T.C.
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ACUTE EFFECTS OF DYNAMIC STRETCHING AND SELF MOBILIZATION EXERCISES ON BALANCE AND PROPRIOCEPTION

MASTER THESIS

M.BERAT AKDAĞ,PT

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APPROVAL

This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated 31.07.2019 and numbered 2019/13-04

Prof. Dr. Bayram YILMAZ

Director of Institute of Health Sciences

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

M. Berat AKDAĞ

Signature

DEDICATION

I would like to dedicate my thesis to my dear parents Canan and Professor M.Zülküf AKDAĞ and I also thank everyone who contributed on me.

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1. TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS/ABBREVIATIONS

ACL	Anterior Cruciate Ligament
PCL	Posterior Cruciate Ligament
ROM	Range Of Motion
GTO	Golgi tendon organ
PNF	Proprioceptive Neuromuscular Facilitation
JPS	Joint Position Sense
PASM	Posteriooanterior Self Mobilization
S.D	Standard Deviation
PST	Post
R	Right
L	Left
Self Mob	Self Mobilization
S.E.M	Standard Error of Mean
(°)	Degree
Din.Str	Dynamic Stretching

ABSTRACT

Akdag, MB.(2019) . Acute effects of Dynamic Stretching and Selfmobilization Exercises on Balance and Proprioception.Yeditepe University, Institute of Health Sciences, Master of Science Thesis in Physical Therapy and Rehabilitation Program, Istanbul, 2019. In this study, dynamic stretching applied to healthy individuals with tight hip flexor muscle and the effects of self-mobilization exercises on muscle tightness , balance and proprioception were investigated. 36 Participants with healthy hip flexor muscle tightness were included in the study. The patients with hip flexor muscle tightness were divided into two groups by simple randomization method. Dynamic stretching exercise was applied to the first group and self-mobilization exercise was applied to the second group. Measurement methods were applied before and after the exercise. Hip flexor muscle tightness was measured by modified Thomas test. Proprioception was measured using a digital inclinometer using the active knee extension method. Dynamic balance was measured by Y balance test. As a result of post-exercise evaluations in both groups, there was a significant improvement in muscle tightness after exercise ($p < 0.05$). There was no significant difference in hip flexor muscle tightness between two groups ($p > 0.05$). These results showed that dynamic stretching and self-mobilization exercises acutely improve muscle tightness. The lack of difference between the two groups shows that these two methods have the same effect on muscle tightness. When the effect on proprioception was compared, no significant difference was found in all proprioception values except the 30 degree left extremity value in the dynamic stretching group ($p > 0.05$). No significant difference was found between the groups in terms of proprioception ($p > 0.05$). Dynamic balance results measured by Y balance test showed a significant increase in both groups ($p < 0.05$). No significant difference was found between the groups in terms of balance. According to these results, dynamic stretching and selfmobilization techniques acutely improve dynamic balance. The fact that there is no difference between the two groups shows that these two techniques do not have any superiority in terms of their effect on dynamic balance. As a result, we can say that dynamic stretching and self-mobilization exercises can significantly improve muscle tightness and dynamic balance , do not significantly change proprioception, however muscle tightness, proprioception and dynamic balance can be affected equally by these two exercises and there is no difference between these two exercises in terms of these parameters.

Keywords: Dynamic stretching, self-mobilization, muscle tightness, proprioception, dynamic balance,exercise.

ÖZET

Akdag, M.B. (2019). Dinamik germe ve Self-Mobilizasyon Egzersizlerinin Denge ve Propriosepsiyona Akut etkileri .Yeditepe Üniversitesi , Sağlık Bilimleri Enstitüsü, Master Tezi Fizyoterapi ve Rehabilitasyon Programı , Istanbul, 2019. Bu çalışmada kalça fleksör kas kısalığı olan sağlıklı kişilere uygulanan dinamik germe ve self mobilizasyon egzersizlerinin kas kısalığı, denge ve propriosepsiyon üzerine olan akut etkileri araştırıldı. Çalışmamıza 36 sağlıklı kalça fleksör kas kısalığı olan birey katıldı. Kalça fleksör kas kısalığı olan kişiler basit randomizasyon yöntemi ile 2 gruba ayrıldı. 1.gruba dinamik germe egzersizi, 2. Gruba ise self mobilizasyon egzersizi uygulandı. Uygulanan ölçüm yöntemleri egzersiz öncesi ve egzersiz sonrası uygulandı. Kalça fleksör kas kısalığı modifiye Thomas testi ile ölçüldü. Propriosepsiyon dijital inklinometre yardımı ile aktif diz ekstansiyon yöntemi kullanılarak ölçüldü. Dinamik denge ise Y denge testi ile ölçüldü. Her iki gruba da egzersiz sonrası yapılan değerlendirmeler sonucunda her iki grupta da egzersiz sonrası kas kısalığında anlamlı iyileşme görüldü ($p<0.05$). İki grup aralarında karşılaştırıldığında kalça fleksör kas kısalığı bakımından anlamlı fark bulunamadı ($p>0.05$). Bu sonuçlar dinamik germe ve self mobilizasyon egzersizlerinin kas kısalığını akut olarak iyileştirdiğini göstermiştir. İki grup karşılaştırıldığında farklılığın olmaması bu iki yöntemin de kas kısalığını aynı derecede etkilediğini göstermektedir. Propriosepsiyon bakımından karşılaştırıldığında dinamik germe grubu 30 derece sol ekstremite değeri dışında ($p<0.05$) diğer tüm propriosepsiyon değerlerinde anlamlı fark bulunmamıştır ($p>0.05$). Gruplar propriosepsiyon açısından kendi aralarında karşılaştırıldığında ise anlamlı fark bulunamamıştır ($p>0.05$). Y denge testi ile ölçülen dinamik denge sonuçları her iki grupta da anlamlı artış olduğunu göstermektedir($p<0.05$). Denge açısından gruplar arasında anlamlı fark bulunmamıştır. Bu sonuçlara göre dinamik germe ve self mobilizasyon tekniklerinin dinamik dengeyi akut olarak geliştirdiği görülmüştür. İki grup arasında fark bulunamaması, bu iki tekniğin dinamik dengeye etkisi bakımından birbirlerine göre herhangi bir üstünlüklerinin olmadığını göstermektedir. Sonuç olarak, dinamik germe ve self mobilizasyon egzersizlerinin kas kısalığını ve dinamik dengeyi anlamlı bir şekilde geliştirebilceği, propriosepsiyonu çok belirgin bir şekilde değiştirmediğini bununla birlikte iki egzersizinde kas kısalığını, proprioception ve dinamik dengeyi aynı derecede etkiliyebildiğini bu iki egzersiz arasında bu parametreler açısından farklılık olmadığını ifade edebiliriz.

Anahtar Kelimeler: Dinamik germe, self mobilizasyon, kas kısalığı, propriosepsiyon, dinamik denge, egzersiz.

1.INTRODUCTION

Muscle tightness in hip flexors is one of the risk factors for musculoskeletal injuries. Studies have shown that muscle tightness is a risk factor especially for knee and hamstring injuries (1,2). The lack of flexibility in muscle can lead to early muscle fatigue and abnormal movement patterns (3). Therefore, it is believed that hip flexor muscle tightness has a negative effect on the dynamic balance and biomechanics of the lower extremity and this can increase the risk of fall (4,5).

The Balance can be expressed as the ability of the body to be controlled with as little muscle activity as possible in dynamic or static positions, to be able to keep and maintain a person's body center of gravity within the support surface (6,7). Balance is divided into two as dynamic and static balance.

Dynamic balance is the active control of the position and posture of the body for an effective movement in spite of differences in the environment when the person is in movement or resting state. Studies have been conducted to determine whether there is any relationship between dynamic balance and hip flexor muscle tightness, and in one of these studies, it was found that there was a negative relationship between hip flexor muscle tightness and dynamic balance performance in secondary school students (4). In some studies, it has been found that there is a relationship between balance and disability (9,10).

Static balance refers to the ability to maintain a person's static position. The information from somatosensory, visual and vestibular systems is important to maintain balance (8).

Proprioception is defined as the ability to detect the position of the joint in space. Proprioseption provides the somatosensory input, which is important and essential for our simple functions we do every day such as standing or for our more complex functions, such as walking and running. Proprioceptive mechanoreceptors provide feedback for the location of the joint in space. Therefore proprioception is critically important for the interaction with the environment (11,12).

Dynamic stretching is the type of stretching that an individual actively exercises without exceeding the limits of extensibility of the joint (13). Dynamic stretching involves contraction of the antagonist muscles simultaneously. This is beneficial for the muscles not effected by static stretching (14). Joint mobilization techniques are commonly used to increase hip mobility, reduce pain, and improve strength production in the hip joint (15). Even though the effectiveness of joint mobilization is largely dependent on the skill of the practitioner, on the other hand self-mobilization techniques are not (16). The purpose of self-mobilization techniques is to improve the mobility of the capsule and potentially other connective tissues. In addition to increasing the mobility of capsule and connective tissue, it also improves muscle training. The muscles in which these techniques are applied help to optimize hip joint motion, and this increased range of joint motion can significantly reduce the person's symptoms (17,18).

The number of studies on the effect of self-mobilization exercises on hip extension ROM and other parameters is quite low. According to the studies, self-mobilization techniques increased hip extension ROM (19).

The aim of our study is to determine the acute effects of dynamic stretching and self-mobilization exercises on proprioception and balance in healthy individuals with hip flexor muscle tightness, and to compare the effects of these two methods on balance and proprioception.

Two hypotheses were determined in the study:

H_0: In healthy individuals, there is no statistically significant difference between the results of balance and proprioception measurements of dynamic stretching and self-mobilization exercises in acute pre exersice and post exersice and there is no significant difference between the dynamic stretching and self mobilization exercises.

H_1: In healthy individuals, there is a statistically significant difference between the results of balance and proprioception measurements of dynamic stretching and self-mobilization exercises in acute pre exersice and post exersice and there is significant difference between the dynamic stretching and self mobilization exercises.

2.THEORATICAL FRAMEWORK AND LITERATURE REVIEW

2.1.Knee Anatomy

Consisting of two joints, the knee joint belongs to the ginglymus type joint class according to the shape of the joint surfaces. The knee joint, which is the largest joint in the body, consists of three bones: tibia, femur and patella. It contains three separate joints; the sellar type between the patella and the femur, two condylar types between the tibia and the femur.

To ensure stability in the knee joint, the harmony between the bone structures is not sufficient. Knee joint has the widest range of motion in the body. Stability in the joint and proper function are provided by ligaments around the joint. The static stabilisers of the knee joint include capsule, meniscus, bone structures and ligaments while the dynamic stabilisers are muscle and tendon structures (Figure 2.1) (20,21,22).

These structures are referred to as;

Bone Structures

Non-bone structures

a)In-joint
- 1)Synovia
- 2)Meniscus
- 3)Cruciate ligaments

b)Off-joint
1)Muskulotendinous structures
2)Bonds

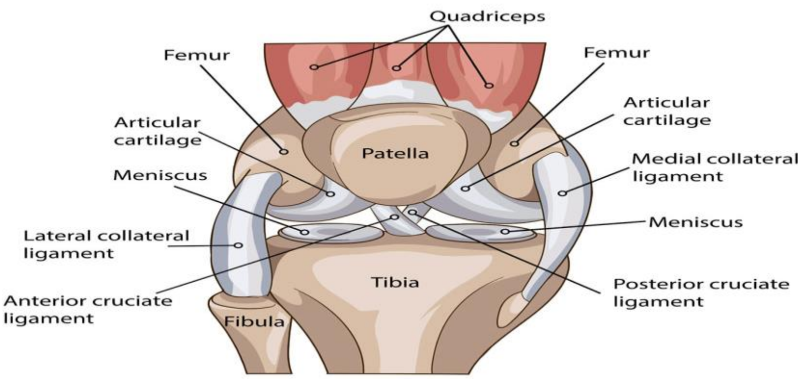

Figure 2.1. Muscle, tendon and ligament structures in the knee.

These structures in the knee joint allow 6 different movements. These movements are flexion, extension, external rotation, internel rotation, abduction and adduction (20,21,22).

2.1.1.Bone structures

Knee joint consists of 3 bones. These bones are femur, tibia and patella. The concave side of the knee joint belongs to the upper end of the tibia and the convex face to the condyle of the femur (Figure 2.2). The third bone, patella, is attached to the anterior side (23).

The distal joint face of the femur is articulated with tibiomeniscal surfaces and patella. The patella settles in the trochlear groove anterior and posterior sides of the two femoral condyle and joins the structure of the joint. The anterior faces of both femoral condyles are oval and the posterior faces are spherical. The range of motion increases due to the spherical structure on the posterior side, the stability increases due to the oval structure on the anterior face while the rotation movement is performed with the flexion. In the frontal plane, the lateral condyle is higher than the medial condyle and this is the cause of the anatomic valgus in the knee (20,24).

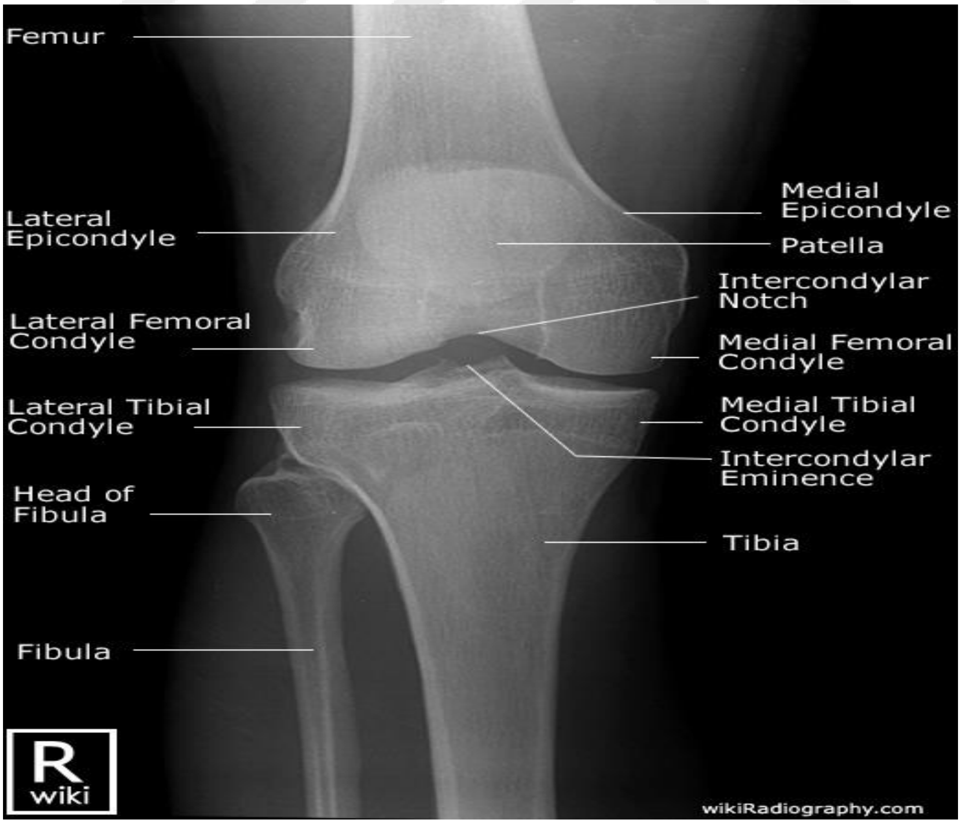

Figure .2.2 Bone structures in the knee.

http://www.wikiradiography.net/page/Knee+%28non+trauma%29+Radiographic+Anatomy

Femur condyles are different in size and shape. The curvature of the lateral condyle increases towards the back. The medial condyle is larger than the lateral condyle and its curvature is more symmetrical. The long axis of the lateral condyle is longer than medial and is located in the sagittal plane. The medial condyle axis is at an angle of 22° with sagittal plan. (20,24).

The groove between the two condyle slides is called trochlea. Trochlea has lateral and medial protrusions, which are laterally higher and larger. Intercondylar notch is between and behind the condyles. ACL and PCL adhere here (20,21).

2.1.1.1.Tibia Proximal Joint Face

The proximal part of the tibia consists of two flat surfaces. The tibial joint surface consists of the lateral and medial tibial plateau. Eminenceia intercondilaris is a structure that separates the medial and lateral tibia plateau.

The medial tibial plateau, where the most of the load is beared, has a larger and flatter surface than the lateral tibia plateau. The lateral tibial plateau is slightly concave. Both of these tibial plateau have a slope of about 7 ° -10 ° towards the posterior.

