Influence of Static Stretch Frequency on Hamstring Muscles Flexibility and Gait Parameters in Young People

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ABSTRACT

Background/aim: *The ability of an individual to move smoothly depends on his flexibility which enhances both safety and optimal physical activities. Reduce of flexibility may cause inefficiency in physical fitness. The hamstrings are example of muscle groups that have a tendency to shorten. Frequency of stretching have not been extensively examined. The purpose of this study was to determine the optimal frequency of passive static stretching to increase the flxibility of the hamstring muscles among young people. This was measured by knee extension range of motion (ROM) as well as functional performance measured by gait parameters.* ***Materials and Methods:*** *Sixty nine subjects (39 males and 30 females) with age ranged from 19 to 24 years who had mechanical habitual bilateral hamstring tightness were randomly assigned to one of three groups. The control group, did not receive any stretch. The other two groups were stretched (30 sec.) for 6 weeks. The second group was stretched five dayes per week while the third group received stretch only two dayes per week.* ***Results:*** *Statisical analysis of the data indicated that both stretching groups showed gains in ROM than did the control group (P<0.05). The gait analysis revealed that the stretch groups had a considerable functional improvement. The change of flexibility and gait parameters appeared to be dependent on the frequency of stretching.* ***Conclusion:*** *The results of this study suggest that five times static stretching per week is more effective method to sustain a hamstring muscles flexibility, increase knee extension ROM and improve gait parameters than two times stretching per week.*
Key Wards: *Flexibility, Hamstrings, Stretching, Knee extension deficit, Gait parameters.*

INTRODUCTION

Hamstring tightness can lead to increased patellofemoral compressive force, which may eventually cause patellofemoral syndrome[25]. On the other hand individuals with "flat" backs (reduced lumbar curvature) while standing tend to have short hamstring muscles. It was presumed that tight hamstring muscles rotate the pelvis posteriorly, resulting in a concurrent reduction of lumbar lordosis and increases the risk for low back pain. Reduced hamstrings flexibility can cause inefficiency in the workplace[10,26].

Hamstring muscles play an important role during gait, at initial contact, the knee is almost fully extended, then it gradually flexes to its support phase peak flexion of approximately 20º during the early portion of midstance. During the latter portion of midstance, it again extends almost fully, and then flexes to approximately 40º during pre-swing. Immediately following toe off, the knee continues to flex to its peak flexion of 60 to 70º at mid-swing, then extends again in preparation for the next initial contact[1,11]. The vertical component of the ground reaction force became less dynamic as the hamstrings became shorter. Walking speed, step and, therefore, stride length decreased as the hamstrings became shorter[3,14].

Decreased hip flexion and increased knee flexion in stance, increased posterior pelvic tilt, decreased pelvic obliquity and rotation and premature ankle dorsi- and plantar-flexion in stance[19]. These results emphasize the need to consider the effects of changing the length of the hamstrings[16]. The present study has significance for patients, athletes, and health professionals how use and/or prescribe stretching to increase knee ROM and /or gait performance. Evaluating the frequency of stretching required to increase ROM at knee joint will allow a more accurate prescription of stretching program to achieve a desired effects. These effects may lead to the injury prevention or rehabilitation, and enhancement of athletic performance. The purpose of the study was to compare the effects of six weeks of repeated static stretching of the hamstring muscles group for two or five session per week to determine the optimal frequency that enhances hamstrings flexibility and gait parameters among young people.

MATERIALS AND METHODS

Sixty nine volunteered subjects (39 males and 30 females) with age ranged from 19 to 24 years who had habitual bilateral adaptive hamstring tightness due to postural problems (e.g. desk job, prolonged cross sitting, ect) participated in the study. Tight hamstrings was determined as knee extension deficit (KED) and defined as having greater than 20 degrees loss of knee extension and measured with the femur held at 90 degrees of hip flexion while the person was positioned in supine measured with active knee extension test (AKET)[6,21]. The subjects were matched in their weight and height, physically active and had no history of neurological abnormalities, previous injuries or disorders of the lower back, lower extremities for one year before the study and hip or knee replacement.

Instrumentations

A double arm goniometer was used to measure knee extension ROM. Prior to data collection, a pilot study to establish interatester reliability of measurments of knee extension ROM was performed. A test-retest design was used on 15 subjects of similar age with measurments taken one week apart. Reliability was determined using an interclass corrlation coefficient(ICC). An ICC of 0.96 was considred appropriate for continuing the study[6,20].

