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Analysis of the relationship between hamstring flexibility with muscular strength and its response to myofascial release

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ABSTRACT
Background: Decreased flexibility can contribute to postural changes, the deficit in the ability to produce strength, and predispose to injuries. Currently, several myofascial release techniques work to improve muscle flexibility. **Objective:** To analyze the relationship between flexibility and muscle strength of the knee flexors and to verify the acute effect of two modalities of myofascial release on the flexibility of the hamstrings. **Methods:** 45 women participated in this study, divided into Manual Release Group, Instrumental Release Group, and Control Group. A sit and reach test, a third finger floor test, an assessment of the popliteal angle, and an assessment of knee flexion muscle strength were performed. Subsequently, the volunteers received a myofascial release session in the hamstring muscle group. After treatment, the volunteers were reassessed. **Results:** Both groups that received myofascial release performed better in flexibility tests. There was no correlation between hamstring flexibility and the ability to produce joint torque from knee flexion. **Conclusion:** The flexibility of the hamstring muscles did not influence the ability to produce knee flexion torque and both myofascial release techniques were effective in improving the flexibility of this musculature.
Keywords: Fascia; Range of joint motion; Musculoskeletal manipulations.

BACKGROUND

Flexibility is the ability to move joints freely, unrestricted in their range of motion (ROM), and free from pain. Thus, the low flexibility of the tissues can result in several biomechanical alterations of posture and joint dysfunctions(1). Good flexibility allows the muscle to adapt, generating greater efficiency in movement(2).

One of the muscle groups that commonly presents reduced flexibility is the hamstrings, a set of muscles consisting of the biceps femoris, semimembranosus, and semitendinosus, they are biarticular, located in the posterior part of the lower limbs between the ischial tuberosity and the tibia and exert the function of knee flexion and hip extension(3). A sedentary lifestyle is one of the main factors that contribute to reducing the flexibility of this muscle group, given that it leads the individual to remain in a sitting posture for an exacerbated amount of hours(3).

The reduction in flexibility is due to the adaptive shortening of the musculature, tendons, and other soft tissues, such as fascia, which are maintained for a long time at some angle of contraction, so in a sitting position, the hamstrings tendons are loose and shorten to increase the tension in the muscle, decreasing the range of joint movement of the joints involved(3).

Deficiency in hamstring flexibility can generate several postural changes and movement limitations. When we talk about this set of muscles, we refer to the limitations of knee extension, hip, and anterior trunk inclination, as well as alterations such as pelvic retroversion and lumbar spine rectification(3). All these structural changes lead to pain, gait impairment, and differences in limb length(3,4). Studies show that muscle shortening can cause loss of muscle sarcomeres, reducing the strength that the individual can exert with that musculature, in addition to implying in the length-tension curve, where the muscle length is shorter(5). In other words, flexibility being worked on can even influence the maintenance of muscle strength, helping the individual to have less chance of overload along the lower limb and trunk(5).

In physiotherapy, several techniques aim to improve muscle flexibility. Among them, we can highlight myofascial release, which refers to a manual therapy technique aimed mainly at the locomotor system, which aims to release fascial tensions, restoring their original flexibility through external forces(6). Myofascial release is based on manual pressure on the fascia to release restrictions, both superficial and deep(6).

Currently, the use of instruments has increased in the scope of myofascial release therapies, both in self-release, where the individual manipulates their tissues with the aid of objects such as foam rollers and balls and in the use of instruments manipulated by a therapist(6,7).

Instrument-assisted soft tissue mobilization is based on the principles of James Cyriax, who uses cross-digital pressure to affect fascial restrictions and adhesions, thereby decreasing pain and increasing range of motion(8). The use of instruments, according to Cheatham, was designed to reach the tissues more deeply and with greater specificity, also reducing the stress that manual release imposes on the therapist's hands. There is a wide range of instruments that have different designs and materials , yet the general objctive

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is the same for all of them. The effects, in theory, are explained by the resorption of excessive fibrosis and collagen repair and regeneration with fibroblast recruitment[8].