2.1.1.2.Patella

Patella is the largest sesamoid bone of the body. Within the extensor mechanism of the knee, it is located between the patellar tendon and the quadriceps tendon. It strengthens the extensor mechanism by extending the lever arm of the quadriceps muscle. The proximal part is wider than distal. Patellar joint surface is divided into lateral and medial facets with a vertical ridges (Figure.2.3). The lateral surface forms 2/3 of the patella. The medial joint surface is smaller and convex. The patella has five contact surfaces. These contact surfaces never contact the femur at all. Maximum joint surface contact occurs when the knee is in the 45° flexion position (20,21).

The patella is affected by the pulling force of the patellar tendon, the pulling force of the quadriceps and the suppressing forces on the patellofemoral surface. When climbing the stairs, 2.5 times the body weight force; 3.5 times the body weight force when descending the ladder, during the walking, 1/3 of the body weight force affects it. These suppressive forces increase with increasing flexion angle in the knee. Between 60º and 90º, the suppressive forces reach to the maximum, while the force on the patella joint face decreases as it extended. The force reaches the minimum at total knee extension position (23).

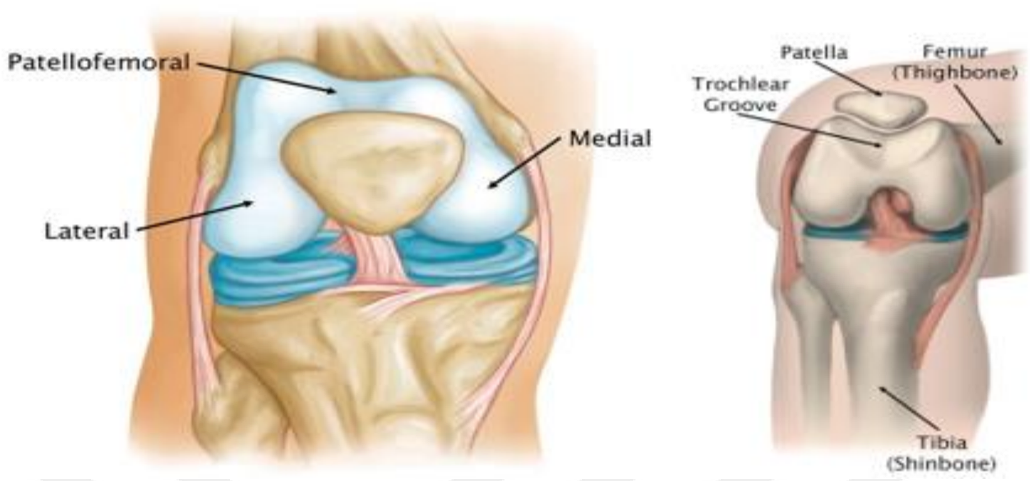

Figure .2.3. Structures of knee joint

https://www.eliteptandbalance.com/articles/physical-therapy/patellofemoral-pain-sydrome-of-the-knee/

2.1.2.Non- Bone Structers

2.1.2.1.In Joint Structers

2.1.2.1.1.Synovium

The knee joint forms the largest synovial space in the body. The synovial membrane proximally overlaps the space between the lower end of the femur and the quadriceps muscle, forming a suprapatellar bursa. Therefore, although the curuciate ligaments are in the joint, they are outside the synovium. Meniscus are also not covered by synovial membrane (20,21).

2.1.2.1.2.Meniscus

Meniscus are semicircular structures consisting of fibrocartilage that allow femoral condyles to settle on the tibial joint surface and deepen the joint surface. They cover two-thirds of the surface of the tibial joint and thinning towards the center. There are two meniscus types: medial and lateral. They are elastic structures with dense collagen fibers in the form of a tight knit to resist the compression loads on joint. These structures, which look like triangles in cross-section, form a letter C and are firmly located in the surrounding capsule and intercondylar distance. Peripheral sections are convex and thick and adhered to the joint capsule, becoming increasingly thinner inward. In the anterior, both meniscus are connected to each other with “lig. transversum genus”. The proximal parts are concave and compatible with the femoral condyles (20,23).

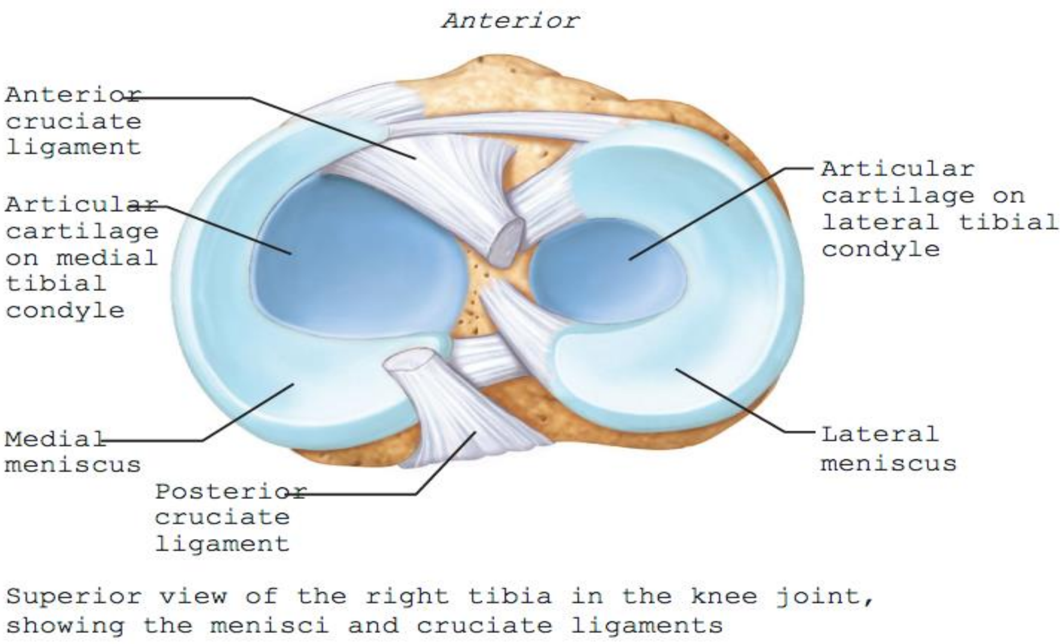

Fig.2.4. Superior view of the right tibia in the knee joint , showing the meniscus and cruciate ligaments

Kean CO, Brown RJ, Chapman J.The role of biomaterials in the treatment of meniscal tears *PeerJ* .2017.5:e4076

The medial meniscus is semicircular and less mobile since its adherent to the medial collateral ligament. The medial meniscus is associated with the articular and semimembranous tendon in the posteromedial. The lateral meniscus is more circular and more mobile than the medial meniscus (20,21).

With the aid of their proprioceptive receptors, the meniscus function as a proprioceptive sensory organ that protects the knee joint from excessive strain and external trauma. The meniscus compensates for the inequality between the contact faces by filling the gap between the joint. This increases the range of motion and ensures that the pressure is evenly distributed over the joint surface. At least 85% of the load transferred from the femur to the tibia is transferred via the meniscus when the knee is at 90 ° flexion and at least 50% when it is in extension (20,23).

Meniscus contribute to joint stability, increase the load-bearing area and reduce the load per unit area. Shock absorption, providing joint lubrication and feeding of joint cartilage are other functions of meniscus (20,21).

2.1.2.1.3. Anterior and Posterior Cruciate Ligaments

ACL and PCL function primarily in the anteroposterior stabilization of the knee. It plays different roles in mediolateral and rotatory stability. It also has an effect on pain and proprioception (20,22,24).

2.1.2.1.3.1.Acl

The ACL starts from the posterior of the medial side of the lateral femoral condyle and adheres to the anterolateral of the eminentia. ACL consists of two bands, anteromedial and posterolateral. The anteromedial band is stretched while the knee is flexed, and the posterolateral band is stretched when the knee is extanded. ACL inhibits valgus and varus forces, but also internal rotation forces. The primary function of ACL is to prevent the tibia from going anteriorly (20,22,24) .

2.1.2.1.3.2.Pcl

PCL is more powerful and less inclined than ACL. The more potent PCL is the primary stabilizer in the anteroposterior plane of the knee. It starts from the lateral surface of the medial femur condyle and adheres posterior to the intraarticular upper surface of the tibia. It is more horizontal in the joint. PCL consists of two bands, anterolateral and posteromedial. The anterolateral band is stretched in knee flexion, while the posteromedial band is stretched in knee extension and knee flexion above 100°. Its primary function is not to allow posterior displacement of the tibia. It also resists external rotation forces. The PCL controls the rolling of the femur on the tibia, ie the femoral rollback, as the knee joint moves towards flexion (22,24).

2.1.2.2.Musculotendinous Structures And Ligaments

2.1.2.2.1.Quadricesps Muscle and Tendon

The quadriceps muscle consists of four parts: vastus lateralis, vastus intermedius, vastus medialis and rectus femoris (Figure.2.5). These muscles adhere to anterior superior iliac spine in proximal and to the upper part of the acetabulum. While some of the fibers of the vastus medialis and lateralis adhere to the lateral and lateral side of the patella, some of them join the structure of the vastus intermedius.

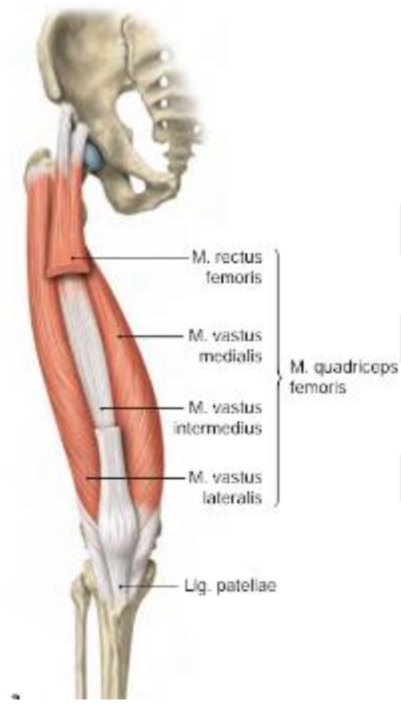

Figure. 2.5. Quadricesps Muscle

Spindler,C .Waschke, J . Lower Extremity in Sobotta Anatomy Textbook : English edition with Latin nomenclature . Waschke. J , Böcker.TM , Paulsen. F , Elsevier:Munich,Germany. 2015. p.217

The last three tendons of the Vastus intermedius pass through anterior of the patella and joins the structure of ligamentum patella. While some fibers of the rectus femoris resultant tendon adhere to the base part of the patella, some of them adhere to the anterior and lateral sides of the patella and join the structure of the ligamentum patella. The ligamentum patella is formed by combining the fibers of the last end tendons of the four heads of the quadriceps muscle. This ligament adheres to the tuberositas tibia as a thick, firm, strip-shaped tendon after encapsulating the patella. There is an average valgus angle of 12 ° between the patellar ligament and the quadriceps femoris.

Quadriceps femoris is the only and strongest muscle that extends the leg. It provides control during flexion during extension of the leg. It protects the stability of the knee by covering a part of body weight during the action. Its innervation is provided by N. Femoralis (25,26).

2.1.2.2.2.Muscles of the Hamstring Group

The muscles on the back of the thigh. This muscle group consists of 3 muscles. These are: M. semitendinozus, M. semimembranozus and biceps femoris muscles (Figure 2.6.) These three muscles combine to form down the pes anserine and adhere to the inner condyle of the tibia. Within this muscle group, N. Tibialis provides the innervation of all muscles except the short head of Biceps femoris. The short head of the M.biceps femoris innervation is provided by N.peroneus communis. Since the muscles in this muscle group pass over the two joints, they extend the femur through the hip joint and make flexion to the leg via the knee joint. The effect of the hamstring muscle group on the knee joint depends on the position of the hip joint. When the hip is in the flexion position, the distance between the beginning and end points of the muscle group increases. As the muscle length increases, muscle tension increases, while the effect of hip flexion poses as knee flexor increases (26).

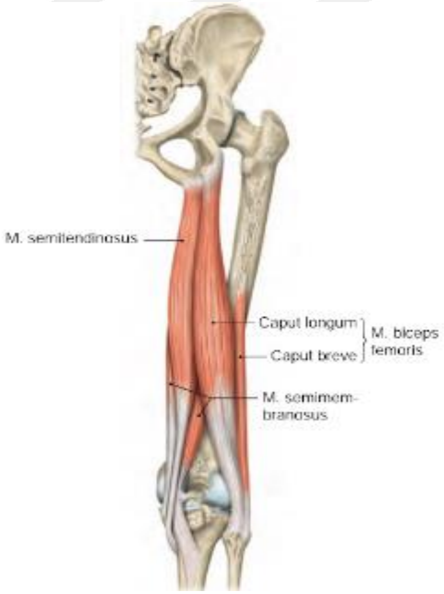

Figure.2.6.*Muscles of the hamstring group*

(Spindler,C .Waschke, J . Lower Extremity in Sobotta Anatomy Textbook : English edition with Latin nomenclature . Waschke. J , Böcker.TM , Paulsen. F , Elsevier:Munich,Germany. 2015. p.208)

M.sartorius: It is the muscle that makes hip flexion, abduction, external rotation and knee flexion.

M.popliteus: It goes from the lateral epicondyle of the femur to the postomedial and adheres to the posterior face of the tibia. It provides rotation of the tibia and prevents the tibia from relacotaion towards the backward under the femur.

M.gastrocnemius: The medial and lateral heads protrude from the posterior aspect of the femural condyles and enclose the soleus muscle. It forms the Achilles tendon downward and adheres to the calcaneus. It makes flexion to the knee joint, plantar flexion to the ankle joint.

2.1.2.2.3. Rotator muscles

The rotational movement in the knee joint takes place in a much more limited range of motion than the range of motion in the extension and flexion movements. During this movement, the meniscus move along the upper articular face of the tibia with the femoral condyles (26).

Internal rotators: M. popliteus, M. semitendinozus, M. semimembranozus, M. sartorius and M.gracilis. As the cruciate ligaments limit the movement, the internal rotation movement can only be made up to 5 - 10 degrees.

External rotators: Those are M. biceps femoris and tensor fascia lata. During the external rotation of the knee joint, as the cruciate ligaments are relased during movement, the external rotation is greater than the internal rotation and can be performed up to 40-50 degrees (23).

2.2. Hip Joint Anathomy

The hip joint is a synovial joint covered with a spherical and large muscle mass, capable of movement in many axes. It is suitable for standing and walking. It is the best example of compatible joints. This harmony between the acetabulum and the femoral head, despite of the minimal differences in joint spacing, is equal at every point in the both hips. This improves joint lubricity and allows the joint to move more easily. Due to its symmetrical structure, it allows rotation of the fixed axle and facilitates the effects of muscles on the joint (27). It is a joint between the upper part of the femur and os coxa that connects the extremity to the pelvis. This joint, which can move around three axes, is a joint of the enarthrosis spheric group. The femoral head is convex on the joint surfaces, while the acetabulum on the outer face of the os cocina forms the concave surface. Os coxa, which forms the concave surface of the joint, consists of three separate bones. These are iliac bone, ischium bone and pubic bone. The muscululus illiacus and the guluteus medius and guluteus minimus muscles adhere to the inner surface of the iliac bone, which forms the large upper part of the hip bone.

Stability is achieved by the joint faces, ligaments and muscle structures. Most of the hip joint stability is due to the joint capsule rather than the surrounding muscle structures (27).

2.2.1.Acetabulum

Acetabulum is the part of the outer surface of the os coxe where the femoral head and the os coxae joint. The face where the acetabulum articulated with the femoral head is called "fasies lunata". It forms a structure that is 2 cm wide whose hyaline cartilage covered aperture forms a downward facing. The edges of the acetabulum were enlarged with a ring made of fibrous cartilage (Figure 2.7). This structure, called labrum acetabulare, surrounds the fossa in all directions by passing over acetabulare to the insus located on the lower face of the acetabulum.

