Acute Effects of Dynamic Stretching and Self Mobilization Exercises on Balance and Proprioception

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Abstract

The aim of this study was to investigate dynamic stretching applied to healthy individuals with tight hip flexor muscle and the effects of self-mobilization exercises on muscle tightness, balance and proprioception. 36 Participants with healthy hip flexor muscle tightness were included in the study. The participants with hip flexor muscle tightness were divided into two groups by simple randomization method. Measurement methods were applied before and after the exercise. Hipflexor muscle was measured by modified Thomas test. Proprioception was measured with 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=0.000). There was no significant difference in hipflexor muscle tightness between two groups (p=0.669). It was found no significant difference in all proprioception values except the 30 degree left extremity value in the dynamic stretching group (p=0.074). There was no difference between the groups in terms of proprioception (p=0.823).Dynamic balance results showed a significant increase in both groups (p =0.001). It was determined no significant difference between the groups in terms of 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. Thereis no difference between these two exercises in terms of these parameters.

Clinical article (J Int Dent Med Res 2021; 14(3): 1210-1218)

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

Received date: 21 June 2021 **Accept date:** 01 August 2021

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 dysfunction 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]

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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.[8,9]

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.[10]

Proprioception is defined as the ability to detect the position of the joint in space. Proprioception 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 Range of Motion (ROM) and other parameters is quite low. According to the studies, self-mobilization techniques increased hip extension ROM.[19]

The aim of the present 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.

Materials and methods

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.

In this study, healthy individuals with 36 hip flexor tightness 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.

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.

Evaluation

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.

Modified Thomas Test

Digital inclinometer (Baseline, China) was used to measure hip extension ROM with modified Thomas test (Figure.1). Volunteers lie on their back and bring the gluteal 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 m.quadriceps femoris. 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.[20]

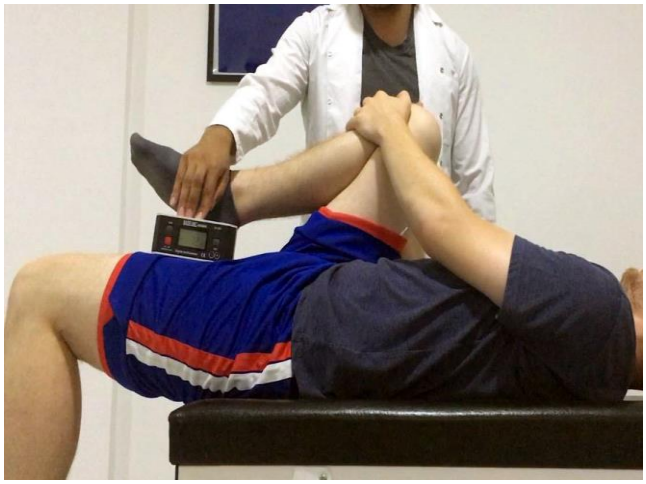

Figure 1. Hip extension range of motion (ROM),measurement test using a digital inclinometer.

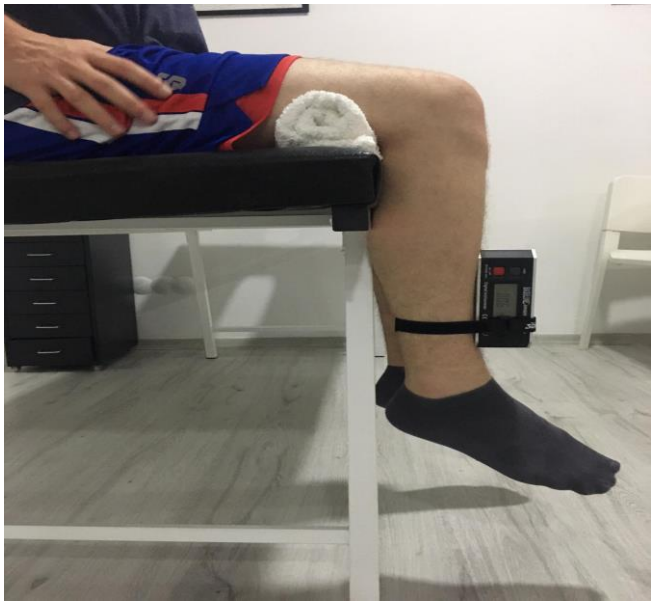

Figure 2. Knee joint position sense (JPS) measurement using Baseline Digital Inclinometer.