- Gaitway TM Instrumented Treadmill (Kistler Instrument Corporation, Amherst, NY, Type 2813M01-A20) equipped with piezoelectric force plates beneath the treadmill belt, with GatewayTM software, version 2.0.8.42. The GatewayTM software discriminates between right- and left-footsteps and allowed raw data to be exported for further analysis.
- All stretches time were adjusted by using stop watch.

Methods

The study was conducted at Physical Therapy Department of Dallah Hospital, Riyadh, KSA. The procedures was adequately explained to the subjects before obtaining their informed consents. The consenting subjects agreed that they would not engage in any other lower limb exercises aside the one designed for this study. The subjects agreed not to increase the intensity or frequency of the routine regular activities during the six weeks training program.

Measurment protocol:

- Once reliability of the measurement was established the baseline (KED) on both lower limbs was measured using a goniometer[6,19,20,21]. Each subject was positioned supine and the hip joint being assessed was flexed to 90. The greater trochanter and lateral epicondyle of the femur and lateral malleolus were palpable and served as landmarks during measurment. Ninety degrees of hip flexion was maintained by one researcher and the subject was instructed to actively extend the knee .The terminal position of knee extension was defined as the point at which the subject complained of feeling of discomfort or tightness in the hamstring muscles. Once the terminal position of knee extension was reached, the second examiner measured the amount of knee extension with the goniometer. Zero degrees were considered to be full extension of the knee.
- Each subject walked on the treadmill[11,12,18,26] for 3 min. for measuring gait parameters at a speed of 1.3 m/s. Each subject had been trained to walk freely for at least five minutes. All subjects were instructed to walk bare feet for three successive trails with 20 seconds interval, and the average had been calculated. The device was adjusted to make the first and last 10 sec. excluded from the total walking test.

All subjects of the study groups were measured for both knee extension deficit (KED) and gait parameters (weight acceptance and push off peak forces, cadence, stride length and step length) initially before they had stretching and post intervention. Two days of rest separated the last day of stretching and the post test. The subject's KED was then reassessed at the 7th day post intervention and recorded as 'carry-over' values to determine the residual effect of the stretching. The subjects in the control group were measured at baseline and after six weeks. No warm up or stretching was allowed before data collection.

Stretching Protocol:

After determining the baseline value, the subjects were then randomly assigned into one of the three equal groups as followes:

Group 1 (G1): Received static stretch exercise for two times per week.

Group 2 (G2): Received static stretch exercise for five times per week.

Group 3 (G3): Served as control and thus did not participate in any static stretch exercise.

The stretching exercise was carried out as followes[5,6,20]: Subjects assumed supine-lying position on a plinth with the feet pointing upward. A straight –leg- raising technique was used for this stretch. The lower limb being stretched was passively moved into the extreme of knee extension, up to the limit where the subject felt a gentle stretch at the posterior aspect of the thigh. Each subject's knee was sustained in extension for 30 seconds with the ankle at 90 degrees without medial or lateral rotation of the lower extremity, and the extremity was raised untile the subject reported discomfort. This placed the hamstring muscles at their greatest possible length. The subject was asked to relax the lower extremity in an effort to prevent contracting muscles from affecting the stretch and to allow for slow stretch. During each session, all subjects in both study groups received four stretches with a 10 seconds rest between stretches for six weeks.

Data Analysis

Means and standered deviations (S.D) for all groups and all measurments were calculated. Two-way ANOVA for repeated measures on one variable (pre test and post test values)was initially performed to determine whether there were difference between values of the three groups. Beccause a significant interaction was found, the follow up analysis were done to determine which group differed from the other:- dependent t-test was calculated on the pre test to post test change for each group - a repeated - measures one-way ANOVA was calculated to assess whether any differences existed in the pre test scores as well as the post test scores across the three groups. A paired t-test was computed to comare the post intervention and carry over values. An alpha level of P≤0.05 was the level of probability.

RESULTS

The mean physical parameters of the subjects are as presented in table 1.

Table (1): Characteristics of the subjects in each group (G1,G2&G3).