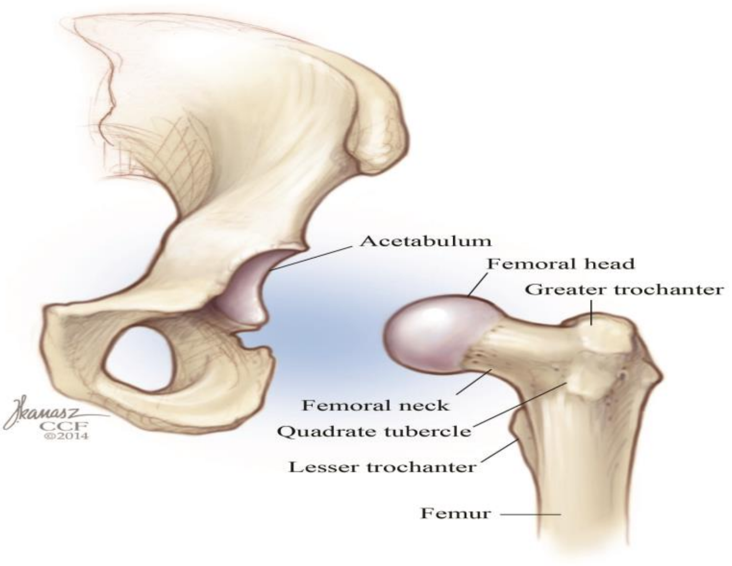

Figure .2.7.Acetabulum and Femoral Head

https://my.clevelandclinic.org/health/diseases/17903-hip-dysplasia/prevention?view=print

2.2.2.Joint Capsule And Ligaments

One of the structures that provide stabilization of the hip joint is the joint capsule. The capsule adheres to the bone of the acetabulum at a distance of 6–8 mm from the labrum (28). The capsule adheres to the anterior intertrochanteric line on the femoral side and adheres slightly above the intertrochanteric line on the femoral head side (29).

There are three extracapsules outside the capsule, which connect the pelvis to the femur and support itself. These are iskiofemoral, pubofemoral, iliofemoral ligaments (Figure 2.8). These ligaments usually relax in flexion, abduction and external rotation movements while the hip joint is in extension (30).

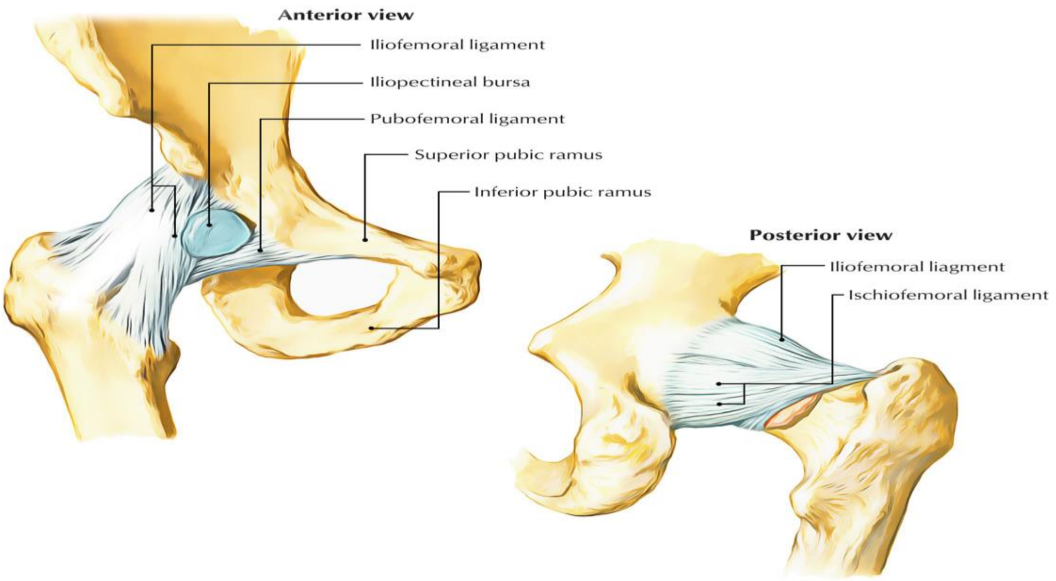

Figure.2.8.Anterior and Posterior view of the Hip Joint Ligaments

https://www.earthslab.com/anatomy/hip-joint/

The most powerful of these three ligament is the iliofemoral ligament which begins as two separate bands from the anterior inferior iliac spine and adheres to the anterior intertrochanteric line in the form of an inverted Y. Iliofemoral ligament mainly limits the hyperextension of the hip. The pubofemoral ligament is builds resistance to the hyperabduction movement of the hip. The ischiofemoral ligament basically keeps the hip in balance while the hip is in extension and located between the pubofemoral and iliofemoral ligaments. The gaps formed between the two bonds are weak points. These weak spots are the cause of hip dislocations towards the anterior and posterior. There are two more ligaments located in hip joint and these are zona orbicularis: the angular ligamentum and ligamentum capitis femoris. These ligaments also contribute to the stabilization of the hip joint (31).

2.2.3.Muscle Anatomy

2.2.3.1.Extensors Muscles of the Hip Joint

Extansor muscles of the hip joint; The posterior fibers of M. Gluteus Maximus, M. Adductor Magnus, M. Hamstring and M. piriformis muscles. The hamstring muscles are composed of three parts: M.Biceps Femoris, M. Semitendinosus, M.Semimembranosus and serve as the main extensors and knee flexors of the hip during walking (Figure.2.9). M.Gluteus Maximus is the strongest extensor of the hip. It has a constant contraction in a standing person, but has little function during walking (32,33).

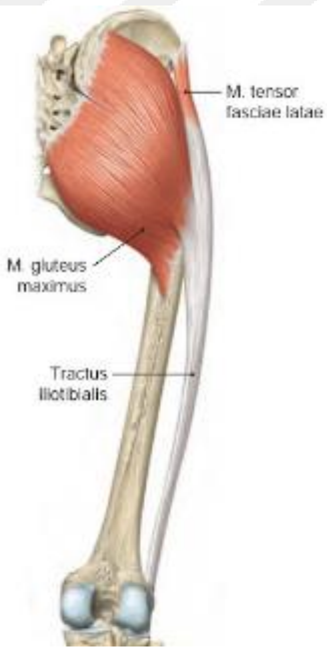

Fig. 2.9. M. Gluteus Maximus

Spindler,C .Waschke, J . Lower Extremity in Sobotta Anatomy Textbook : English edition with Latin nomenclature . Waschke. J , Böcker.TM , Paulsen. F , Elsevier:Munich,Germany. 2015. p.206

2.2.3.2.Flexors Muscles of the Hip Joint

The main flexor muscle flexing the hip joint is ileopsoas. This muscle consists of psoas major, psoas minor and iliacus. Psoas major, begins from 12. thoracic costa and 5. lumbar transverse process and adhere to the small trochanter. Towards the level of the inguinal ligament, the psoas major and iliacus muscles merge to form the "iliopsoas" muscle. Rectus femoris, sartorius, tensor fascia lata and pectineus muscles help the flexion of the iliopsoas muscle (34), (Figure 2.10.)

Figure.2.10. Flexors Muscles of the Hip Joint

Spindler,C .Waschke, J . Lower Extremity in Sobotta Anatomy Textbook : English edition with Latin nomenclature . Waschke. J , Böcker.TM , Paulsen. F , Elsevier:Munich,Germany. 2015. p.206

2.2.3.3.External Rotator Muscles of the Hip Joint

The muscles that provide external rotation of the hip are provided by the short muscles that begin in the pelvis and adhere to the back of the trochanter major. These muscles; M.Gemellus Superior, M. Gemellus Inferior, M.Quadratus Femoris, M. Obturator İnternus, M. Obturator Externus, M.Piriformis and the posterior part of the M. Gluteus medius.

2.2.3.4.Internal Rotator Muscles of the Hip Joint

There is no muscle that primarily performs internal hip rotation. However, the tensor fascia lata, the anterior part of the M. Gluteus Medius, and the M. Gluteus Minimus secondarily rotates the hip. This muscle group includes M. Pectineus, M. Adduktor Magnus M.Adduktor Longus, M Adduktor Brevis, and M. Gracilis muscles (29).

2.2.3.5.Abductor Muscles of the Hip Joint

This muscle group includes M. Tensor Fascia Lata, M. Gluteus Maximus, M. Gluteus Minimus, M. Gluteus Medius and M. Sartorius muscles. In addition to abducting the hip joint, these muscles have an important role to supply an adequate contraction force to prevent the pelvis from falling into the space that has been when the extremity cut off from the ground during the phase of gait (32,33).

2.2.3.6.Adductor Muscles of the Hip Joint

M. Adductor Brevis, M Adductor Longus, ischofemoral part of M. Adductor Magnus, M. Gracilis and M. Pectineus muscles are included in the muscle group that adducts the hip joint (32,33).

2.2.4.Static Stabilizers of Hip Joint

The static stabilizer structure of the hip joint consists of acetabular labrum and ligaments. The acetabular labrum adheres to the bony acetabular edge. It extends outward, increasing the overall surface area and depth of the acetabulum (Figure.2.7). It provides a socket formation by taking part of the head-neck junction of femur. The acetabular labrum adheres to the edge of the acetabulum. It is in fibrocartilage structure, ring-shaped and is associated with articular cartilage. The primary ligaments of the hip, one of the hip joint static stabilizers, make up a large portion of the capsule. These ligaments are pubofemoral, ischiofemoral, iliofemoral (Bigelow's Y ligament), teres ligament (ligamentum teres) and transverse acetabular ligaments.

It strengthens the stabilization of the hip joint by covering the neck and head of Femur. Static stabilizers stabilize the hip by limiting the abduction, internal rotation and extension of the hip joint. In hip flexion and internal rotation, the ligaments are relaxed, and in extension and external rotation the ligaments are tightened (32,33,35).

2.2.5.Dynamic Stabilizers Of Hip Joint

The hip joint has a wide range of motion, although not as much as the shoulder joint. This feature of the joint increases the risk of joint dislocation.Trough the static and dynamic stabilizers of the hip joint, this risk of dislocation is greatly reduced. Dynamic stabilization of the hip joint is achieved with functionally antagonistic muscles in the hip and thigh region. In anatomical and functional disorders occurring in muscles, the stabilization of the joint is reduced as the dynamic stabilizer mechanism of the joint is disrupted in pathological conditions. While the knee joint is in the flexion position, the hip can be approached to the chest area during the flexion movement, while the knee joint is in extension position, the hip flexion range of motion is greatly reduced.

The reason is that the hamstring muscles are stretched in the extension position, restricting movement and creating dynamic stabilization. Another dynamic stabilizer in the hip joint is the external rotation muscles, which are stronger than the internal rotation muscles (36).

2.2.6. Rom Of The Hip Joint

Hip joint movements consist of extension, flexion, adduction, abduction and rotations with special physiological limitations allowed by soft tissues. Hip flexion is limited to the Hamstring muscle group.

The extension movement is restricted by the ligament structures in the capsule. Adduction is limited by the abductor muscles and tensor fascia latae muscle; Abduction is limited by the adductor muscle group and rotations are limited by fibrous capsular fibers.

Table.2.1.The degree of hip joint ROM

Joint Movement	Degree
Flexion	135∘
Extension	10-30∘
Abduction	40-45∘
Adduction	20-30∘
Internal Rotation	35-40∘
External Rotation	45∘
Abduction	65-90∘
Adduction	40∘
Internal Rotation	45∘
External Rotation	40∘

The primary flexor of the hip is the iliopsoas muscle and the insert has 135 degrees of hip flexion. Hamstring and gluteus maximus muscles are the muscles that make extension to the hip. They make 30 degrees of extension to these two muscle. The primary muscles abducting the hip joint are the gluteus medius and gluteus minimus muscles. The adductor brevis, adductor longus, pectineus, grasilis, and adductor magnus are adductors of the main joint. This muscle group has approximately 20-30 degree of adduction to the joint (Table.2.1). The superficial muscle layer of the joint forms tensor fascia latae, gluteus maximus, and iliotibial band.

In the second layer, there are gluteus medius and gluteus minimus muscles. These muscles adhere to the trochanter major and the fascia over the hip joint capsule from the anterior and posterior. On the posterior, short outer rotators, gemellus superior, piriformis, gemellus inferior, obturator internus and quadratus femoris encapsulate the joint capsule and are inserted into the medial part of the trochanteric process from proximal to distal.

Although there are muscles that pass over the hip joint such as rectus femoris and hamstrings in the joint, the gluteal muscles, which are the primary dynamic stabilizers, are gluteus medius, gluteus minimus and gluteus maximus, adductors, iliopsoas, tensor fascia latae, iliotibial bands and deep muscle structures (pectineus, inferior gemellus, obturator internus and externus). These deep muscle structures of the hip are considered to be the "rotator cuff" muscles of the hip and have "fine tuning" roles in hip movements (36).

2.3.Balance

Balance is defined as the ability of the body to be controlled with as little muscle activity as possible in dynamic or static positions, and to control the body's gravity center within stability limits along the support area (37). To maintain any position or to ensure proper transitions between positions, the sensory alerts transmitted from the environment, from the central nervous system, are rapidly analyzed and used for motor responses. The performance of motor skills depends on the ability to maintain control and stability throughout the movement. The movements are formed by a successful combination of sensory, muscular and neurological functions. The deterioration in these functions affects the ability to maintain balance.

Balance control is a complex motor capability that involves the planning of flexible movement patterns, integration of sensory inputs and their implementation (38). The analysis of information from the external environment allows regulatory reflexive movements, provides information about the orientation of the person to maintain posture control in space (39). However, sensory inputs from the external environment alone are not sufficient to maintain postural control. Postural stability depends on the effectiveness of the systems within the nervous system, complete neural pathways for motor control and the integrity of muscle mass (40). Environmental components on balance include visual, vestibular and somatosensory systems. The central nervous system combines environmental inputs transmitted from these systems and determines many appropriate muscular responses to control posture on the support base and body position (41,42). Balance, which forms the basis of good performance, acts as a conductor in the muscular and nervous systems. One's ability to maintain balance is defined as an important factor in the development of other motor systems (43).

2.4. Proprioception

Proprioception; it is defined as the ability to detect body parts and the position of the joint in space. With the afferent stimuli from muscle tendon, joint capsule, ligament, meniscus and skin receptors (44), proprioceptive mechanism occurs by combining the inputs from the vestibular and viscous systems to regulate periarticular muscle activity, which provides joint stabilization by the central nervous system (45). Proprioception, which establishes the interaction between the affarent and the efferent system, is a complex neuromuscular system that provides body orientation and stabilization during dynamic and static physical activities (46).

Proprioception is accepted as the sixth sense of the human body after vision, taste, smell, hearing and touch, which are the senses that define the external world. Position perception of the body and body parts is provided by certain special receptors in and around the muscles, joints and skin. Different types of receptors perform different functions by providing information to all levels of the central nervous system. According to the information obtained, a motor response occurs with the body part in a dynamic or static state (47).

2.4.1.Proprioceptive Receptors

2.4.1.1.Joint Receptors

Paccini and ruffini receptors are receptors similar to the Golgi tendon organ (GTO). They are histologically found in the meniscus, lateral and medail collateral ligaments, the joint capsule, and the infrapatellar fat pads (48).

- Ruffini receptors (type 1): Most defined receptor. They are receptors that are slow-adaptive, capable of being active in a low threshold, dynamic and static state (50). In addition to the static joint position, the Ruffini receptors receive information on the velocity, intraarticular pressure and amplitude of joint rotation (46). It is found in the joint capsule and ligaments (50).
- Paccini receptors (type 2): It is defined as a fast adapting dynamic receptor having a low threshold specificity (49). It is a receptor that is activated in the dynamic state, inactivated in the static state and at a constant rate. (46). They are found in the joint capsule. These receptors are responsible for the transmission of high frequency vibration senses (50).
- GTO-like receptors (type 3): They are the largest mechanoreceptors in the joint. Slowly adapting receptors that have high threshold and are only activated during dynamic movement and excessive joint movement.
- Free nerve endings (type 4): They are receptors that are activated in dynamic and static conditions and are slow to adapt. The receptors in the relevant muscles and ligaments receive the sense of pain (46).

2.4.1.2.Skin Receptors

These receptors give information about the kinesthesia and joint position sensation when stretched, but there is no evidence of their contribution to providing joint stabilization. (46,51).

2.4.1.3.Muscle Receptors

The Mechanoreceptors in muscles are GTO and muscle spindle.

* Muscle spindle, located in the middle region of the muscle fiber, is the mechanoreceptor carrying information about the muscle length and the rate of change of length. It is 3-20 millimeters (mm) long. The muscle spindle consisting of intrafuzal muscle fibers adheres to

extrafusal muscle fibers. Since there is no actin and myosin in the middle of the intrafuzal muscle fibers, the receptor part of the muscle spindle does not have the ability to contract. The intrafuzal fibers are divided into two as Nuclear Chain Fibers and Nuclear bag fibers. There are many nuclei in the center of the Nuclear bag fibers. Nuclear Chain Fibers are half of the length of Nuclear bag fibers.