Proprioception Measurement

Digital inclinometer was used for joint position sense measurements. 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 2).

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.[20,21]

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).

Figure 3: 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.[22]

Exercises

Dynamic Stretching Exercise

The volunteer was lying down in the prone position. The posterior inferior spina is fixed to the bed on ilum. The knee is flexed 90 °(Figure.4). 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.[20]

Figure 4. Dynamic stretching technique used for stretching hip flexor muscles.

Figure 5. Posteroanterior selfmobilizations (PASM) with the band.

Self-Mobilization Exercise

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 gluteal lines on the side to be treated (Figure.5). 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 posteroanterior direction is provided. Exercise was done in 10 repetitions, 6 sets for each side. Rest between sets is determined as 10 seconds.[19]

Statistical Analyses

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.

Results

Physical Properties Measurements

It was found no significant differences between the groups of the dynamic stretching exercise and the self-mobilization exercise in relation to physical properties measurements (Height, weight and age) in individuals (p>0.05)(Table 1)

Parameters	Din. Str.	Self.Mob.	p
Height (m)	1.700±0.101	1.754±0.102	p=0.685
Weight (kg)	66.777 ±17.444	75.058±13.617	p=0.085
Age (year)	23.722±2.674	23.235±2.305	p=0.759

Table 1. Demographic characteristics of individuals (dynamic stretching (Din.Str), self mobilization (Self.Mob). Values were presented as Mean ±Standard Deviation (S.D).

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=0.000)(Table 2). 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=0.000)(Table 3).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=0.669)(Table 4-5).

Paramaters	Right Before Mean±S.D	Right After Mean±S.D	p	Left Before Mean±S.D	Left After Mean±S.D	p
Muscle tightness (°)	9.105±2.355	6.455±1.899	**p=0.000**	8.987±2.686	6.506±2.467	**p=0.000**
proprioreception 30(°)	5.484±2.957	2.148±1.446	**p=0.002**	4.588±2.415	3.221±2.090	p=0.074
proprioreception 60 (°)	4.407±2.103	3.126±2.305	P=0.074	4.292±2.898	3.878±3.090	p=0.60
Balance Anterior (cm)	110.988±16.248	122.133±22.509	**p=0.002**	115.466±25.114	126.055±24.863	**p=0.001**
Balance posteriomedial (cm)	119.338±25.160	128.600±26.806	**p=0.039**	123.055±24.522	131.977±27.033	**p=0.001**
Balance posteriolateral (cm)	106.766±15.586	118.694±21.307	**p=0.010**	115.477±22.103	123.900±25.737	**p=0.028**

Table 2: Statistical analyses of the dynamic stretching exercise. Values were presented as Mean ±Standard Deviation (S.D).

Paramaters	Right Before	Right After	p	Left Before	Left After	p
Muscle tightness (°)	9.355±2.805	7.414±3.180	**p=0.000**	9.420±2.782	6.936±2.620	**p=0.000**
Proprioreception 30 (°)	3.867±2.587	2.502±1.830	p=0.071	4.018±2.808	2.861±1.999	p=0.102
Proprioreception 60 (°)	5.225±3.685	5.148±4.258	p=0.965	5.328±3.805	4.236±3.085	p=0.157
Balance Anterior (cm)	102.438±13.914	115.994±21.483	**p=0.001**	112.688±19.092	120.916±19.307	**p=0.003**
Balance posteriomedial (cm)	122.422±18.021	132.583±19.034	**p=0.002**	122.138±19.535	132.327±18.591	**p=0.035**
Balance posteriolateral (cm)	106.088±15.435	118.083±22.742	**p=0.001**	105.483±21.238	122.055±24.679	**p=0.000**

Table 3. Statistical analyses of the self mobilization exercise. Values were presented as Mean ±Standard Deviation (S.D).