In a study, Markovic et al[7] demonstrated the difference in the acute effects between two myofascial release techniques on hip and knee range of motion in soccer athletes. The techniques consisted of the foam roller (self-release) and the fascial abrasion technique (FAT) performed by a therapist and with the aid of an instrument. The conclusion was that the magnitude of the values obtained through instrument-assisted soft tissue mobilization (IASTM) through FAT was twice as high compared to foam roller on knee and hip range of motion in the studied population, despite that, both had statistically significant results. In addition Debruyne, in a literature review, analyzed the possible differences between the use of foam rollers and massage roller on the gain of hamstring flexibility, the research conclusion indicates that massage rollers are more suitable for this purpose than foam rollers, which have little evidence of their effectiveness. Possible justifications for this conclusion are that in the foam roller studies, participants performed self-treatment by applying their body weight to the roller, while in the massage roller studies, subjects were subjected to therapies by an investigator. trained or by mechanized massage devices, in this way the treatments with the massage roller would be applied with greater force or with more uniform force on the tissue, influencing the treatment results[9].

Although myofascial release is a conduct frequently applied in clinical practice, there are still few studies that compare the effects of performing this technique in an instrumental versus manual way to gain flexibility in the hamstring muscles. Therefore, this study aims to analyze the relationship between flexibility and strength of the hamstring muscles and the acute effect of two modalities of myofascial release on the flexibility of this musculature in young women. We hypothesized that both techniques will bring flexibility gains for the volunteers, however, they will be more significant with the instrumental release. Furthermore, individuals with greater flexibility will present greater strength.

METHODS

Subjects

Young female university students participated in this study, who were randomly divided into three groups: Manual Release Group (GLM, n=15), Instrumental Release Group (GLI, n=15), and Control Group (CG, n=15), as shown in Table 1. Participants were recruited through personal communication, pamphlets distributed at the university, and social networks. The eligibility criteria for this study were: female gender, age between 18-30 years, who do not have degenerative diseases in the joints of the lower limbs, history of injuries or trauma to the lower limbs, and discrepancy in limb length.

The present study was submitted to the local ethics committee (4,168,924) and all participants signed an informed consent form.

Table 1. Sample Characterization.

	Group control (n=15)	**Manual release group (n=15)**	**Instrumental release group (n=15)**
Age (years)	24,30± 3,10	22,30±1,88	22,40±1,83
Body mass (kg)	63,60±13,22	61,64±8,16	55,00±7,66
Estature (m)	1,60±0,05	1,63±0,06	1,62±0,06
BMI (kg/m2)	24,89±4,58	23,16±1,92	20,91±1,96
		10,70±3,12	9,56±2,08

***Note:** Mean values ± standard deviation

Assessment Procedures

The evaluation procedures were performed in one day. In the laboratory, the volunteers performed anamnesis, assessment of the flexibility of the hamstrings, third finger to the ground test, assessment of the popliteal angle, and assessment of muscle strength of knee flexion, of the dominant lower limb. After the assessment, the intervention groups received a myofascial release session on the hamstring muscle group while the control group remained at rest. Subsequently, all volunteers repeated the flexibility tests.

Determination of the dominant member

To determine the laterality of the lower limb, three attempts were performed for each of the following activities: accurately kicking a ball, climbing steps, and recovering balance after a subsequent disturbance [10].

Sit and Reach Test

To assess flexibility, the sit and reach test, proposed by Wells and Dillon[11], was performed. This test aims to evaluate the flexibility of the hamstring muscles and the lumbar region. Thus, the subject is seated with knees extended and lower limbs slightly apart, feet resting on the wooden box, elbows extended and upper limbs flexed anteriorly, as shown in figure 1. From this position, the performer performs a forward movement with the trunk, trying to reach with the hands the greatest possible displacement on a scale graduated in centimeters at the top of the box, without performing knee flexion. The volunteers performed the test 3 times, and the highest value obtained was considered for analysis.

Popliteal Angle Assessment

The evaluation of the popliteal angle aims to measure the retraction of the hamstring muscles. The volunteers were positioned in dorsal decubitus with the hip of the tested limb at 90° and the contralateral limb fully extended on the examination table. Photo reflective markers were placed on the greater trochanter of the femur, tibial plateau, and lateral malleolus, and a Sony® digital camera was positioned two meters from the volunteer. Then the tested limb was subjected to passive stretching until the muscle's first resistance to stretching was perceived, this point was recorded using a photograph for angulation analysis, as shown in Figure 1. For data analysis, the Kinovea software and two straight lines, joining the greater trochanter of the femur to the tibial head and the tibia to the lateral malleolus, the junction of the two straight lines form the popliteal angle[12].

