goalies, associated with the hip area, and design a training routine based on the tools offered by the literature review. Some information was found, but the reasons behind the information have not been studied very thoroughly. Implementing the core exercises mentioned in the product will help the goalies to maintain a high hip position while making saves, which will decrease the stress on the hips. (Kallio & Koskinen K 2015) Implementing the hip area exercises may help in maintaining healthier hip positions, thus reducing stress on the hips.

The criteria for choosing the sources were: 1) Validity (preferably academic-grade texts) 2) publication year and 3) written in either English or Finnish.

The objectives for the thesis were to study the anatomy of hip and core areas, and to develop a training routine to improve the muscles and mobility of the areas. The author believes that those objectives were met. The anatomy of hip and core areas were studied and discussed in the literature review. The author developed his competence regarding the area of the study, which will help in planning the off-ice training for goalies. The product implements exercises to the most vital muscles identified, so the author feels that the product and literary review match.

The video manual serves as a tool for helping goalie coaches to plan their off-ice training. It is also a tool, which the goalies' individual off-ice training will partly be based on. For example, they are told to perform specific exercises during a given week. Thus, the value of the product is for the other goalie coaches in the organization who can and should use the product. Also, it is hoped that the effect of the product being implemented could be drastically a decreasing number of hip area problems.

As discussed in the article from (University Of Michigan, 2018), the stopping motion is a significant factor in placing stress on the hip area. That is also a topic of research and discussion. The common opinion is that goaltenders need to perform their movements as fast as possible, and with as much force as possible, to give themselves more time to prepare for the upcoming situation. However, using a significant amount of force to perform the pushing movement, the result is that the stopping motion requires a significant amount of force as well. The forces that the powerful stopping motion place on the hip are very significant. However, if a goaltender

does not stop forcefully (while causing significant stress on the hips and knees), it can cause them to lose a significant amount of time, thus being late on the play. Extended discussion and research on how to prevent the excess stress and strains, while still maintaining the adequate speed in the movements, would be extremely beneficial. In terms of preventing excess strains, it can be extremely beneficial for the goalies to know the correct movement techniques. The responsibility for teaching the correct movement techniques is on the goalie coaches. While this thesis did not focus on the on-ice part of goaltending at all, that is obviously vital too. The on-ice education of goalie coaches in the organization is constantly ongoing.

The effect and significance of the core is also a topic that would benefit from more extensive research. The majority of sources used in this thesis have been very "general", in terms of not being hockey goalie specific. One of the main sources for the physical requirements was the academic article of Petteri Kilpivaara. In the work, (Kilpivaara 2011) analyzed the physical, mental and tactical requirements of playing goalie, in along with analyzing the status of the sport in Finland. This thesis only focuses on the physical part of playing goalie. While the physical demands have not changed significantly since the publication of Kilpivaara (2011), some of the finer technical details have. In the case of this particular thesis, the age of the analysis did not prove to be a limiting factor. However, a slight revision of the techniques analyzed in the work could be beneficial. In terms of user experience, the imagery of the analysis can be seen as dated, in terms of image quality and equipment in the images, and the reason for that is simply that the research is at the time of writing this thesis, 10 years old. However, as mentioned, physical demands have not changed significantly, and thus the work is still extremely high-quality and useful for this particular thesis. Goalie-specific research would deepen the current knowledge and give new knowledge in terms of just how vital core control is for a goaltender. That research could implement longer training interventions along with measurements of mobility, for example around the hip area. In addition, muscle strength could be measured, and then compared to the frequency of hip area injuries.

The thesis process has helped the author to learn more about the main muscles of the hip and core areas. The increased knowledge has had an impact on the daily work done in the organization. In terms of off-ice training for goalies, hip and core areas are now the main points of focus in training in TuTo and Kisurit. For example, something to look into is an examination of hip area mobility that would be conducted by a trained physical therapist. That could expose the possible weaknesses in muscle control or mobility in the hip area. Thus, it could be possible that some injuries could be prevented. After the examination, possible risk factors would be targeted

through a training plan. The thesis process has been a difficult process. In the beginning, the product and the theoretical background were unclear, and they did not match. The theoretical background was then limited and focused on the topics relevant to the topis of the thesis.