Two sensory endings are present in the receptor segment of the muscle spindle. These are primary and secondary termination. Primary afferent fibers are found in the core of the Nucleus and are called group IA fibers. Secondary afferent fibers are referred to as group II fibers and encircle one or both sides of Nuclear Chain Fibers.

Group IA fibers are activated at sudden and slow speed, and group II fibers are activated only at slow speed stress and inform the spinal cord. Group IA fibers are stimulated by sudden stretching of the muscle and the same muscle is contracted rapidly from the medulla spinalis through the monosnaptic reflex path.

Muscle contraction is continued for a long time with the signals transmitted from the group II fibers as long as the muscle remains excessively long. This dynamic strain reflex decreases after the muscle reaches its new length (52).

Intrafuzal fibers are stimulated by gamma motor nerves. Speed feedback and muscle spindle are primarily responsible for joint position. The muscle spindle is responsible for proprioception and postural control, especially when the eyes are closed (53).

Golgi tendon organ (GTO): A single axon enters the GTO located at the junction of the muscle and tendon and gives free ends without myeline between the collagen tissue. The tendon is stretched during muscle contraction, the collagen fibers flatten and the GTO receptors are stimulated. With this stimulation, inhibition of the same muscle occurs while excitation occurs in the antagonist one. (46). When the tension in the tendon and the muscle become excessive, the muscle relaxes. Thus, damage to the tendon and muscle is prevented.

The muscle spindle senses changes in the length and length of the muscle while the GTO detects the tension of the muscle (51).

Complementary, slowly adapting muscle and joint receptors form information about the joint position from the periphery. Fast adaptive mechanoreceptors are sensitive to movement changes (50).

Proprioception is defined as afferent information from the periphery of the body for joint stabilization, postural balance and other conscious perceptions (46).

2.4.2.Proprioception and Sensorimotor Control

The function of proprioception in motor control is divided into two as the role of internal and external environment. Its role in the internal environment is related to modification and planning. Its role in the peripheral environment is related to visual inputs and proprioception against sudden changing body positions.

Muscle stiffness is divided into intrinsic and extrinsic reflex components. High collagen-containing fascia and tendons have elastic and viscoelastic properties. The increased stiffness of the intrinsic component including actin and myosin cross-bridges results in increased reflective neural activation in the muscle. Thus, muscle prick transmits information faster.

2.4.3.Components of Proprioception

Proprioception includes structures related to agility and balance that ensure the correct and harmonious movement, the coordination, the ability to change the speed and direction of movement, the response and timing to be given to the resistance. All of these are proprioceptive abilities incorporated into the somatosensory system, which includes neuromuscular control. (54,55).

2.4.4.Methods of Measurement of Proprioception

Although there are many methods for the measurement of proprioception in the literature, there is not a system that evaluates this alone. The most common method of assessment is the use of the kinesthesia, joint position sense and resistance sensation. It is necessary to evaluate proprioception within the components and within all neuromuscular control and components.

* Joint position sensation: This technique, which is a reliable method in the evaluation of proprioception, can be performed passively or actively in closed kinetic and open-source positions. The joint to be measured is taken passively or actively to the target angle. The individual is asked to find this target angle passive or actively. The difference between the angle indicated by the person and the target angle is recorded. Inclinometer, goniometer and

isokinetic systems are used in joint position sensation measurements (48,56). Passive measurement of joint position sensation is thought to test joint receptors and thus cortical connections, such as the measurement of kinesthesia (GTO-like and ruffuni receptors). It is thought that joint positioning sensation test with active placement tests both muscle and joint afferents (50).

* Resistance feeling: Measurement is made by comparing the ability of individuals to repeat the strength generated by the measured muscle group at different angles. Minimal and submaximal contraction of the muscle group to be measured is taught clearly as eyes wide open. Then, with the eyes closed, the taught force is expected to be generated. The error rate of the person is recorded (56-57).

* Kinesthesia: The knee to be measured is moved passively in the direction of extension or flexion at speeds of 0.5 - 2.5 degrees/sec. The angle value is measured when the person feels the movement. This test is thought to test joint receptors more than muscle receptors (57). This test is thought to test receptors similar to Ruffin and GTO that are slowly adapting from joint receptors (56,58).

2.4.5.Knee Joint Proprioceptive Sense

The Cruciate ligament is one of the important stabilizer structures. Through the mechanoreceptors in the structure at the same time, they play a role in providing proprioception. The Mechanoreceptors constitute 1-2% of the anterior cruciate ligament structure and proprioceptive sensation is adversely affected after ligament injury (59,60).

It has been shown that a lot of free nerve endings in the anterior cruciate ligament as well as Ruffini, Paccini, GTO receptors. These receptors have also been found in the posterior cruciate ligament, lateral and medial collateral ligaments and capsule (61), and menisco femoral ligaments (62). Meniscus is considered as a proprioceptive sensory organ. This is because it protects the joint from excessive stresses due to the presence of proprioceptive receptors (63).

2.4.6.Factors Affecting Proprioception

Age, temperature change, fatigue, joint degeneration, regular exercise and use of bandages are among the factors affecting proprioception. It is known that the cold adversely affects the proprioceptive sensation, whereas the heat positively affects (64). Fatigue has been shown to change the sensation of movement and joint position by negatively affecting the sensitivity of muscle spindle receptors (65,66). It has been reported that the use of banding, brace (67) and bandage (68) positively affects proprioception as it increases proprioceptive input (56).

Proprioceptive sensory exercise studies with the muscle spindle, although the increase in the number of afferent input does not increase the proprioceptive response accelerated exercise training improves proprioceptive sensation (69).

Proprioceptive sensation decreases with age (70). Joint degenerations, such as osteoarthritis, which cause damage to joint cartilage, menicus, joint and ligament receptors, result in muscle weakness and decreased motor neuron activity due to this damage. As a result, proprioceptive input is reduced and proprioception is adversely affected (71).

2.5.Stretching Exercises

Muscle tissue is composed of connective tissue. The connective tissue consisting of collagen and other fibers has viscoelastic properties and allows the tissue to elongate. The viscoelastic structure allows plastic stretching. After the elimination of the force that causes the tissue to stretch, a permanent elongation of the tissue occurs. Elastic structure creates elastic stress in the tissue. After the force exerted on the tissue, the tissue returns to its old length (72,73). One of the main features of deformation occurring in viscoelastic tissue is the change of deformation depending on time. So when the applied force is applied quickly, the deformation will be elastic and the tissue will immediately return to its original state. If the load is applied for a while (stretching and holding), the deformation will be viscous and the tissue will slowly return to its original state (73).

Stretching exercises, by activating the nervous system muscle elongation and elongation in joint range of motion creates an extension (74,75). Therefore, stretching exercises should be applied to various tissues, including connective tissue, beyond normal limits (74).

There are some studies showing the benefits of stretching exercises, preventing injury, reducing post-exercise delayed muscle pain (76) and increasing muscle performance, which constitute a significant part of rehabilitation (77). However, the effect of stretching exercises on proprioception is not clear enough.

2.5.1.Types of Stretching Exercises

Stretching exercises are divided into 4 main groups.

These are:

1. Static Stretching
    a. Active Stretching
    b. Passive Stretching
2. Dynamic Stretching
3. Ballistic Stretching
4. PNF Stretching (78).

2.5.1.1.Static Stretching

Static stretching is a type of stretching that involves keeping the muscle group in a long position for a certain period of time. It is a controlled and slow movement with proper posture of the body. During static stretching, moderate tension should be felt in the treated muscle. Pain should not be felt during the stretching period. It is generally recommended for sedentary and newcomers as the risk of injury is low. It has been shown to be an effective method to increase flexibility in muscle.

Static stretching is divided into two:

2.5.1.1.1.Active Static Stretching

Active stretching is the type of stretching at a certain position using the power of the agonist muscles. The tension of agonists in active stretching helps to relax the antagonist muscle group.

2.5.1.1.2.Passive Static Stretching

When the patient is in the loose position, it is applied by hand or mechanically an external force to extend the shortened tissue. It decreases muscle pain and muscle fatigue after exercise.

2.5.1.2.Dynamic Stretching

It is a type of stretching that involves the use of movements such as swinging and springing, which are within the boundaries of normal joint movement that are controlled and soft. In dynamic stretching, the lower and upper extremities oscillate slowly and in a controlled manner. It is the most recommended type of stretching before sporting activities. If these exercises are repeated continuosly, it has been found that it improves movement memory and provides dynamic control and neuromuscular control.

2.5.1.3.Balistic Stretching

It is the repetitive springing, sudden jump or forced loading of movement on the muscles in a stretched position. The disadvantage of ballistic stretching is that injury may occur at the end of the overload. The level of the technic should be determined and applied without exceeding the limits. Ballistic stretching is not suitable for the injured muscle group (79).

2.5.1.4.Stretching with Proprioceptive Neuromuscular Facilitation (PNF) Techniques

It is a very special combination of motion created to increase the neuromuscular efficiency of the muscle groups applied. Some PNF techniques are used to relax the muscles on one side while the muscles on the other side are stretched (80).

The PNF technique is a combination of isometric stretching and isotonic stretching to achieve maximum static flexibility. These techniques include hold-relax, contract-relax, slowly and reversal hold-relax, agonist contraction, agonist contraction and hold-relax. Because of the resistance to stretching, the degree of pain is high, the risk of injury is less than ballistic stretching and higher than static stretching.

Tension applied to the muscle creates a tension reflex in the muscle. Stretching reflex produces stimulation in the muscle. Stretching to muscles is applied when it is aimed to increase dynamic muscle performance. Stretching may be contraindicated when tendon, bone, muscle or joint damage occurs

The purpose of the use of stretching in PNF is to reduce muscle fatigue, to elongate muscle, to facilitate muscle contraction with the created stretching reflex (79).

2.5.2. Effects of Stretching

The effects of stretching exercises are divided into two groups as acute and chronic.

2.5.2.1.Acute effects of stretching

The acute effects of stretching are shortterm effects. It depends on the extensibility of muscle and tendon units. When the acute effects of stretching are examined, it is seen that it increases the mobility of the connective tissues and increases the range of motion of the joint. According to the researches, there is an increase in flexibility immediately after the stretching. Stretching exercises performed in the right technique before and after the exercise make it easier to meet the load on actin and myosin filaments. It facilitates the resistance of the resistance during the exercise by the elastic structures. Reduces micro tears in muscle fibers.

The long-term effect of stretching is chronic effect. Long-term stretching exercises increase the number of sarcoma in the muscle and increase muscle length (79). However, the effect of sarcomere increase on muscle strength and the mechanical structure of the muscle tendon unit is not clear.

Although the opinion that stretching exercises do not reduce muscle stiffness in the chronic period is widespread, there is insufficient evidence for this condition. When the muscle is toned, the concentric force on the muscle is better transmitted. It can absorb shocks better while the muscle is in a compliant state. But the difference between this condition and toned muscle is unknown. Chronic stretching can increase compliance while reducing the force. The mechanism that causes this is not clear enough and the study on this issue is not sufficient (81).

2.6.Self Mobilization

Mobilization and manipulation are two common modalities that are used in various situations, with different technic methods and mechanisms of action. Mobilization is performed within the passive limits of normal joint movement. Manipulation is performed by passing the passive normal joint movement in the area called paraphysiological gap. Mobilization are light, oscillatory, low-amplitude maneuvers that give the patient a feeling of stretching (78). The primary purpose of self-mobilization techniques is to increase the mobility of capsules and other connective tissues. It reduces joint symptoms by regulating joint movement.

Self-mobilization techniques have been used to treat many musculoskeletal dysfunctions, including functions previously thought to be difficult to treat (16). Self mobilization exercises have been shown to improve the range of motion by changing the activity in mechanoreceptors. Self mobilization normalizes abnormal afferent inputs from mechanoreceptors in the joint and provides an increase in power. However, according to some studies, mobilizing normal tissues has been shown to decrease muscle output and cause less muscle activation due to pressure on tissues (82).

3.MATERIAL AND METHOD

3.1.Experimental Groups and Study Design

This study was carried out in the Department of Physiotherapy and Rehabilitation of the Institute of Health Sciences at Yeditepe University in order to determine the acute effect of Dynamic Stretching and Self-Mobilization exercises on Balance and Proprioception. Necessary permission and approval were obtained from Yeditepe University Medical Faculty Hospital Non-Interventional Clinical Research Ethics Committee (10.04.2019). Pre-study evaluation and technic methods are explained in detail to all participants. Persons signed a detailed consent form that they volunteered to participate in the study. 36 people between the ages of 18-30 participated in the study.

3.1.1.Inclusion criteria

- To give consent to participate voluntarily.
- Being between the ages of 18 and 30.
- The hip extension ROM measurements of volunteers must be between + 5 ° and + 15 °
- The volunteers must have the hip flexor muscle tightness.

3.1.2.Exclusion criteria

- Previous knee surgery or fracture history
- To be diagnosed with any disease related to the area of the knee and hip.
- Having a degenerative spine disease.
- Having visual and motor disorder.
- Having balance problem.
- Being pregnant.
- Unstable hypertension.

In our study, healthy individuals with 36 hip flexor tightness according to G Power analysis, were included. A total of 76 people were included in the study. 40 people were excluded from the study since their flexor muscle tightness were not identified, 36 patients with hip flexor muscle tightness were included in the study. 36 randomized individuals were divided into two groups.

FLOW CHART

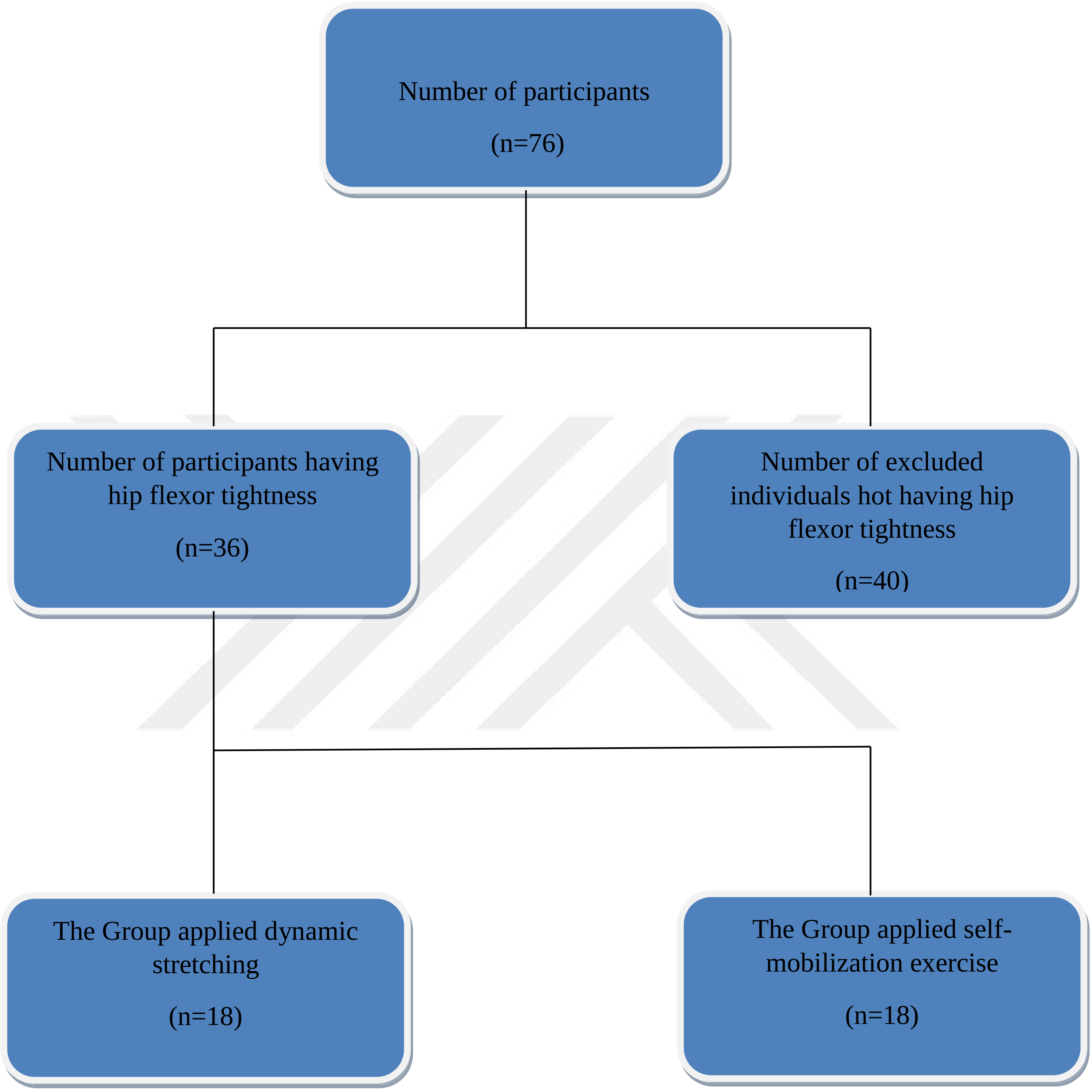

Table 3.1:Flow Chart

A total of 76 people participated in the study. 40 patients without hip flexor muscle thightness were excluded from the study. 36 patients with hip flexor muscle tightness were included in the study. 36 people were randomized into two equal groups by simple randomization method. Dynamic stretching exercise (n = 18) was applied to one group and self-mobilization exercise (n = 18) to the other.