Third Finger To Ground Test

The third finger to the ground test was also used to assess the flexibility of the hamstrings. With the lower limbs fully extended, feet together and pointed forward, the subjects performed a trunk flexion until the moment of great discomfort in the hamstring muscles with the arms towards the floor and relaxed head, as shown in figure 1. measured with a tape measure, the distance of the third finger in relation to the ground[13].

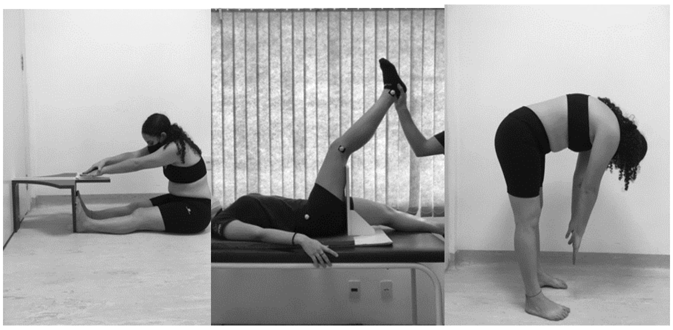

Figure 1. Assessment of Hamstring Flexibility: Sit and Reach Test (A), Popliteal Angle Assessment (B), Third Finger to Ground Test (C).

Knee Flexion Muscle Strength Assessment

To assess the ability to produce knee flexion joint torque of the dominant lower limb, a manual Lafayette® dynamometer was used. The volunteers were positioned in the prone position, with the knee flexed at 90° and stabilized on the table with a belt in the region of the pelvis and distal end of the femur, as shown in Figure 2. The dynamometer was positioned in the region of the Achilles tendon[14].

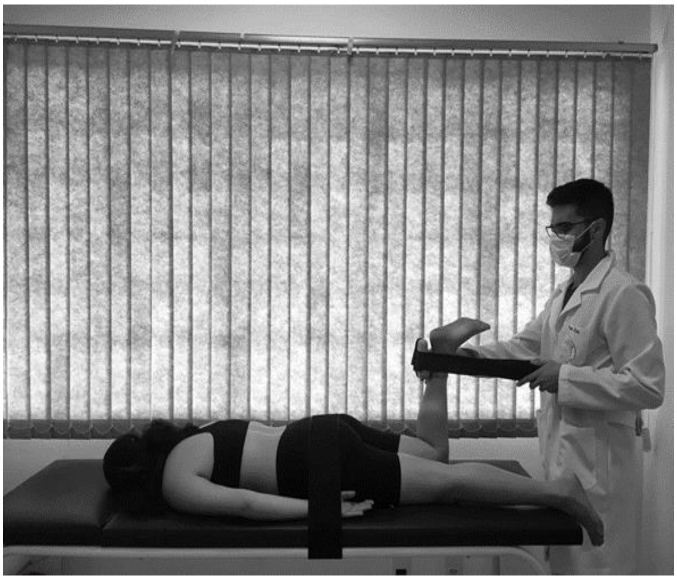

Figure 2. Knee Flexor Muscle Strength Assessment.

Myofascial Release of the Hamstrings

Volunteers in the treatment group received a hamstring myofascial release session. The two chosen techniques were performed with the volunteers in the prone position on a stretcher. The treatment lasted 10 minutes, and in the first 2 minutes the pressure exerted was lower than the remaining 8 minutes, for muscle desensitization. A sliding cream was also used for both techniques, performed by the same trained therapist[15].

For the GLI, the Gustavo Pilon punch instrument was used, as shown in Figure 3C, applying uniform and moderate pressure on the entire posterior musculature of the thigh with movements in the direction of the muscle fiber.

For the GLM, the technique was performed with a deep slide of the hands over the musculature, as shown in Figures 3A and B. The therapist placed the thumbs of both hands on the hamstrings of the limb to be treated and with the other fingers supporting the lateral part. of the leg, just for stabilization. In addition, the pressure was performed with all fingers extended and one hand on top of the other. Moderate and slow pressure was applied with movements in the direction of the muscle fiber.