## 11.1 Reliability of the thesis

The thesis is aimed to be as reliable as possible. Sources are thought out and considered. The sources are mostly academic-grade texts (thesis or higher-level texts), except for a few exceptions. Thus, the responsibility of evaluating of the reliability of the non-academic sources is largely on the author. For example, the InGoal Magazine that has been used as a source, is a magazine that focuses on a lot of topics within the ice hockey goaltending world. (InGoal Magazine). While InGoal Magazine is not an academic source, it is considered to be a reliable source in the field of goaltending. InGoal Magazine is used as a source in topics that do not require scientific research, such as the importance of the butterfly. When discussing about something that needs to be backed, or is backed by scientific research, the source is not InGoal Magazine. The International Ice Hockey Centre of Excellence (IIHCE) is a source that is very comparable to the InGoal magazine. The IIHCE is ran by the Finnish hockey Federation, and the writers are hockey experts.

There are multiple criteria when considering the credibility of a source. Those include: the author and their expertise in that particular field, is the author objective. In terms of the information, it should be examined whether the information is recent enough. In terms of internet sources, source criticism should be extremely strict. The most trustworthy sites are those of the authorities and known organizations. (Haaga-Helia 2021)

## 11.2 Ethicalness of the thesis

All the work used as a source has been credited to their respective authors. There is no confidential material used in the thesis, and the names mentioned are public figures. The author does not see any ethical issues with the work. As mentioned, there is no confidential material used, for example private test results. The material used is publicly available. All of the images are used with kind permission from their authors. Figures one and 12 were entirely made up by the author, and figure 11 was adapted, and the source is listed. The videos for the product were

filmed by the author himself, thus no consent is required. The background music used in the videos is royalty-free, thus no specific rights are necessary, since the video is not made for commercial usage.

### 11.3 Personal development

The thesis should demonstrate the student's ability in research-based, critical, developmental and ethical thinking. They should be used as the foundation for the development of expertise. (Kajaani University Of Applied Sciences, n.d) One of the competences for a student in the field of sports and leisure management is the ability to retrieve, analyze and critically evaluate information. (Kajaani University of Applied Sciences, N.d c) In this particular thesis, information had to be retrieved, analyzed, evaluated and combined. That has forced the author to develop in those areas. Combining information from anatomical sources to the requirements of playing goalie is ultimately the key in this thesis. Without the ability to do so, this thesis would not have been possible to create. The whole thesis process is individual, which is a good thing. The author could choose a subject, that both interests and develops himself the best. Choosing a subject that the author is interested in, can make the work significantly easier. During the thesis, the author gained a wealth of knowledge, that can and will be used in the daily coaching work, especially the effects of different muscles and training methods. The author learned about product development, and its phases. The author got new ideas for possible future research, whether carried out by himself or through someone else.

The author got confirmation for his own suspicions that training of hip area muscles may help prevent hip injuries. In terms of personal development, the goal for the author was to deepen his own knowledge about the subject and get new ideas to implement in his daily work in the organization. That was achieved.

What has helped the author in the thesis process is the knowledge of the organization and the primary customers. The author has worked in the organization in total a time of approximately six months. The challenges facing the customers were known, as well as their strengths.

## 11.4 The product

The product was chosen to be a training routine because the commissioning party (the organization) does not have a plan for the off-ice training of goaltenders. When implemented, the product will hopefully be able to reduce the amount of hip area problems the goaltenders experience later on in their careers.

The product that was developed in this thesis was a video that contains exercises for developing the muscles that are vital for a goaltender. The muscles are those, that were chosen to be the most vital, according to the anatomy research combined with the requirements of playing goalie.

Video was chosen as a format for the product due to a few key facts. Number one: the ease of distribution. The distribution for an online video (in this case, one that is uploaded on YouTube) is very easy. The link can be sent to anyone, anywhere in the world. When comparing a video to for example written instructions, the customers can see how the exercises should be done and model their own performance after the video.

Evaluation of the effectiveness of the product could be done at some point. One way to determine the effectiveness would be to have a group perform the exercises on a regular basis, and have another group not perform them, and then compare the changes in hip mobility, strength and core strength. However, this would be very difficult to do as a reliable study. The goaltenders are so different in terms of many things, such as physical development as children and teens, body shapes, training motivation et cetera. If it were possible to make those variables constant, then an examination and studying of changes would be feasible.