Group	Age (Yrs) X±S.D	Weight(Kg) X±S.D	Height(M) X±S.D
G1	22±2.55	61.60±7.67	1.68±0.67
G2	22±1.70	60.76±7.44	1.70±0.08
G3	23±0.82	58.67±6.87	1.62±1.74
P- value	0.14	0.74	0.54

Significance*at P≤ 0.05 SD= Standard deviation

Comparisons between baseline and post intervention values within each group revealed that both study groups (G1 & G2) showed gain in knee ROM and improvement in KED (P<0.05). There was no significant difference in the baseline knee extension deficit (KED) values among all subjects (Rt. & Lt.) when compared across the three groups (P>0.05). However, there were a significant differences regarding the post intervention values among the three groups and between each two groups with P-value < 0.05 (Table 2 & Fig. 1&2).

Table (2): Comparisons of of knee extension deficit (KED) mean values (Rt. & Lt.) at baseline and post intervention between each two groups.

Group	Baseline		Post intervention	
	(Rt.) X±S.D	(Lt.) X±S.D	(Rt.) X±S.D	(Lt.) X±S.D
G1 G2	32.07±5.64 29.20±6.45	29.87±4.1 28.94±5.8	19.00±3.2 12.04±2.1	16.88±6.81 11.90±3.04
P-value	0.33	0.53	0.01*	0.001*
G1 G3	32.07±5.64 32.50±5.12	29.87±4.1 30.34±4.9	19.00±3.2 33.00±6.01	16.88±6.81 30.95±7.30
P-value	0.42	0.46	0.001*	0.000*
G2 G3	29.20±6.45 32.50±5.12	28.94±5.8 30.34±4.9	12.04±2.1 33.00±6.01	11.90±3.04 30.95±7.30
P-value	0.29	0.91	0.005*	0.001*

Significance*at P≤ 0.05. Rt.: Right. Lt.: Left. SD= Standard deviation.

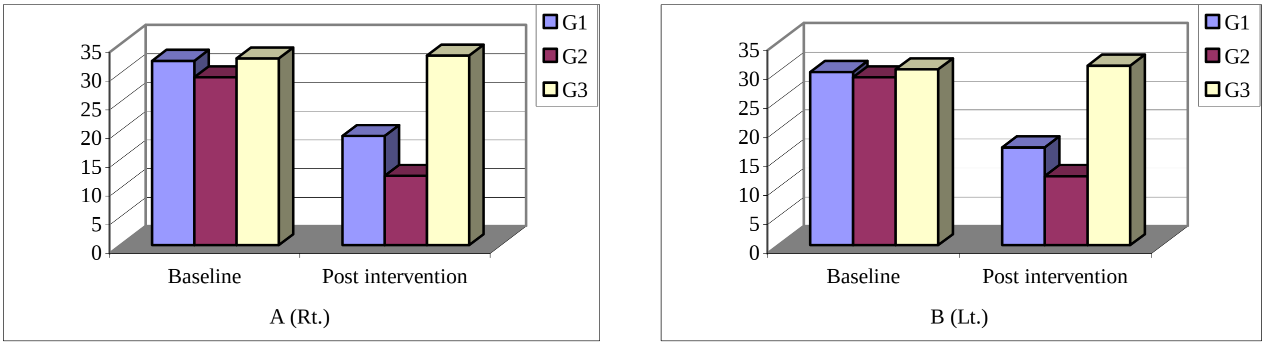

Fig. (1: A&B): Mean values of Knee extension deficit (KED) at baseline and post intervention for both sides (Rt. &Lt.) in the three groups(G1,G2&G3).

Comparisons of the post intevention and carry over values within each study group revealed no significat difference (P>0.05) between the Post intervention and carry- over KED values within the second group. However,there was a significant difference between post intervention and carry-over values within the first group. There was also a significant difference between both study groups (G1 & G2) regarding carry- over values with P-value < 0.05.

Table (3): Comparisons of KED values post intervention and carry- over of the study groups.

Group	G1		G2	
	(Rt.) X±S.D	(Lt.) X±S.D	(Rt.) X±S.D	(Lt.) X±S.D
Post intervention	19.00±3.2	16.88±6.81	12.04±2.1	11.90±3.04
Carry- over value	24.40±3.13	22.99±5.98	13.10±1.89	10.89 ±2.7
P- value	0.05*	0.03*	0.1	0.41

Significance*at P≤ 0.05 Rt.: Right Lt.: Left SD= Standard deviation

Comparisons between baseline gait parameters among the three groups showed no statistical differences while post intervention comparisons showed statistical significat differences between the two study groups with P< 0.05. Comparisons between basline and post intervention values within the G1 and G3 revealed no statistical significat changes. Comparisons within the G2, showed that peak values of vertical forces during the weight acceptance and push off were significantly greater at baseline measures with mean values (469.63±31.9, 500.69±2.51) compared to the post intervention (370.10±13.3,430.15±12.75) and the differences were statistically significant (P=0.002, 0.001).There were also a statistical significant differences regarding cadence, stride length and step length (table 4 & 5 and Fig. 2 A & B). This means that the significant gain in KROM with improving the

KED in the first group is not suffecient to improve the gait parameters while increase in KROM in the G2 post intervention result in statistical significat improvement in gait parameters.