3.1.3.Physical Properties

The sex, age, height, body weight and dominant side of the individuals were recorded. People with hip flexor muscle tightness are identified and included in our study. People included in the study are divided into two groups by simple randomization method. Dynamic stretching exercise was applied to the first group and self mobilization exercise was applied to the second group. Immediately after the specified technique was applied, the measurement methods were applied once more. The identified methods were applied to both extremities of the volunteers.

3.2.Evaluation

3.2.1.Questionnaire for the Demographic Characteristics of Participants

The questionnaire, which was prepared by the researchers and applied face to face, includes questions that question the age, gender, occupation, education level, income level, marital status, sociodemographic conditions, chronic diseases, family history, drugs used, smoking alcohol habits and exercise behaviors.

3.2.2.Hip Extansion ROM Measurement

Digital inclinometer was used to measure hip extension ROM (Figure. 3.1). Hip extension measurement was performed with modified Thomas test. Measurement values were measured with digital inclinometer.

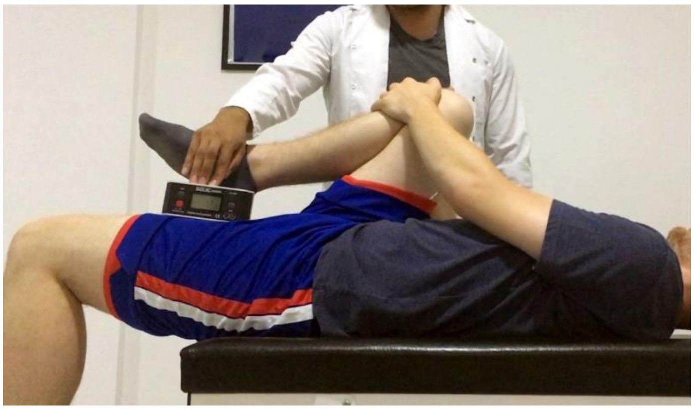

Figure.3.1. Hip extension range of motion (ROM),measurement test using a digital inclinometer

Volunteers lie on their back and bring the guluteal lines up to the border of the bed. The knee of the measurement side is in the flexion position between 80 ° and 90 °. The measurement is taken by placing the digital inclinometer in the middle of the anterior side of the thigh. The measurement was taken before and immediately after the technic. Each measurement was done 3 times. The average of 3 measurements were taken and recorded (83).

Figure.3.2: Baseline Digital Inclinometer

3.2.3.Proprioception Measurement

Digital inclinometer was used for joint position sense measurements. (Figure.3.2). During the test process, the individuals were placed on the edge of the bed and the knees were flexed at 90 °. During the measurement, the eyes of the individuals were closed. The inclinometer was fixed with velcro to the lateral side of the leg to be measured 3 cm above the lateral malleoli (Figure 3.3).

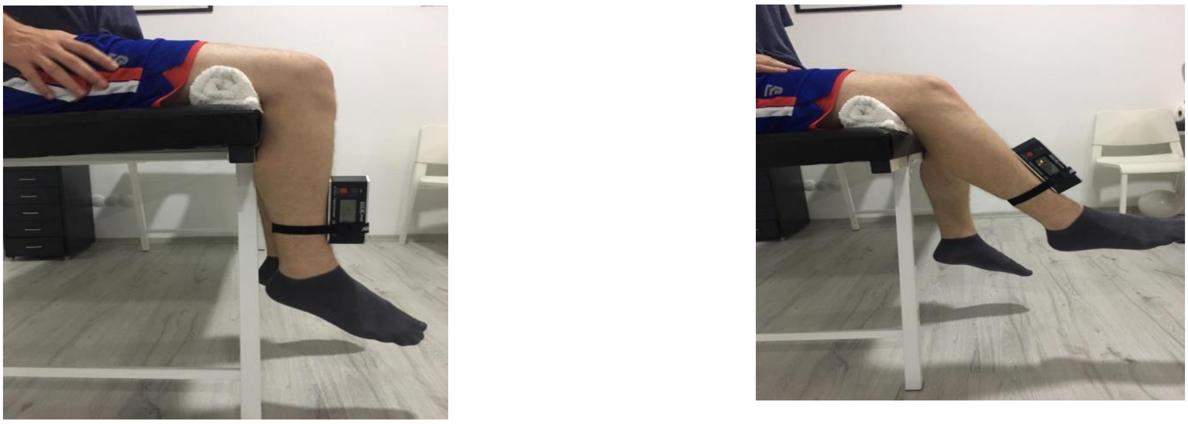

Figure3.3. Knee joint position sense (JPS) measurement using Baseline Digital Inclinometer

The target angles are 30 ° and 60 °. The volunteer was told the determined target angle before each measurement. The relevant target angle was taught twice to the subject before the measurement. And the volunteers were asked to find the target angles three times. The deviation from the target angle of the measurement results repeated six times was recorded at all angle values (83-84).

3.2.4.Dynamic Balance Assessment – Y Balance Test

Y Balance Test is a balance test designed to measure dynamic balance. The participant, who always started on the right foot, was asked to keep the other foot in three directions (anterior, postero-medial and posterolateral) with the fingertip while standing on one foot. It was taken care not to lose its balance, the heel of the standing leg to stand up, to touch the fingertips of the extended foot slightly, and to bring the touched foot to the fixed foot without touching the ground (Figure.3.4).

Figure 3.4. Y Balance Test

The test was repeated 3 times with 15 sec rest intervals for each direction. Scores were recorded in cm. These values recorded in cm were recorded with the formula Anterior + Posteromedial + Posterolateral: 3 x Limb Length (85).

3.3. Exercises

3.3.1.Dynamic Stretching Exercise

The volunteer was lying down in the prone position. The posterior inferior spina is fixed to the bed on illiac. The knee is flexed 90 °(Figure.3.5). The person extends the hip until they feel tension in the anterior. And in this position, it actively stretches for 2 seconds. For each side of the exercise, a total of 6 sets of 10 repetitions were performed. The sets were rested for 10 seconds. The total stretching time for this protocol was determined to be 120 seconds (83).

Figure .3.5. Dynamic stretching technique used for stretching hip flexor muscles.

3.3.2.Self Mobilization Exersice

İndividuals were initially placed in the lunge position with the side to be treated at the back. Exercise was performed with the help of a resistance band. The resistance band is fixed. The band was placed tautly at the end of the guluteal lines on the side to be treated (Figure.3.6).

Figure.3.6. Posteroanterior (PASM) selfmobilizations with the band

The subject was asked to perform some knee flexion with the other side. Stress was felt in the thigh area of the treated side. At this point, we stopped and waited for 2 seconds. The initial position was then returned. Thus, mobilization in the posterioanterior direction is provided. Exercise was done in 10 repetitions, 6 sets for each side. Rest between sets is determined as 10 seconds (19).

3.4.Statistical Analysis

In our study, healthy individuals with 36 hip flexor tightness according to G Power analysis, were included. Statistical analysis of the data was performed with SPSS 20.0 package program.The groups were divided into two groups by simple randomization method. Shapiro-wilk test was used to test whether the data were normally distributed or not. Student’s t-test was used to compare the mean of the 2 groups. For the normally distributed data, t-test, which tests the means of two independent groups, was used for parametric tests, for Mann-Whitney U test for non-normal distribution data, and Wilcoxon test for data of dependent (pre-post) groups. Pearson correlation or Spearman correlation analysis was used to determine the relationship between the variables.

4.RESULT

4.1.Muscle Tightness Measurement

As a result of the statistical analysis of the effect of dynamic stretching on muscle tightness, a statistically significant decrease was found between pre and post dynamic stretching exercise in relation to right and left lower extremities (p <0.001)(Figure 4.1)(Table 4.1). It was determined that the muscle tightness of the right and left lower extremities pre and post the self mobilization exercise reduced significantly after statistical analysis (p <0.001)(Figure 4.2)(Table 4.2).When the effects of two different exercise practices on muscle tightness were examined, it was found that there was no significant alteration between the differences between the right and left extremities pre and post exercise (p>0.05)(Table 4.3-4.4).

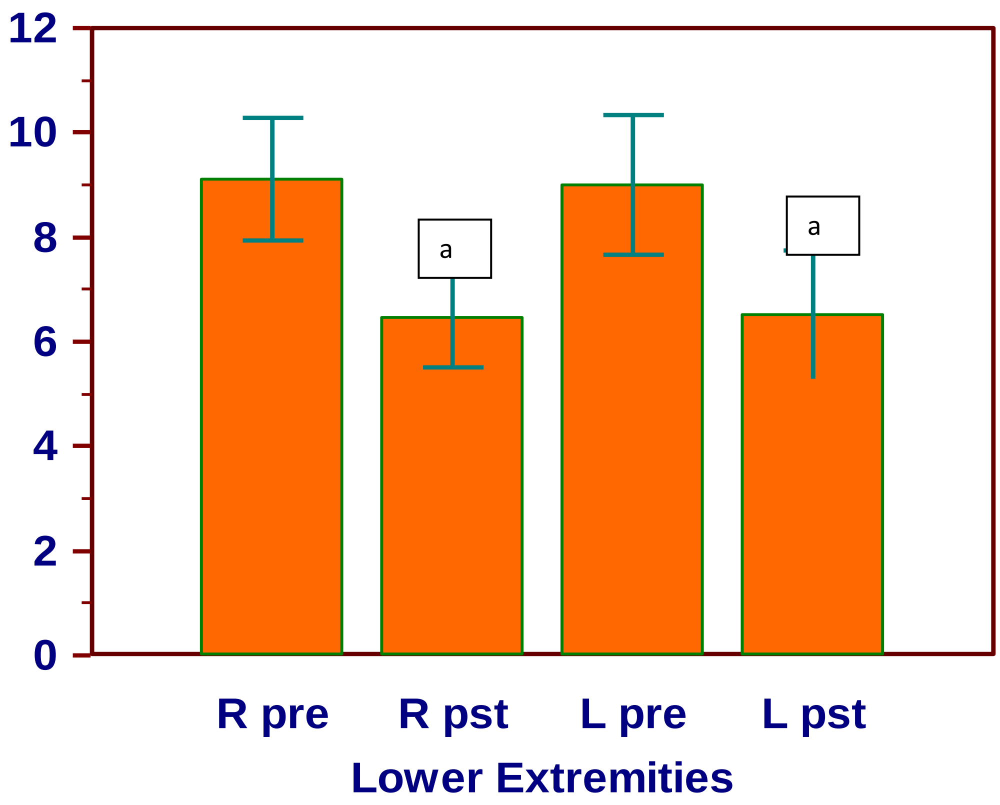

Figure 4.1: Muscle tightness values pre and post the dynamic stretching exercise in lower extremities.

It was determined a statistically significant decrease about muscle tightness between pre and post the dynamic stretching exercise in relation to right and left lower extremities (a = p <0.001, R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

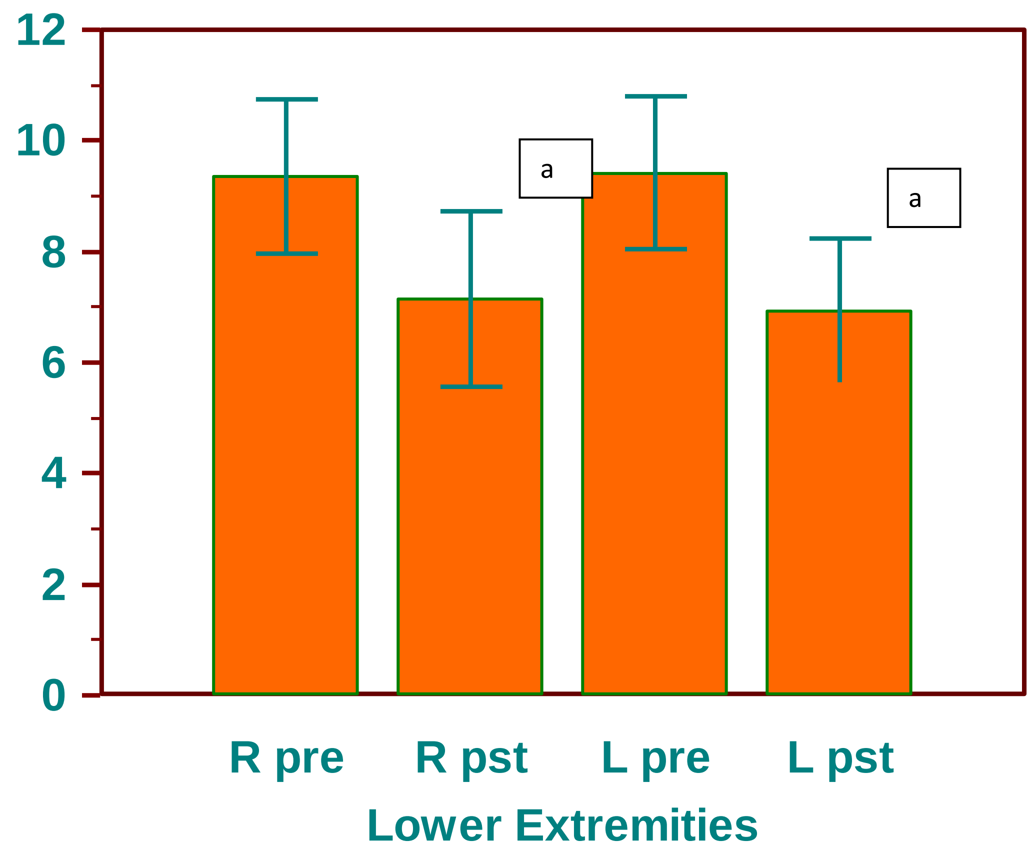

Figure 4.2: Muscle tightness values pre and post the self mobilization exercise in lower extremities.

Significant decrease was found about muscle tightness on right and left lower extremities after the self mobilization exercise (a = $p<0.001$, R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Proprioception Measurement

Proprioception 30°

It was determined that after the dynamic stretching exercise, proprioreception 30 was significantly reduced in the right lower extremity (p <0.01)(Figure .4.3)(Table. 4.1), however, proprioception 30 was not changed after dynamic stretching exercise in left lower extremity (p>0.05). The self-mobilization exercise did not significantly change the value of proprioception 30 in the right and left lower extremities (p>0.05)(Figure.4.4)(Table.4.2). When the effects of two different exercise practices on proprioception 30 were examined, it was shown that there was no significant alteration between the differences between the right and left lower extremities before and after exercise (p>0.05) (Table.4.3-4.4).