The feedback of the commissioning party is as follows: According to the work done, we can support the complete training of goalies. We can take the special needs of goalies into consideration when planning and executing training. The author has, in addition to the thesis, been working and helping in changing the training of goalies in our hockey community. (Arppe, 2021)

List of references


Aho, I. (2016). Retrieved from Keskivartalon lihasten harjoittaminen Spinegym-laitteella-Vaikutukset lihasvoimaan ja EMG-aktiivisuuteen: https://jyx.jyu.fi/bitstream/handle/123456789/48451/URN:NBN:fi:jyu-201601251272.pdf?sequence=1

Arokoski, M. H., Arokoski, J. P., Haara, M., Kankaanpää, M., Vesterinen, M., Niemitukia, L. H., & Helminen, H. J. (2002). Hip Muscle Strength and Muscle Cross Sectional Area in Men with and without Hip Osteoarthritis. *The Journal of Rheumatology*(10), pp. 2185-2195. Retrieved from Hip Muscle Strength and Muscle Cross Sectional Area in Men with and without Hip Osteoarthritis: https://www.jrheum.org/content/jrheum/29/10/2185.full.pdf

Arppe, T. (2021). Personal Communications.

Cambridge Dictionary. (n.d.). *Cambridge Dictionary*. Retrieved from https://dictionary.cambridge.org/dictionary/english/productize

Coast performance rehabilitation. (2019). Retrieved from Top three exercises to build strong hip flexors: https://www.coastperformancerehab.com/blog/top-three-exercises-to-build-strong-hip-flexors

Cronkleton, E., & Robinson, D. (2020). *Healthline.* Retrieved from Hip exercises for Building Adductor Strength and Preventing Injury: https://www.healthline.com/health/adductor-exercises#strength-exercises

Davis, N. (2020). *Healthline.* Retrieved from 30 Exercises to Make the Most of Your Oblique Workout: https://www.healthline.com/health/fitness-exercise/oblique-workout#beginner-routine

Fox, B. J. (2014). Retrieved from Side Lying Adductor Leg Raise Exercise: https://www.youtube.com/watch?v=bQ4YHTCGKaM

Gold, M., Munjal, A., & Varacallo, M. (2020). *PubMed.* Retrieved from Anatomy, Bony Pelvis and Lower Limb, Hip Joint: https://www.ncbi.nlm.nih.gov/books/NBK470555/

Haaga-Helia. (2021). *LibGuides.* Retrieved from Näin haet tietoa: Valitse luotettava lähde: https://libguides.haaga-helia.fi/nain-haet-tietoa/valitse-luotettava-lahde

Harris-Hayes, M., Mueller, M. J., Sahrmann, S. A., Bloom, N. J., Steger-May, K., Clohisy, J., & Salsich, G. B. (2014). Persons with Chronic Hip Joint Pain Exhibit Reduced Hip Muscle Strength. *Journal of orthopaedic and sports physical therapy*, pp. 890-898, Doi: 10.2519/jospt.2014.5268. Retrieved from Journal of Orthopaedic&Sports Physical Therapy: https://www.jospt.org/doi/pdfplus/10.2519/jospt.2014.5268

Hibbs, A. E., Thompson, K. G., French, D., Wrigley, A., & Spears, I. (2008). Optimizing performance by improving core stability and core strength. *Sports med*, pp. 995-1008.

Horschig, A. (2018). *Squat University.* Retrieved from The McGill Big 3 for Core Stability: https://squatuniversity.com/2018/06/21/the-mcgill-big-3-for-core-stability/

Huxel Bliven, K. C., & Anderson, B. E. (2013). Core Stability Training for Injury Prevention. *Sports Health*(5), pp. 514-522, Doi: 10.1177/1941738113481200. Retrieved from Core stability training for injury prevention: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3806175/

InGoal Magazine. (n.d.). Retrieved from https://ingoalmag.com/magazine/

InGoal Magazine. (2015, november 28). Retrieved from Goalies 101: Talking about the butterfly: https://ingoalmag.com/news/goalies-101-talking-butterfly/

International Ice Hockey Centre of Excellence. (N, d). Retrieved from Maalivahtien oheisharjoittelu: https://www.iihce.fi/suomeksi/Fyysinenharjoittelu/Maalivahtienoheisharjoittelu/tabid/3813/Default.aspx