Figure 3. Myofascial Release of the Hamstrings: Manual (A and B) and Instrumental (C).

Statistical analysis

Statistical analysis was performed using the PASW statistics 18.0® (SPSS) software. After verifying the normality and homogeneity of the data by the Shapiro-Wilk test, the Ano One Way test was applied to compare the groups before and after myofascial release and the Pearson Correlation test to verify the relationship between knee flexor strength and the flexibility variables. In all statistical tests, a significance level of $p<0.05$ was adopted.

RESULTS

The Anova Repeated Measures test showed differences before and after treatment (p= 0.001, F= 0.900) and interaction between group and treatment (p= 0.048, F= 0.299). Regarding the comparison between the groups, there was no significant difference (p> 0.05).

Bonferroni's Post hoc test showed that, regarding the treatment effect, the instrumental release group showed an improvement of 3.24% in the popliteal angle (p = 0.035), an increase of 10.48% in the sit and reach test (p = 0.035). = 0.003) and an improvement of 32.76% in the 3rd finger floor test (p = 0.001), as shown in Table 2. In turn, the manual release group showed an improvement of 8.26% in the sit performance and achieved (p = 0.009) and 37% on the 3rd finger floor test (p = 0.013). The control group showed no significant difference for the variables analyzed (p> 0.05). The table presents these results.

Pearson's correlation analysis showed a weak positive correlation between knee muscle strength and performance in the sit and reach test (r = 0.409 p = 0.025), as shown in Table 3.

Table 2. Flexibility of the hamstring muscles before and after myofascial release.

	Control Group		**Manual release group**		**Instrumental release group**	
	Before	After	Before	After	Before	After
Popliteal Angle (degrees)	162,0 04,94	157,10± 6,52	160,70± 6,94	162,00±8,71	151,40±9,51	156,30±8,31*
Sit and reach (cm)	28,65 ± 7,73	29,15± 7,24	28,10 ±9,63	30,42 ± 9,11*	24,15 ±7,58	26,68 ±7,56*
3 finger-floor test (cm)	3,40± 5,38	2,90 ± 4,62	8,10± 7,68	5,10± 5,10*	11,60 ±7,48	7,80± 5,89*

***Note:** Mean values ± standard deviation. cm= centimeters. *denotes significant difference.

Table 3. Correlation of knee flexor strength with flexibility variables.

	Knee Flexion Strength
Popliteal Angle	
r	-0,115
p	0,546
Sit and reach	
r	0,409
p	0,025
Test 3 Finger Floor	
r	-0,105
p	0,580

DISCUSSION

Our study aimed to analyze the effect of two myofascial release techniques on the flexibility of the hamstring muscles and their relationship with knee flexion muscle strength. The results partially confirm our initial hypothesis. Both techniques improved flexibility, with no significant differences between them. On the other hand, we did not observe a correlation between the flexibility of the hamstrings and the ability to produce torque.

Regarding myofascial release techniques, a possible explanation for the improved performance in the sit-and-reach and 3-finger floor test is that these manipulations break adhesions between collagen fibers and release trigger points, decreasing pain and improving function[8,16]. The literature shows that the force to break or remove myofascial adhesions would be greater than what physiologically most people could perform, but a therapist applying considerable pressure with the elbows, for example, could transmit significant pressure to the fascia, contributing to better malleability of this tissue[16].

However, some studies have shown other mechanisms involved in myofascial release, which consist of improving function and decreasing general stiffness, rather than just releasing adhesions. According to Behm and Wilk (2019) and Kalichman and David (2017), the effects of myofascial release involve the participation of the central nervous system in the modulation of tone along with sensory feedback from the Golgi tendon organs (GTO). When the OTG registers an increase in tension, its stimulation leads to a reduction in muscle activity as a protective reaction to the muscle (autogenous inhibition). Thus, if the neural impulse to the active component of the locomotor system is reduced, this can generate a decrease in rigidity and an increase in compliance throughout the myofascial system, that is, the pressure applied in the myofascial release can stimulate the GTO and activate this reflex of autogenous inhibition. In addition, this technique encompasses peripheral changes in the mechanical properties of the tissue, through vasodilation and local fluid dynamics, hydrating the fascia and modifying its viscoelasticity, converting it into a more gel-liquid state, in response to mechanical stimuli induced with myofascial release[16,17].