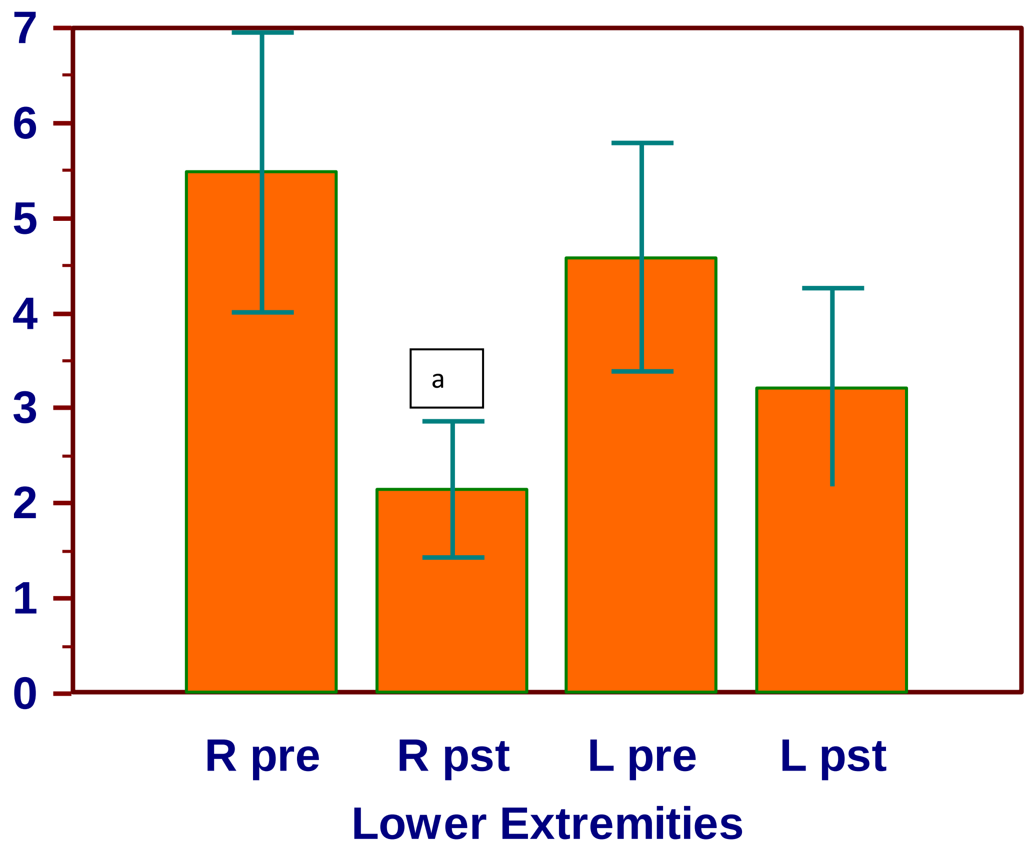

Figure 4.3: Proprioception 30° values before and after the dynamic stretching exercise in lower extremities.

The dynamic stretching exercise caused significant decrease about proprioception 30° in the right lower extremity (a=p <0.01), however, it could not affect to the left lower extremity(p>0.05). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

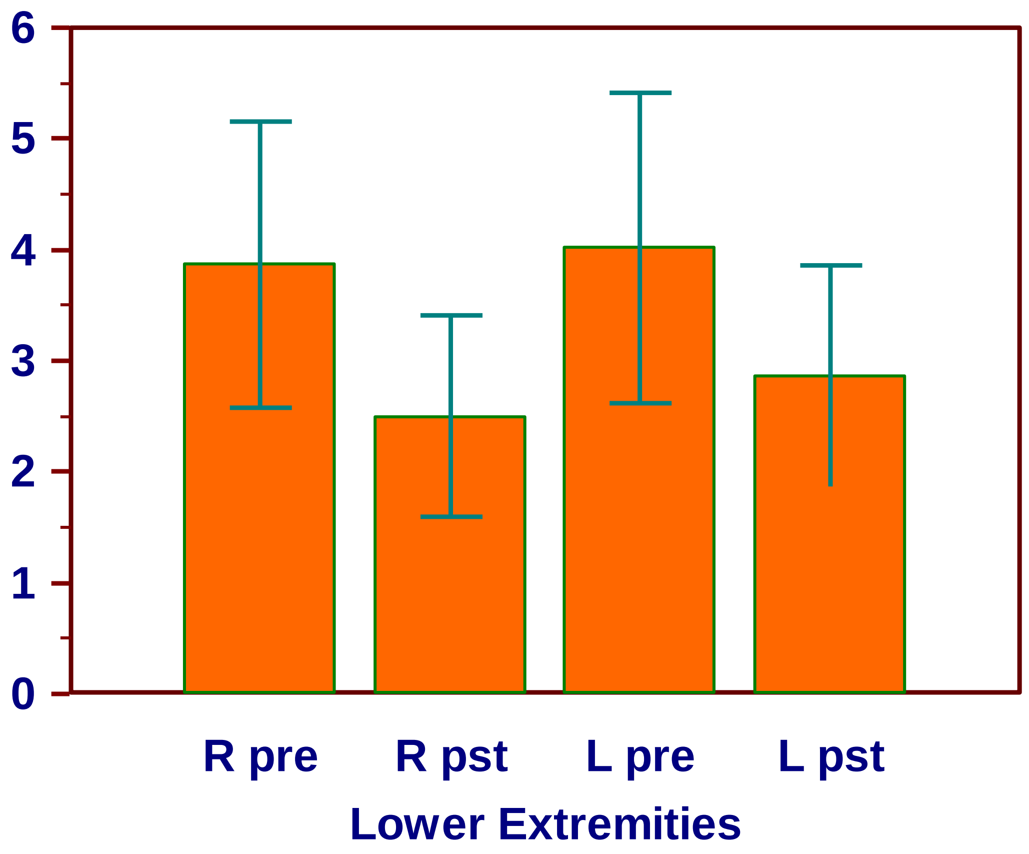

Figure.4.4: Proprioception 30° values before and after the self mobilization exercise in lower extremities.

The self-mobilization exercise could not change about proprioception 30° in the right and left lower extremities ($p>0.05$). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Proprioception 60°

After the dynamic stretching exercise, the proprioception 60° value of the right and left lower extremities was found to be statistically unaltered (p>0.05)(Figure.4.5) (Table.4.1). It was also determined that after self-mobilization exercise, the proprioception 60 value of the right and left lower extremities was found to be statistically unchanged (p>0.05) (Figure.4.6) (Table.4.2). When the effects of two different exercise practices on proprioception 60° values were examined, there was no significant difference between exercise practise (the dynamic stretching and self-mobilization) in relation to proprioception 60° values (p>0.05) (Table. 4.3-4.4).

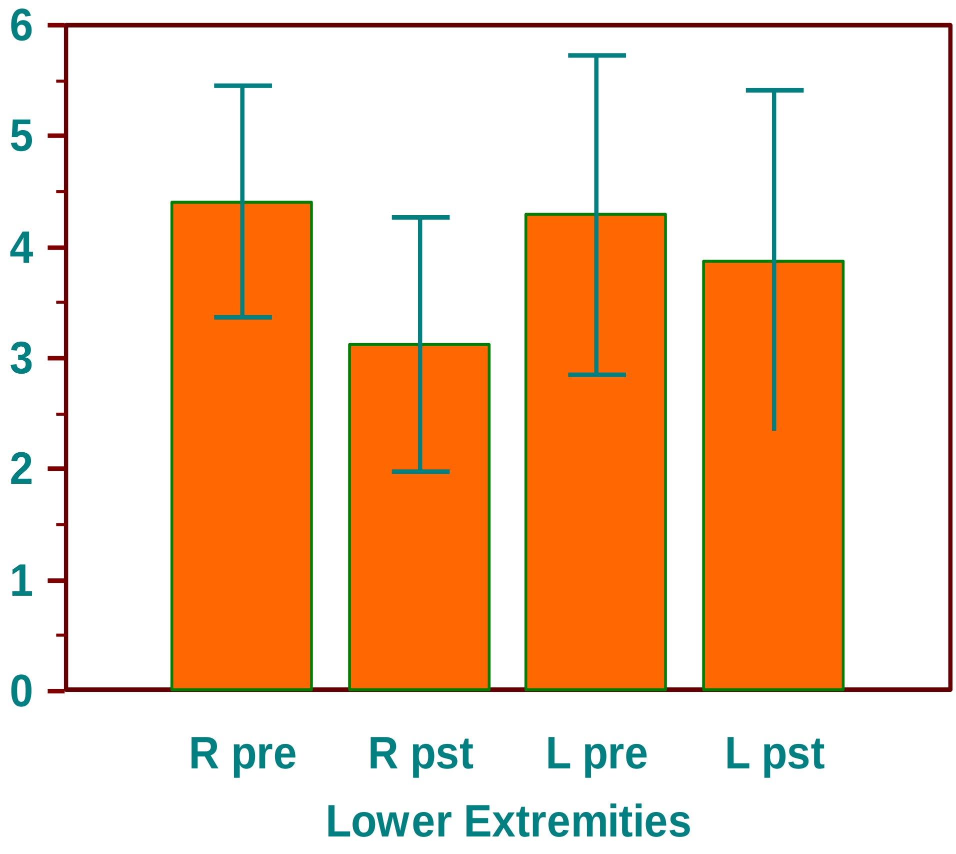

Figure 4.5: Proprioception 60° values before and after the dynamic stretching exercise in lower extremities.

The dynamic stretching exercise could not induce significant change the proprioception 60° value of the right and left lower extremities (p>0.05). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

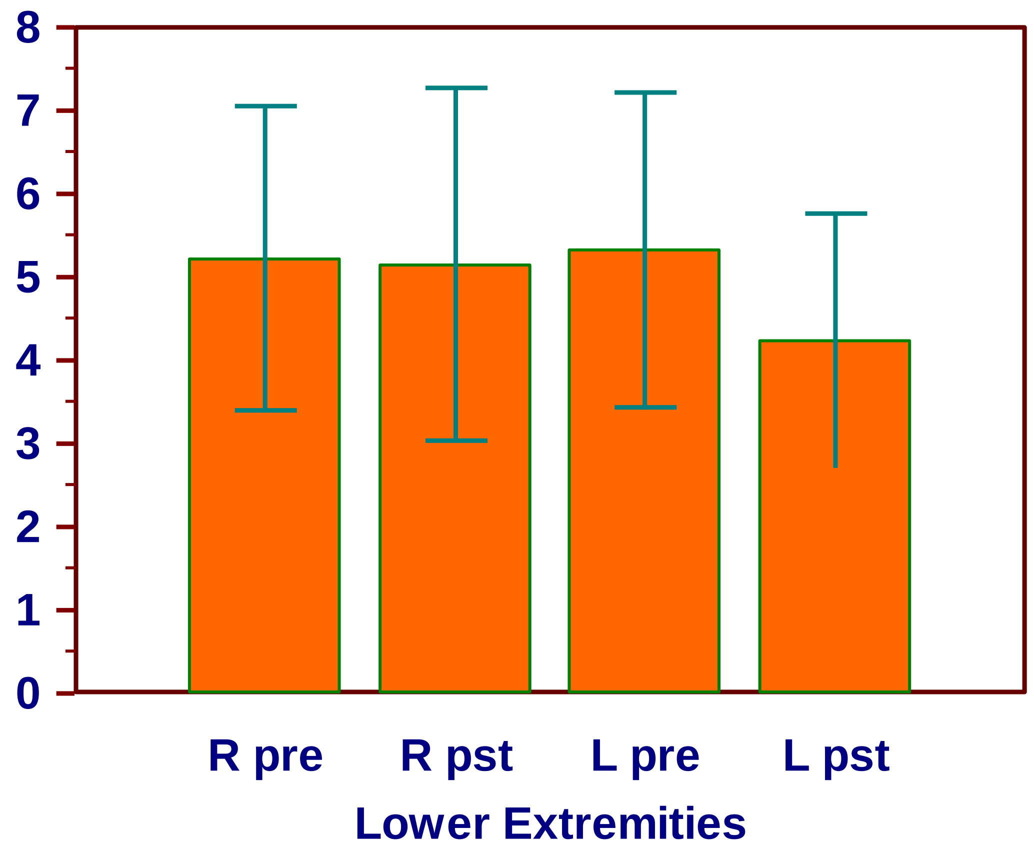

Figure 4.6: Proprioception 60° values before and after the self mobilization exercise in lower extremities.

The self-mobilization exercise could not induce significant change the proprioception 60° value of the right and left lower extremities ($p>0.05$). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Balance Measurement

Balance Anterior

When we examine the effect of dynamic stretching exercise on balance anterior value, a statistically significant increase was found between before and after dynamic stretching in relation to right and left lower extremities ($p <0.05$)(Figure.4.7)(Table.4.1). It was also found that the balance anterior values of the right and left lower extremities before and after the self mobilization exercise increased significantly after statistical analysis ($p<0.05$)(Figure.4. 8)(Table 2). When the effects of two different exercise practices on balance anterior values were examined, there was no significant difference between exercise practise (the dynamic stretching and self-mobilization) in relation to balance anterior values ($p>0.05$) (Table 4.3-4.4).

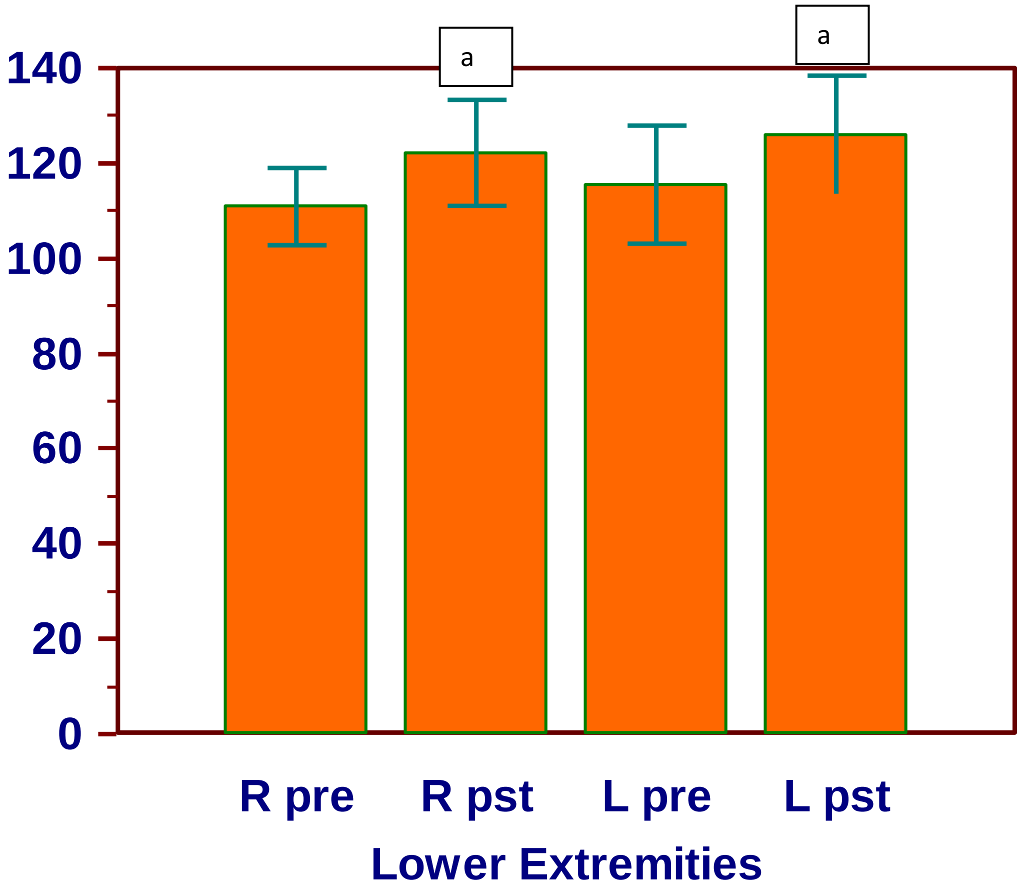

Figure.4.7: Balance Anterior values before and after the dynamic stretching exercise in lower extremities.

After the dynamic stretching exercise, the balance anterior value of the right and left lower extremities was found to be statistically increased (a=p<0.05). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

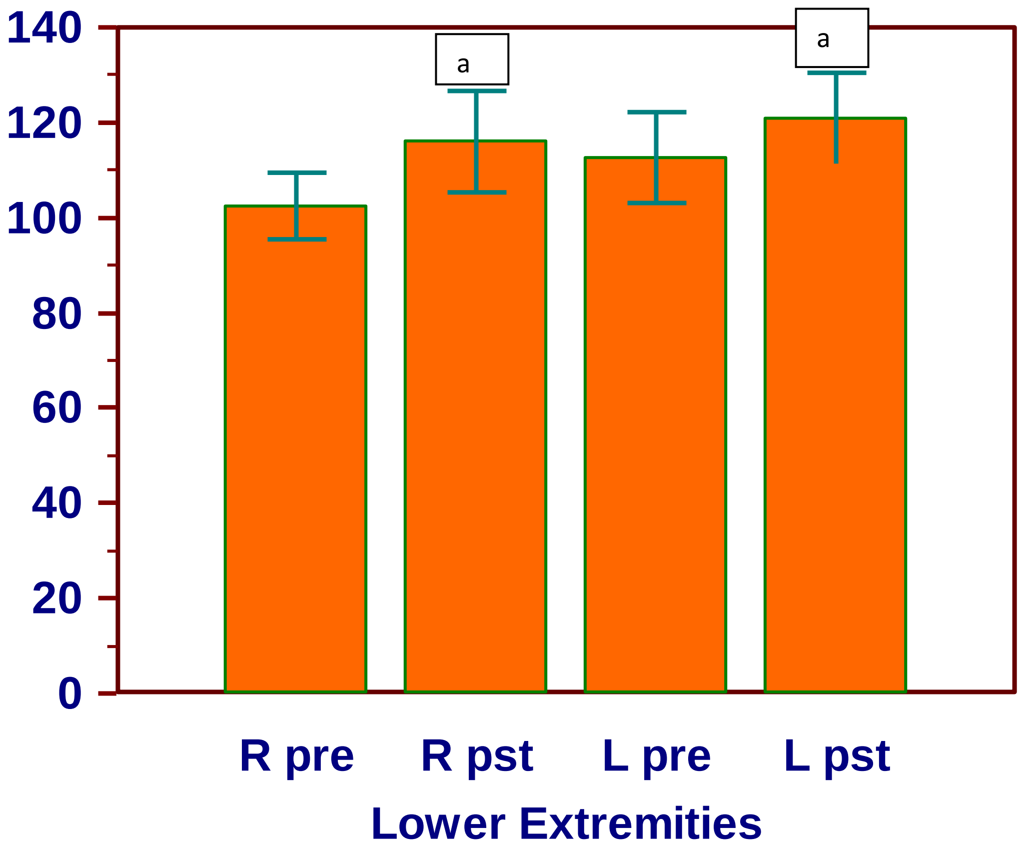

Figure.4.8: Balance Anterior values before and after the self mobilization exercise in lower extremities.