Johns Hopkins Medicine. (2020). *Johns Hopkins Medicine.* Retrieved from Hip Problems- What is the hip? : https://www.hopkinsmedicine.org/health/conditions-and-diseases/hip-problems

Kajaani University of Applied Sciences. (n, d a). Retrieved from Opinnäytetyöpankki-Luotettavuus: https://www.kamk.fi/fi/opari/Opinnaytetyopakki/Teoreettinen-materiaali/Tukimateriaali/Luotettavuus

Kajaani University Of Applied Sciences. (N,d b). Retrieved from Study guide: http://opinto-opas.kamk.fi/index.php/en/68146/en/68091/ASL17S/year/2017

Kajaani University of Applied Sciences. (N.d c). *Study Guide.* Retrieved from http://opinto-opas.kamk.fi/index.php/en/68146/en/68090

Kallio, T., & Koskinen K, S. (2015). Retrieved from Lonkat kovilla jääkiekkomaalivahdin perhostorjunnassa: https://www.terveystalo.com/Global/sport/Lonkat%20kovilla%20j%C3%A4%C3%A4kiekkomaalivahdin%20perhostorjunnassa.pdf

Kapandji, I. (1995). Kinensiologia 2. Alaraajojen nivelten toiminta. In I. Kapandji, *Kinesiologia 2. Alaraajojen nivelten toiminta.*

Kenler, M. (2021). *The signal.* Retrieved from https://www.anabolicaliens.com/blog/gluteus-minimus-exercises

Kibler, B. W., Press, J., & Sciascia, A. (2006). The role of core stability in athletic function. *Sports Medicine*(3), pp. 189-198, Doi: 10.2165/00007256-200636030-00001.

Kilpivaara, P. (2011). *Jääkiekon maalivahtipelin pelipaikka-analyysi ja valmennuksen ohjelmointi.*

Korn, M. (2015). Retrieved from Braden Holtby's All Access Pre-Game Preparation: https://www.youtube.com/watch?v=PkSNiUe78N0

Löytynoja, K. (2019). Retrieved from Jääkiekkomaalivahtien lonkkavammat ja niiden ennaltaehkäisy: https://www.theseus.fi/bitstream/handle/10024/261364/Opinn%C3%A4ytety%C3%B6_L%C3%B6ytynoja_Kaisa.pdf?sequence=2&isAllowed=y

Lau, M. (N, d). Retrieved from Dead bugs exercise variations-Most underutilized exercise: https://theprehabguys.com/dead-bugs-exercise-variations/

Lefkowith, C. (n.d.). *Redefining Strength.* Retrieved from DON'T IGNORE THIS NASTY LITTLE SUCKER – THE TFL OR TENSOR FASCIAE LATAE: https://redefiningstrength.com/dont-ignore-this-nasty-little-sucker-the-tfl-or-tensor-fasciae-latae/

Marturana Winderl, A. (N, d). *Self.* Retrieved from 13 of the Best Obliques Exercises: https://www.self.com/gallery/obliques-exercises

Mayo Clinic. (2020). Retrieved from Core exercises: Why you should strengthen your core muscles: https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/core-exercises/art-20044751

Mehta, N., U. Nwachukuwu, B., & T. Kelly, B. (2019). Retrieved from Hip injuries in ice hockey goaltenders: https://doi.org/10.1053/j.otsm.2019.04.005

Miers, B. (2018). *Midwest Goalie School.* Retrieved from Why goalies are prone to develop hip injuries and what YOU can do to prevent them. Ben Miers, DPT shares his professional insight: https://midwestgoalieschool.com/2018/06/why-goalies-are-prone-to-develop-hip-injuries-and-what-you-can-do-to-prevent-them-ben-meirs-dpt-shares-his-professional-insight/

NHS Royal Berkshire. (2019). Retrieved from Femoroacetabular impingement (FAI): https://www.royalberkshire.nhs.uk/patient-information-leaflets/Physiotherapy%20Hip%20Femeroacetabular%20impingement%20FAI.htm