Table (4): Comparisons of mean values of gait parameters at baseline and Post intervention in the first group (G1).

Gait Parameters	Baseline X±S.D	Post intervention X±S.D	P-value
Weight acceptance peak force (N.)	473.15±31.72	499.51±21.51	0.54
Push - off peak force (N.)	513.05±31.99	517.05±41.73	0.99
Base of support(Cm.)	10.59±1.81	11.22±1.30	0.65
Cadence(step/min.)	67.33±6.65	69.33±6.75	0.31
Stride length(Cm.)	135.43±2.48	139.5±3.29	0.32
Step length(Cm.)	67.17±6.23	70.52±7.63	0.17

Significance*at P≤ 0.05 SD= Standard deviation.

Table (5): Comparisons of mean values of gait parameters at baseline and Post intervention in the secondt group (G2).

Gait Parameters	Baseline X±S.D	Post intervention X±S.D	P-value
Weight acceptance peak force (N.)	469.63±31.9	370.10±13.3	0.002*
Push - off peak force (N.)	500.69±2.51	430.15±12.75	0.001*
Base of support(Cm.)	9.47±1.10	9.71±1.54	0.56
Cadence(step/min.)	68.44±8.12	79.27±9.12	0.03*
Stride length(Cm.)	133.1±4.68	154.72±3.92	0.006*
Step length(Cm.)	61.24±6.67	79.31±8.23	0.01*

Significance*at P≤ 0.05 SD= Standard deviation

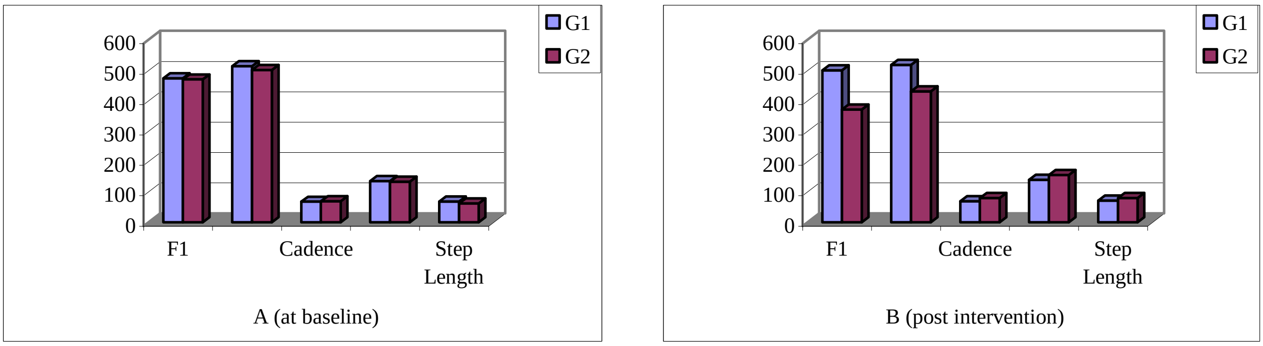

Fig. (2: A&B): Mean values of weight acceptance peak force(F1), Push - off peak force (F2), Cadence, Stride length and Step length in the first and second groups(G1,G2) at baseline and post Intervention.

DISCUSSION

The hamstring muscles are important contributors to the control of human movement and are involved in a wide range of activities from running and jumping to forward bending during sitting or standing and the postural control actions[13,26]. Flexibility of the muscles can be enhanced by simple, non-surgical procedures like stretching. Stretching is believed to provide many physical benefits, including improved muscles flexibility and gait performance, as well as injury prevention[15,22].