After the self mobilization exercise, the balance anterior value of the right and left lower extremities was found to be statistically increased (a=$p<0.05$). (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Balance Posteriomedial

In the present study, a statistically significant increase was determined between before and after dynamic stretching in relation to right and left lower extremities for balance posteriomedial values respectively ($p<0.05$, $p<0.01$)(Figure 9)(Table.4.1). It was also found that after self-mobilization exercise, the balance posteriomedial values of the right and left lower extremities was found to be statistically increased respectively ($p<0.01$, $p<0.05$)(Figure. 4.10)(Table.4.2). When the effects of two different exercise practices on balance posteriomedial values were examined, there was no significant difference between exercise practise (the dynamic stretching and self-mobilization) in relation to balance posteriomedial values ($p>0.05$) (Table 3-4).

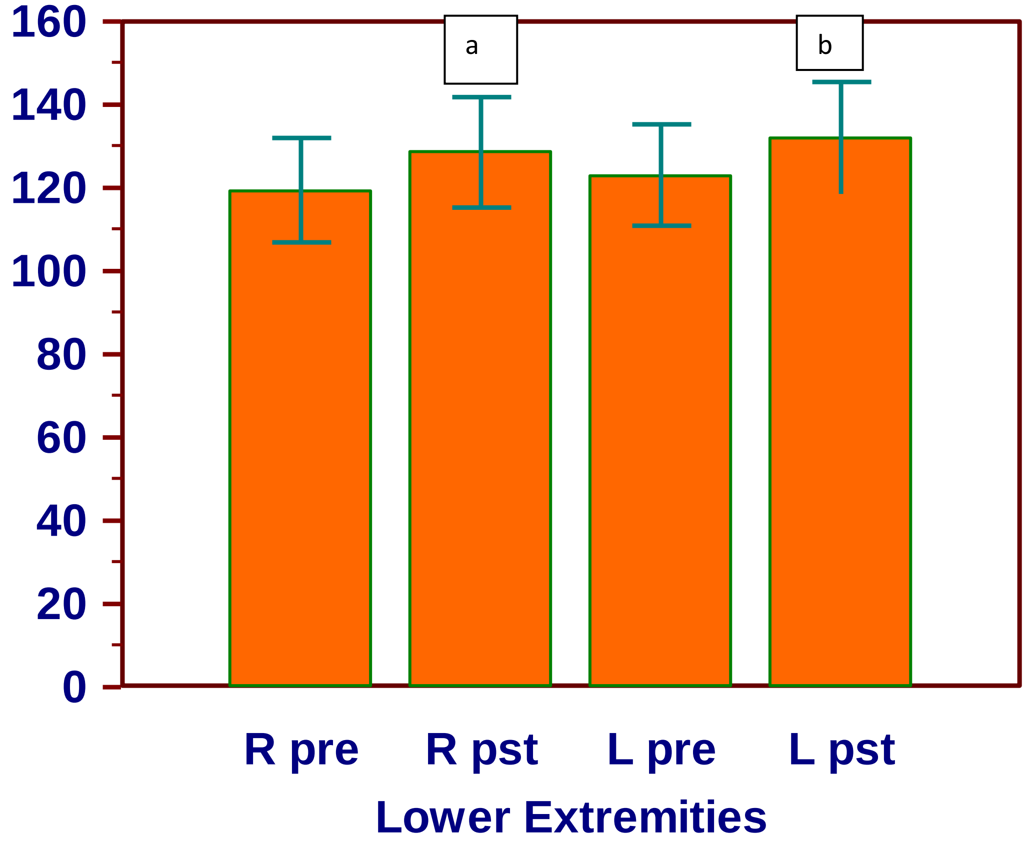

Figure.4.9: Balance posteriomedial values before and after the dynamic stretching exercise in lower extremities.

It was determined that after the dynamic stretching exercise, balance posteriomedial values were significantly inreased in the right and left lower extremities respectively (a=p<0.05, b= p<0.01) (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

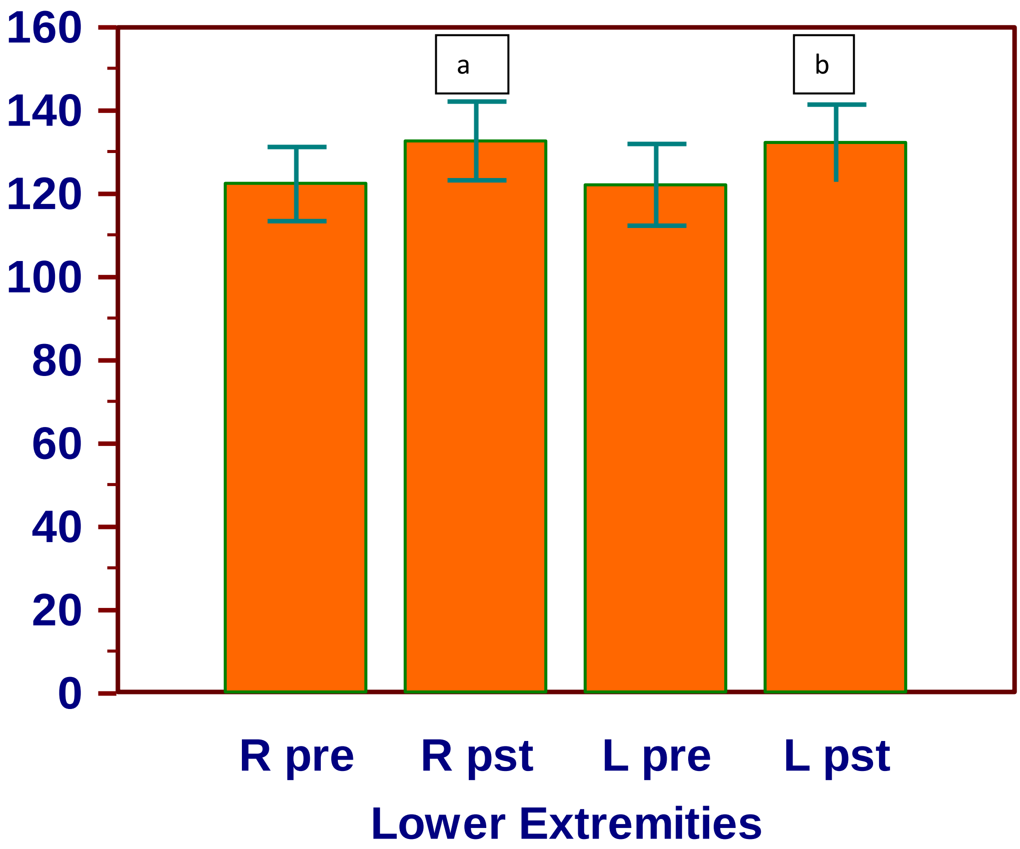

Figure.4.10: Balance posteriomedial values before and after the self mobilization exercise in lower extremities.

As a result of the statistical analysis of the effect of self mobilization on balance posteriomedial, a statistically significant increase was found between before and after self mobilization in relation to right and left lower extremities respectively (a=p<0.01, b=p<0.05) (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Balance posteriolateral

It was investigated the effect of dynamic stretching exercise on balance posteriolateral value, a statistically significant increase was found between before and after exercise in relation to right and left lower extremities (p <0.05)(Figure.4.11) (Table 1). It was also determined that after self-mobilization exercise, the balance posteriolateral values of the right and left lower extremities was found to be statistically increased respectively (p<0.01, p<0.001)(Figure.4.12) (Table.4.2). When the effects of two different exercise practices on balance posteriolateral values were examined, there was no significant difference between exercise practise (the dynamic stretching and self-mobilization) in relation to balance posteriolateral values (p>0.05)(Table. 4.3-4.4).

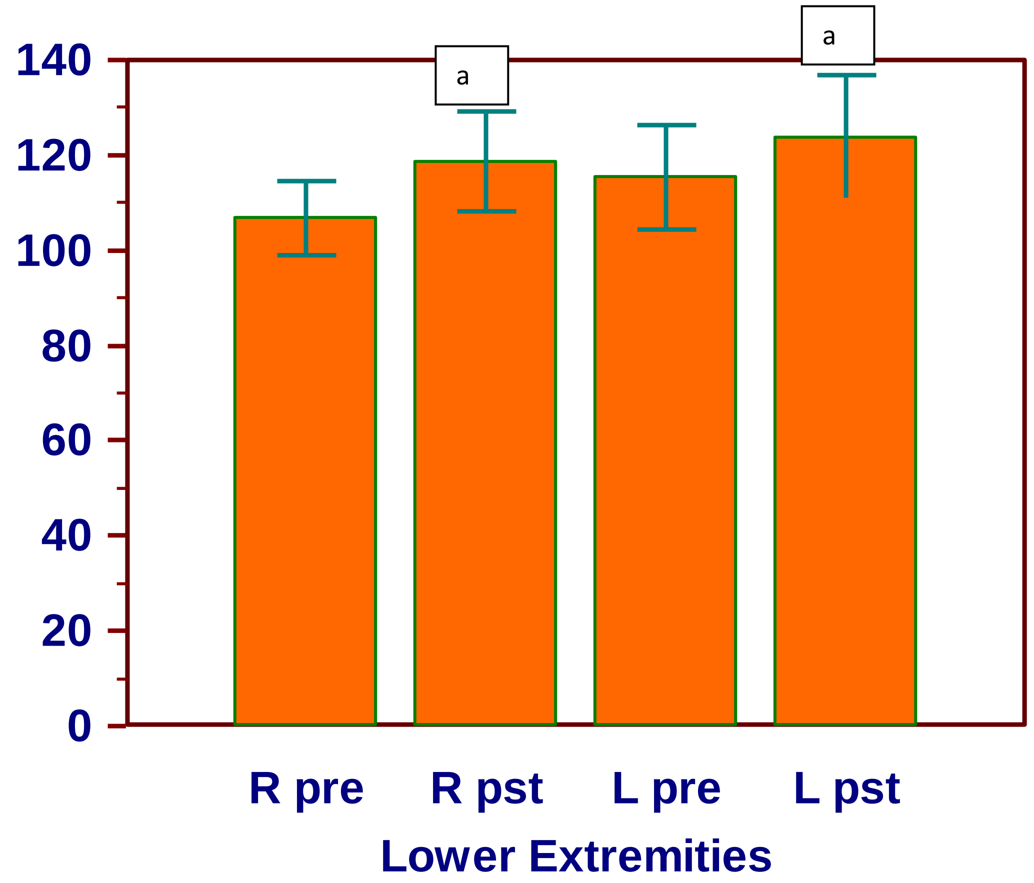

Figure.4.11: Balance posteriolateral values before and after the dynamic stretching exercise in lower extremities.

The dynamic stretching exercise caused significant increase about balance posteriolateral values in the right and left lower extremities (a=p<0.05) (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

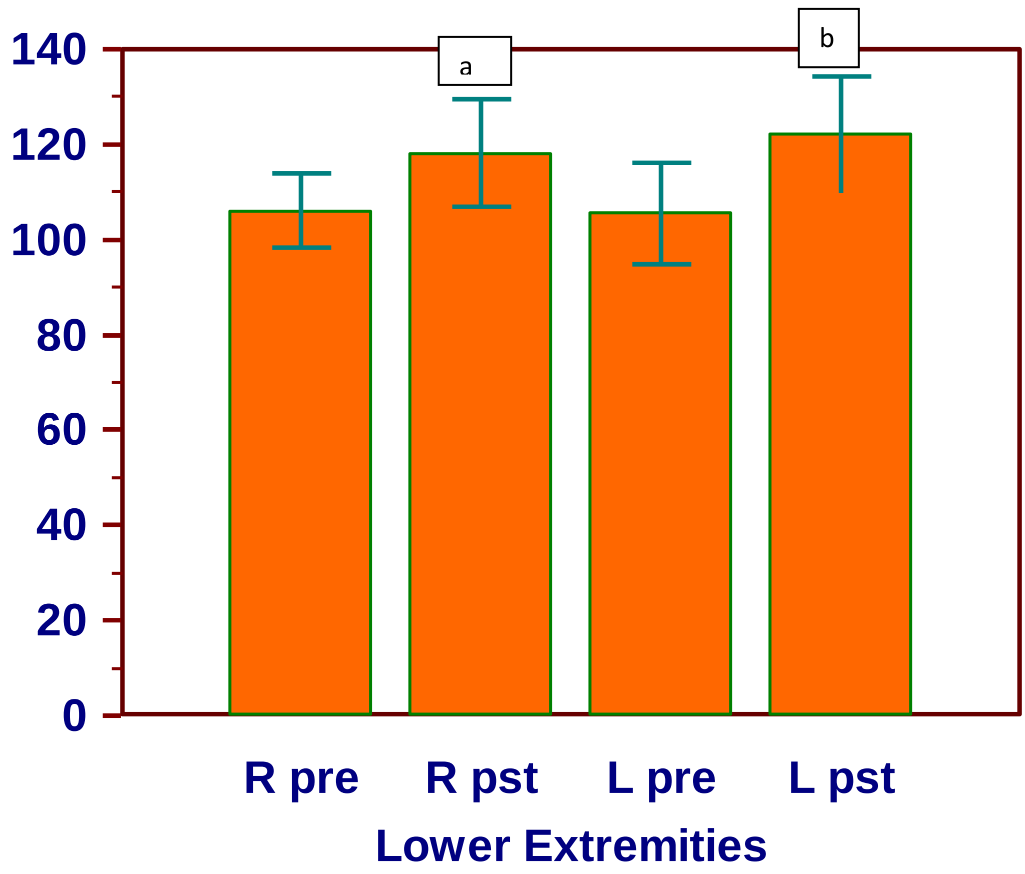

Figure.4.12: Balance posteriolateral values before and after the self mobilization exercise in lower extremities.

It was found that the self-mobilization exercise may cause increase significantly to the values of balance posteriolateral in the right and left lower extremities respectively (a=p<0.01, b=p<0.001) (R pre=Right pre, R pst=Right post, L pre=Left pre, L pst=Left post). Values were presented as Mean ±Standard Deviation (S.D).

Table.4.1: Statistical analyses of the dynamic stretching exercise.

Paramaters	Right Pre Mean±S.D	Right Post Mean±S.D	p	Left Pre Mean±S.D	Left Post Mean±S.D	p
Muscle tightness (°)	9.105±2.355	6.455±1.899	**p<0.001**	8.987±2.686	6.506±2.467	**p<0.001**
proprioreception 30(°)	5.484±2.957	2.148±1.446	**p <0.01**	4.588±2.415	3.221±2.090	p>0.05
proprioreception 60 (°)	4.407±2.103	3.126±2.305	p>0.05	4.292±2.898	3.878±3.090	p>0.05
Balance Anterior (cm)	110.988±16.248	122.133±22.509	**p<0.05**	115.466±25.114	126.055±24.863	**p<0.05**
Balance Medial (cm)	119.338±25.160	128.600±26.806	**p<0.05**	123.055±24.522	131.977±27.033	**p<0.01**
Balance Lateral (cm)	106.766±15.586	118.694±21.307	**p<0.05**	115.477±22.103	123.900±25.737	**p<0.05**

Values were presented as Mean ±Standard Deviation (S.D)

Table.4.2: Statistical analyses of the self mobilization exercise.