Nordman, S. (n.d). Retrieved from Tappara juniorit: http://juniorit.tappara.fi/juniorit/tiedostopankki/473/Tapparan_mv_manuaali_vol_2.0.pdf
Ocran, E. (2020). *Kenhub.* Retrieved from Hip Joint: https://www.kenhub.com/en/library/anatomy/hip-joint
Parantainen, J. (2013). Tuotteistajan pikaopas Vol 1. In *Tuotteistamisen perusteet* (p. 16). Helsinki: Ediste Oy.
Pasanen, K. (2015). In S. Valmentajat.
Physiopedia. (N.d). Retrieved from Hip Anatomy: https://www.physio-pedia.com/Hip_Anatomy
Rämet, L., Saari, J., & Virkkala, J. (N.d). *International Ice hockey centre of Excellence.* Retrieved from Jääkiekkomaalivahdin lantionseudun ja alaraajojen liikkuvuuden kehittäminen: https://www.iihce.fi/tabid/172/Default.aspx
Rehab my patient. (2020). Retrieved from Psoas Major: https://www.rehabmypatient.com/hip/psoas-major
Rehab my patient. (2020a). *Rehab My Patient.* Retrieved from Illiacus: https://www.rehabmypatient.com/hip/iliacus
Rehab my patient. (2020b). *Rehab My Patient.* Retrieved from Gluteus Medius: https://www.rehabmypatient.com/hip/gluteus-medius
Rehab my patient. (2020c). *Rehab My Patient.* Retrieved from Gluteus Maximus: https://www.rehabmypatient.com/hip/gluteus-maximus
Rehab my patient. (2020d). *Rehab My Patient.* Retrieved from Internal Oblique: https://www.rehabmypatient.com/abdomen/internal-oblique
Rehab my patient. (2020e). *Rehab my Patient.* Retrieved from External oblique: https://www.rehabmypatient.com/abdomen/external-oblique
Rintasalo, H., & Turpela, R. (2018). Retrieved from Keskivartalon hallinta osana judokoiden vammojen ennaltaehkäisyä: https://www.theseus.fi/bitstream/handle/10024/143374/rintasalo_hanna_turpela_riia.pdf?sequence=1&isAllowed=y
Sendic, G. (2020a). *Kenhub.* Retrieved from Internal abdominal oblique muscle: https://www.kenhub.com/en/library/anatomy/internal-abdominal-oblique-muscle
Sendic, G. (2020b). *Kenhub.* Retrieved from Illiopsoas muscle: https://www.kenhub.com/en/library/anatomy/iliopsoas-muscle
Sendic, G. (2020c). *Kenhub.* Retrieved from Adductor Mangus: https://www.kenhub.com/en/library/anatomy/adductor-magnus
Sendic, G. (2020d). *Kenhub.* Retrieved from Transversus abdominis muscle: https://www.kenhub.com/en/library/anatomy/transversus-abdominis-muscle
Set For Set. (2020, January). Retrieved from 13 best erector spinae exercises: https://www.setforset.com/blogs/news/13-best-erector-spinae-exercises
Suomen Jääkiekkoliitto. (N.d). Juniorimaalivahtien valmennusopas.
Suominen, A., Kantola, J., & Tuominen, A. (n.d.). Retrieved from Reviewing and Defining productization: https://www.researchgate.net/profile/Arho_Suominen/publication/236326445_Reviewing_and_Defining_Productization/links/5656c32108aeafc2aac09552/Reviewing-and-Defining-Productization.pdf
Terveyskylä. (2018). Retrieved from https://www.terveyskyla.fi/niveltalo/mihin-sattuu/lonkka/lonkan-rakenne
TuTo Ry. (n.d). Retrieved from https://www.tuto.fi/
University Of Michigan. (2018). *University Of Michigan.* Retrieved from Exercise&Sport science initiative- University of Michigan: https://essi.umich.edu/project/femoroacetabular-impingement-in-ice-hockey-goaltenders/ Vaskovic, J. (2020). *Kenhub.* Retrieved from

External abdominal oblique: https://www.kenhub.com/en/library/anatomy/external-abdominal-oblique-muscle

Vesterinen, V. (2020). Retrieved from Harjoittelun ohjelmointi ja rytmitys: https://kihuenergia.kihu.fi/tuotostiedostot/julkinen/2020_ves_harjoittel_sel15_94455.pdf

Wörner, T., Clarsen, B., Thorborg, K., & Eek, F. (2019, December 18). Elite Ice Hockey Goalkeepers Have a High Prevalence of Hip and Groin Problems Associated With Decreased Sporting Function. *Orthopaedic Journal of Sports Medicine*, p. Doi: 10.1177/2325967119892586.