Proprioception Measurement

Proprioception 30°

It was determined that after the dynamic stretching exercise, proprioception 30° was significantly reduced in the right lower extremity (p=0.002)(Table 2), however, proprioception 30° was not changed after dynamic stretching exercise in left lower extremity (p=0.074). The self-mobilization exercise did not significantly change the value of proprioception 30° in the right and left lower extremities (p=0.071, p=0,102)(Table 3). 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=0.057, p=0.823)(Table 4-5).

Proprioception 60°

No statistically significant difference was found between the right and left lower extremities in respect with the proprioception at 60 degree after dynamic stretching exercises (p=0.074, p=0.60)(Table 2). 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=0.965, p=0.157)(Table 3). When the effects of two different exercise practices on proprioception 60° values were examined, there was no significant difference between exercise practice (the dynamic stretching and self-mobilization) in relation to proprioception 60° values (p=0.329, p=0.591) (Table 4-5).

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=0.002, p=0.001)(Table 2). It was also found that the balance anterior values of the right and left lower extremities increased significantly after the self-mobilization exercise (p=0.001, p=0.003)(Table 3). When the effects of two different exercise practices on balance anterior values were examined, there was no significant difference between exercise practice (the dynamic stretching and self-mobilization) in relation to balance anterior values (p=0.656, 0.899) (Table 4-5).

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=0.669
Proprioreception 30 (°)	-3.336±0.771	-1.365±0.637	p=0.057
Proprioreception 60 (°)	-1.281±0.701	-0.077±0.992	p=0.329
Balance Anterior (cm)	11.144±2.696	12.928±2.907	p=0.656
Balance posteriomedial (cm)	9.261±3.536	10.160±2.522	p=0.837
Balance posteriolateral (cm)	11.920±3.970	11.990±2.717	p=0.989

Table 4. The comparison of two different exercise (dynamic stretching (Din.Str), self mobilization (Self.Mob)) for right lower extremities. Values were presented as Mean ±Standard Error of Mean (S.E.M).

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=0.039, p=0.001)(Table 2). 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=0.002, p=0.035)(Table 3). When the effects of two different exercise practices on balance posteriomedial values were examined, there was no significant difference between exercise practice (the dynamic stretching and self-mobilization) in relation to balance posteriomedial values (p=0.837, 0.798) (Table 4-5).

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=0.669
Proprioreception 30 (°)	-1.367±0.647	-1.157±0.670	p=0.823
Proprioreception 60 (°)	-0.413±1.037	-1.093±0.702	p=0.591
Balance Anterior (cm)	10.588±2.840	8.227±2.159	p=0.899
Balance posteriomedial (cm)	8.922±2.062	10.180±4.451	p=0.798
Balance posteriolateral (cm)	8.422±2.994	16.570±2.913	p=0.059

Table 5. The comparison of two different exercise (dynamic stretching (Din.Str), self mobilization (Self.Mob)) for left lower extremities. Values were presented as Mean ±Standard Error of Mean (S.E.M).

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=0.010, p=0.028)(Table 2). 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=0.001, p=0.000)(Table 3). When the effects of two different exercise practices on balance posteriolateral values were examined, there was no significant difference between exercise practice (the dynamic stretching and self-mobilization) in relation to balance posteriolateral values (p=0.989, p=0.059)(Table 4-5).

Discussion

Decreasing muscle strength and decrease in muscle mass with age have been reported to adversely affect proprioception.[23] In the present 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.[24] The improvement in muscle tightness is thought to decrease the risk of injury.

In the present 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.[20,25-27] 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.[25] 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.[26] 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.[27] 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 this study, a significant difference has been found in the hip extension ROM after dynamic stretching exercise.[20]

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 above mentioned mechanisms.[28]

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.[28] 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.[20,21,29] 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,[30] and this decrease may adversely affect proprioceptive skills.[31] Indeed, Hayes et al. in their study, determined the reduction of nerve conduction after applied passive static stretching to the gastrosoleus muscle.[32] 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.[33] 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.[20] In literature 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.[34-36] 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 .[34] In another study, 30 male football players between the ages of 1725 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.[35] 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.[36] 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.[20] In our study, muscle tightness was acutely decreased 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.

Conclusions

In conclusion, it can be suggested 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.

Declaration of Interest

The authors report no conflict of interest.

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