Paramaters	Right Pre	Right Post	p	Left Pre	Left Post	*p*
Muscle tightness (°)	9.355±2.805	7.414±3.180	**p<0.001**	9.420±2.782	6.936±2.620	**p<0.001**
Proprioreception 30 (°)	3.867±2.587	2.502±1.830	p>0.05	4.018±2.808	2.861±1.999	p>0.05
Proprioreception 60 (°)	5.225±3.685	5.148±4.258	p>0.05	5.328±3.805	4.236±3.085	p>0.05
Balance Anterior (cm)	102.438±13.914	115.994±21.483	**p<0.05**	112.688±19.092	120.916±19.307	**p<0.05**
Balance Medial (cm)	122.422±18.021	132.583±19.034	**p<0.01**	122.138±19.535	132.327±18.591	**p<0.05**
Balance Lateral (cm)	106.088±15.435	118.083±22.742	**p<0.01**	105.483±21.238	122.055±24.679	**p<0.001**

Values were presented as Mean ±Standard Deviation (S.D)

Table.4.3:The comparison of two different exercise (dynamic stretching (Din.Str), self mobilization (Self.Mob)) for right lower extremities.

Parameters	Right Difference Din. Str. Mean±S.E.M	Right Difference Self.Mob. Mean±S.E.M	p
Muscle tightness (°)	-2.733±0.518	-2.207±0.401	p>0.05
Proprioreception 30 (°)	-3.336±0.771	-1.365±0.637	p>0.05
Proprioreception 60 (°)	-1.281±0.701	-0.077±0.992	p>0.05
Balance Anterior (cm)	11.144±2.696	12.928±2.907	p>0.05
Balance Medial (cm)	9.261±3.536	10.160±2.522	p>0.05
Balance Lateral (cm)	11.920±3.970	11.990±2.717	p>0.05

Values were presented as Mean ±Standard Error of Mean (S.E.M)

Table.4.4: The comparison of two different exercise (dynamic stretching (Din.Str), self mobilization (Self.Mob)) for left lower extremities.

Parameters	Left Difference Din. Str. Mean±S.E.M	Left Difference Self. Mob. Mean±S.E.M	p
Muscle tightness (°)	-2.481±0.447	-2.481±0.447	p>0.05
Proprioreception 30 (°)	-1.367±0.647	-1.157±0.670	p>0.05
Proprioreception 60 (°)	-0.413±1.037	-1.093±0.702	p>0.05
Balance Anterior (cm)	10.588±2.840	8.227±2.159	p>0.05
Balance Medial (cm)	8.922±2.062	10.180±4.451	p>0.05
Balance Lateral (cm)	8.422±2.994	16.570±2.913	p>0.05

Values were presented as Mean ±Standard Error of Mean (S.E.M).

Table.4.5:Demographic characteristics of individuals (dynamic stretching (Din.Str), self mobilization (Self.Mob)).

Parameters	Din.Str	Self.Mob	p
Height (m)	1.700±0.101	1.754±0.102	p>0.05
Weight (kg)	66.777 ±17.444	75.058±13.617	p>0.05
Age (year)	23.722±2.674	23.235±2.305	p>0.05

Values were presented as Mean ±Standard Deviation (S.D). There was no significant difference between the groups in terms of Height, weight and age.

5. DISCUSSION

In our study, it was aimed to determine whether dynamic stretching and self-mobilization exercises had acute effects on muscle tightness, proprioception and balance. In addition to this, the superiority to each other and differences of these two exercises in terms of muscle tightness, proprioception and balance parameters were aimed to determine.

Decreasing muscle strength and decrease in muscle mass with age have been reported to adversely affect proprioception (86). In our study, the age range was determined as 18-30 to eliminate the negative effects of proprioceptive measurements depending on age. In addition, no significant difference was found between the groups in terms of mean age, gender, height and weight.

In this study, the effect of dynamic stretching and self-mobilization exercises on muscle tightness is the basis of our study, since the muscle tightness is an important risk factor for lower extremity injuries. If this situation is not eliminated, it can cause significant musculoskeletal problems during physical activity (80).The improvement in muscle tightness is thought to decrease the risk of injury.

In our study, it was determined that there was a significant improvement in muscle tightness in both the right and left lower extremities after the measurements of tightness of muscle before and after exercise. Our results regarding the effect of stretching exercise on muscle tightness are consistent with the data of some studies in the literature (83,87,88,89).

If we need to give an example to these studies, Winters et al. determined that hip extension ROM decreased and hip flexor muscle tightness decrease as a result of active and passive stretching protocols applied to individuals (87). In their study, Malai et al. applied PNF – Hold relax technique to individuals with tight hip flexor muscles. After the technic, hip extension ROM was measured and as a result of the measurement, they found that the tightness of the hip flexor muscle decrease in both extremities (88). In their study, Godges et al. applied static stretching to one group with tight hip flexor muscle and PNF – Hold relax technique to the other group. The researchers found that hip flexor muscle tightness decrease in both groups and hip extension ROM increased in both groups (89). However, in a study performed by Aslan et al., similar to our study, applied dynamic stretching to the hip flexor muscles and acute effects of the exercise on hip extension ROM were analysed. As a result of the study, a significant difference was found in the hip extension ROM after dynamic stretching exercise (83). The results of this study are consistent with the results of our study regarding tightness of muscle after dynamic stretching exercise.

In our study, self-mobilization exercise was applied to the other group. Muscle tightness measurements were performed before and after the technic. After the statistical analysis of the recorded measurements, it was found that tightness of muscle in the right and left lower extremities was decrease acutely. This acute effect of self-mobilization is consistent with the findings of some studies (19).

The number of studies in the literature about self-mobilization is very limited. The findings obtained by Habersaat et al. are consistent with the results of our study. In this study, the acute effect of self-mobilization technique on hip extension ROM was examined. The study was conducted with a total of 60 people, 31 women and 29 men. The groups were randomized equally into two group and each group was applied self-mobilization technique in different directions. In both groups, there was a significant positive difference between pre- and post-exercise ROM measurements after the technic of self-mobilization technique (19).

The lack of a significant difference in the comparison of the effects of dynamic stretching and self-mobilization exercises on muscle tightness indicates that these two methods affect muscle tightness equally. In our study, dynamic stretching exercise and self-mobilization exercise decreased muscle tightness and increased flexibility. It is claimed that these two exercises help to meet the load affecting actin and myosin filaments more strongly.This may cause elastic structures to better resist resistance during exercise. Apart from this, it is stated that the exercises minimize micro tears in muscle fibers and reduce the tone of skeletal muscles. We believe that exercise may lead to a reduction in the risk of injury due to the afore mentioned mechanisms (79).

We designed this study to find out whether dynamic stretching and self-mobilization exercise affect knee proprioception, and if so, to what extent. As known, proprioception is associated with the risk of disability. It is known that worsening of proprioception can increase the risk of disability. Thus, improvement in proprioception reduces the risk of disability. Studies have shown that some exercises and treatment protocols may change the proprioception (79). The fact that the number of studies are few on the effect of dynamic stretching and self-mobilization exercise on the proprioception, which had no side effects and which could have a very positive effect when properly performed and could affect the quality of life, led us to do this study. In our study, as in many studies in the literature proprioception was measured by the active joint position method (83,84,90). Active joint position method was measured with digital inclinometer in our study.

In the present study, it was found that there was a decrease in the 60 degrees proprioception deviation angle values of the right and left lower extremities after dynamic stretching exercise and this decrease was not significant. Similarly, although the 30 degree proprioception deviation angle of the left lower extremity was decreased, it was stated that this decrease was not significant. However, 30 degrees proprioception deviation angle of the right lower extremity was significantly decreased. It was determined that self-mobilization exercise decreased all proprioception values but this decrease was not significant. Studies have shown that stretching exercises may reduce the sensitivity of muscle receptors and in this, may reduce nerve conduction from 1a afferent fibers (91), and this decrease may adversely affect proprioceptive skills (92). Indeed, Hayes et al. in their study, determined the reduction of nerve conduction after applied passive static stretching to the gastrosoleus muscle (93).

On the other hand, it has been reported that stretching exercises provide proprioceptive input and improve proprioception by activation of muscle spindle and golgi tendon organ (94). In a study similar to our conducted by Aslan at al. even though no difference between the proprioception values before and after exercise was observed in the group applied dynamic stretching, positive increase on some values was observed same as our study (83). In literatur search, no prior studies were found which conducted to investigate the effect of self-mobilization exercises on proprioception. Our study is the first one in terms of this perspective.

The decrease in proprioception deviation angle values after dynamic stretching and self-mobilization exercises and being a significant decrease in the right lower extremity generally compromise with the possibility that these two exercises may affect proprioception.

Another measurement parameter of our study was dynamic balance. Dynamic balance was measured by Y balance test. As a result of the analysis performed in our study, it was determined that both dynamic stretching and self-mobilization exercises significantly increased anterior, posteromedial and posterolateral balance values in the right and left lower extremities. In our study, the improvement and increase in balance parameters after dynamic stretching and self-mobilization were consistent with the increase in balance performance obtained after the exercise (95,96,97). In one of these studies, Handrakis et al. investigated the acute effect of static stretching on balance and found a significant improvement in dynamic balance after exercise (95). In another study, 30 male football players between the ages of 17-25 were applied static and dynamic stretching. The effect of these exercises on dynamic balance was investigated. After the measurements, it was reported that an increase in dynamic balance performance of the groups after exercise was observed (96). In a similar study by Amiri-Khorasani, dynamic and static stretching exercises were applied to 24 female football players. The acute effect of dynamic and static stretching on balance performance was examined. Dynamic and static balance performance was measured after the technic. As a result of the measurements, it was seen that there was a significant increase in the dynamic and static balance performance of the group applied dynamic stretching. This increase was found to be higher than the group applied static stretching (97). The fact that there is no difference between the two methods in terms of balance shows that these two methods can be used as an alternative to each other in terms of balance. In our literature research, no prior study conducted about the effect of self-mobilization on balance was found.

Negative effects of hip flexor muscle tightness on dynamic balance have been shown in studies (83). In our study, muscle tightness was acutely decreas by dynamic stretching and self-mobilization exercises. We think that this decrease in muscle tightness improves the dynamic balance. We can say that both dynamic stretching and self-mobilization exercises increase the balance acutely and reduce the risk of injury due to balance problems. We also suggest that dynamic stretching and self-mobilization exercises before physical activity can reduce muscle tightness, improve balance and reduce the risk of lower extremity injury.

Findings related to dynamic stretching and self-mobilization indicate that further studies needed whether these exercises may affect other parameters. Dynamic stretching and self-mobilization exercises can be used to solve many problems and to determine the physiological mechanisms of action, more detailed and further studies are needed.

6. CONCLUSION

In conclusion, we can say that dynamic stretching and self-mobilization exercises can significantly reduce muscle tightness, and increase balance parameters, yet do not significantly alter proprioception,. However, we can state that muscle tightness, proprioception and dynamic balance can be affected equally in both exercises.

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Appendix 8.1

Özgeçmiş

Kişisel Bilgiler

Adı	Mahmut Berat	**Soyadı**	AKDAĞ
Doğum Yeri	DİYARBAKIR	**Doğum Tarihi**	15.07.1994
Uyruğu	T.C	**TC Kimlik No**	2964474190
E-mail	fztbrtakdag@gmail.com	**Tel**	05346556154

Öğrenim Durumu

Derece	Alan	Mezun Olduğu Kurumun Adı	Mezuniyet Yılı
Doktora			
Yüksek Lisans			
Lisans	Fizyoterapi ve Rehabilitasyon	**Lefke Avrupa Üniversitesi**	2016
Lise	-	**Ortadoğu Koleji**	2012

Bildiği Yabancı Dilleri	Yabancı Dil Sınav Notu
İngilizce	YÖKDİL:68

İş Deneyimi (Sondan geçmişe doğru sıralayın)

Görevi	1.1.1. Kurum	Süre (Yıl - Yıl)
Fizyoterapist	Özel Yardımeli Özel Eğitim ve Rehabilitasyon Merkezi	2018-2019
Yarı zamanlı Öğretim Görevlisi	Üsküdar Üniversitesi	2016-2017

Appendix 8.2

Demografik Özellikler Tarih :…/….. /………

1)Hastanın Adı Soyadı: …………………… Telefonu:

2)Yaş:

3) Cinsiyet: ( ) Kız ( ) Erkek

4) Boy uzunluğu (cm):

5) Vücut ağırlığı (kg) :

6) Dominant taraf: El ( ) sağ ( ) sol

Ayak ( ) sağ ( ) sol

7)Medeni Durumunuz:

( ) Hiç evlenmemiş ( ) Evli

( ) Boşanmış ( ) Ayrı yaşıyor ( ) Eşi ölmüş

8) Eğitim durumunuz

Okuryazar değil ☐
İlköğretim ☐
Lise ☐
Üniversite ve üzeri ☐

8) Mesleğiniz:

9)Maddi durumunuz:

1000TL'den az ☐ 1000-2000TL ☐ 2000-3000TL ☐ 3000TL ve üzeri ☐

10) Sosyal güvenceniz:

Var ☐ Yok ☐

11) Çocuğunuz : ( ) var ( )yok Varsa kaç çocuğunuz var....................

12) a) Sigara kullanıyor musunuz?

( )Hiç içmedim ( )Sigara içtim ama bıraktım ( )Halen içiyorum

b) Günde kaç adet sigara içiyorsunuz?......................adet/gün

Sigara: ....Paket/Yıl

13) Alkol kullanıyor musunuz? ( ) Evet ( ) Hayır

Hangi sıklıkla?...........

14) Herhangi bir sürekli hastalığınız var mı? Varsa hangileri?

( ) Sürekli bir hastalığım yok

( ) Romatizma ( ) Ortopedik hastalık ( ) Nörolojik problemler

( ) Travma ( ) Diğer...........

Appendix 8.3

Dinamik germe ve Self mobilizasyon egzersizlerinin, Denge ve Proprisepsiyon üzerine akut etkileri.

ARAŞTIRMAYA KATILIM ONAM FORMU

Bu çalışma Yeditepe Üniversitesi Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon Bölümü tarafından yürütülen **"Dinamik germe ve Self mobilizasyon egzersizlerinin, Denge ve Proprisepsiyon üzerine akut etkileri."** başlıklı araştırma kapsamında planlanmıştır. Bu çalışmanın amacı kalça fleksör kas kısalığı olan sağlıklı kişilere uygulanan dinamik germe ve self mobilizasyon egzersizlerinin , kas kısalığı , denge ve proprioepsiyona olan akut etkilerini belirlemektir.Çalışmamıza katılmayı kabul eden gönüllülerin ; yaşı, cinsiyeti, sosyodemografik koşulları, var olan hastalıkları, geçirilen cerrahi durumları, kalça fleksör kas kısalığının olup olmamasına gore çalışma grubuna dahil edilecektir. Ve belirlenen parametreler kapsamında değerlendirilecektir.

Araştırma ile ilgili sizden doldurmanızı istediğimiz formları doğru bir şekilde doldurmanızı ve herhangi bir şikayetiniz ya da rahatsızlığınız olduğunda bize bildirmeniz gerekmektedir. İstediğiniz zaman çalışma dışına çıkma hakkınız olduğunu bilmenizi isteriz. Bu araştırma kapsamında yapılacak olan değerlendirmelerde herhangi bir risk bulunmamakta ve yapılacak hiçbir değerlendirme size zarar vermeyecektir. Bu araştırma dahilinde sizden herhangi bir ücret talep edilmemektedir. Bu araştırmada yer almanız nedeniyle size hiçbir ödeme yapılmayacaktır. Kişisel bilgileriniz herhangi bir amaçla, kurum yöneticileri veya üçüncü kişilerle paylaşılmayacaktır.

Katılımınız için teşekkür ederiz.

Sorumlu araştırmacı: Dr.Öğr.Üyesi Şule DEMİRBAŞ

Yardımcı Araştırmacı: Fzt.M. Berat AKDAĞ – 0534 655 6154 (24 saat ulaşılabilecek kişi)

"Dinamik germe ve Self mobilizasyon egzersizlerinin, Denge ve Proprisepsiyon üzerine akut etkileri" isimli çalışmada katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. **Çalışma hakkında yazılı ve sözlü açıklama adı belirtilen araştırmacı tarafından yapıldı.** Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın katılmayı kabul ediyorum.

Gönüllünün Adı /Soyadı /İmzası /Tarih

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