The findings of this study corroborate those of Simatou et al (2020)[18], in which they demonstrated that instrumental release (IASTM -Ergon®) on the lateral line of the lower limbs was superior to self-release techniques with a foam roller and static stretching in increasing the range of motion of hip adduction and with Kuruma et al (2017)[15], who concluded that manual myofascial release of the quadriceps region resulted in significant increases in active and passive range of motion of knee flexion.

Another study that supports our results is that of Katariya et al (2019)[19], who showed that instrument-assisted soft tissue mobilization (IASMT) using a punch-like tool (Edge tool) was effective in increasing the extensibility of hamstring muscles in passive knee extension range of motion and that IASMT further reduced therapist effort.

Regarding the comparison of different myofascial release techniques, this study showed that different forms of myofascial release can contribute to patient improvement. Therefore, the applicability of the techniques becomes broader because it does not depend on specific instruments to have the desired effect, and can be performed only with the manual skill of the therapist. Therefore, it allows you to choose the preferred method that best suits your clinical practice. Stanek et al (2018)[20] compared the effects of two release techniques on dorsiflexion range of motion.

Compressive myofascial release was compared with the technique with gastron instruments, an IASTM procedure that is similar to manual but uses a stainless steel instrument. The results showed that the compressive release was beneficial to the range of motion of the joint, which did not happen with the group that received the Gastron technique, compared to the control group, which did not receive any intervention. Despite this, some studies managed to demonstrate efficiency in the Gastron technique about knee extension and hip abduction angles, demonstrating that the use of instruments can also be beneficial for ROM.

Thus, the many discrepancies between the studies can be attributed to differences between the populations studied, which differed between healthy people, without soft tissue restrictions, and people with restrictions, as well as the pressures used with the instrument, which are difficult to measure. during the application, and also the time of application of the protocols, which makes the comparison of results delicate[20].

On the other hand, the findings of the present study showed no significant difference in the volunteers' level of flexibility and the ability to produce joint torque from knee flexion. This may be related to the fact that the evaluated volunteers did not present significant compromises in the flexibility of the hamstring muscles, not having significant losses in the number of sarcomeres in series, decrease in muscle size, or loss of functional capacity due to severe shortening[5].

In addition to these factors, we can understand that changes in the length-tension curve influence the point where the muscle generates its maximum tension, called the optimal point, where each individual will have a specific angulation to generate the highest possible peak torque, that is, for individuals with the musculature too shortened or too elongated, the muscle may lose its ability to perform maximum force, which may mask the maximum force value when performing the test at a 90º knee angle[5,21]. However, for this to be relevant, there must be a significant change in the muscle length of the individuals tested, and as in the present study no major impairments of flexibility were found, changes in strength graduation due to shortening or stretching of the hamstring muscles cannot be justified.

Given this, we can conclude that the flexibility of the hamstring muscles can be improved with myofascial release techniques, a positive fact given that good flexibility of the hamstring muscles is associated with benefits such as avoiding or alleviating back pain, reducing the overload imposed on the spine, reduce the risk of injuries, improve static and dynamic posture, optimize the energy expenditure of the muscles, which may be related to a good capacity to produce torque.[21,22]

Finally, we can mention the relatively small sample size as limitation of our study, as well as the fact that the effects obtained with the techniques are exclusively acute, not allowing us to say that these effects are chronically prolonged.

CONCLUSION

We conclude that there was no significant correlation between the level of flexibility of the hamstring muscles and the ability to produce knee flexion torque and that myofascial release techniques, manual and instrumental, were equally effective in improving the flexibility of the posterior thigh muscles.

Authors' contribution: DHS, MG and AF contributed to the elaboration of the design of the study; MG e AF development of the study and data acquisition. DHS, MG, AF and MTN contributed to article design and data tabulation. DHS, MG, AF and MTN contributed to the critical review, correction and approval of the final version.

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Conflict of interest: There was no conflict of interest.

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