The outcome of this study revealed that the application of 6-weeks hamstring static stretching regimen with a duration of 30 seconds resulted in significant improvement in hamstring muscles flexibility and gain in knee ROM in the two intervention study groups which is consistent with current literatures[5,6,19,20]. This observed trend is similar to that of an earlier study by Chen et al[(21)] who reported that static stretching protocols for either 4 or 8 weeks are effective in terms of improving flexibility of hamstrings.

Whereas the results of this study indicated that the five times stretching per week result in greater gains in KROM and to be more effective in maintaining ROM compared to the two times stretching regimen per week. Previous researchers[24,27] demonstrated that the stopping and starting of the stretching program appears to add no particular benefit to the athletes. They suggested that increased ROM after stretching may not be due to changes in the structure of the muscle and connective tissue, but possibly an increase in the tolerance to stretch. If these structural changes occur with short periods of muscle stretching, they are short lived due to the effect of cessation and resumption of stretching. The effect of resumption of a muscle stretching program is of interest due to the apparent lack of consistency in maintaining stretching programs by athletes and previously discharged clients.

Other researchers[7,8] concluded that although the immediate effects of stretching decrease visco-elasticity and increase stretch tolerance, the effect of stretching over 3 to 4 weeks appear to affect only stretch tolerance with no change in visco-elasticity. The mechanism by which regular long term stretching improving performance is likely related to stretch – induced hypertrophy. When a muscle is stretched daily for six weeks, some hypertrophy occurs even though the muscle has not been contracting.

The results of this study showed also no significant change in the gait parameters in the control and the first study group post stretching program while the results of the second group revealed improvement in gait parameters including the vertical forces (weight acceptance and push - off peak forces), cadence, stride length and step length post intervention. The results showed that hamstring tightness adversly affected gait. The results in consistent with previous studeis which concluded that step and stride length decreased as the hamstring shortened[4,14,18]. Whitehead et al.,[26] reported that the vertical component of the forces became greater as the hamstrings became shorter.Stride length was decreased due to decreased knee extension in terminal swing, which caused premature initial contact, at a shorter step length. The authers reported that hamstrings shortening adversely affect gait but in normal subjects the popliteal angle needed to be greater than 85° for this effect to be significant so even substantial restriction of hamstrings length can be accommodated in the normal individuals.

Conclusion

Longer frequency (five times weekly) static strtching of the hamstring muscles resulted in a greater gains and a more sustained increase in knee ROM indicating improvement in hamstrings flexibility as well as gait parameters in young people.

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الملخص العربى

تأثيرمدى تكرار الإطالة الثابتة على مرونة عضلة الفخذ الخلفية وقياسات المشي في الشباب

أجريت هذه الدراسة بهدف تحديد مدي تكرار تمارين الاطالة السلبية الثابتة الامثل اسبوعيا (يومين أو خمس أيام) ل لعضلة الخلفية للفخذ للأشخاص الذين يعانون من قصر ميكانيكي (بطبيعة عاداتهم) لعضلة الفخذ الخلفية فى مرحلة الشباب . أختير 69 شخص (39 ذكر -30 أنثى) ممن يعانون من قصر بالعضلة الخلفية لاسباب ميكانيكية تتراوح أعمارهم من 19الى 24 سنة تم تقسيمهم عشوائيا الى ثلاث مجموعات متساوية. تلقت المجموعة الاولى والثانية تمرين شد ثابت لاطالة العضلة اسبوعيا لمدة ستة أسابيع ، المجموعةالاولى بواقع مرتين أسبوعيا والثانية بواقع خمس مرات أسبوعيا بينما لم تتلق المجموعة الثالثة اى تمرين. أسفرت النتائج الإحصائية عن وجود تحسن فى المدى الحركى لمفصل الركبة فى المجموعتين اللاتى تلقين شد ثابت وقد كان التحسن بفرق احصائى واضح فى المجموعة التى تلقت تمرين الاطالة خمس مرات اسبوعيا عن المجموعة التى تلقد التمرين مرتين اسبوعيا بينما لم يتغير المدى الحركى فى المجموعة التى لم تتلق برنامج أطالة. بالنسبة لمقاييس المشى فقط تحسنت بدرجة احصائية واضحة فقد فى المجموعة التى تلقت إطالة للعضلة الخلفية لمدة خمس أيام فى الاسبوع عنها فى المجموعة الاولى مما يدل على ان هذا المعدل الاسبوعى لبرنامج الاطالة الثابتة لعضلة الفخذ الخلفية هو الأنسب لما له من تأثير ايجابي واضح على المدى الحركى لمفصل الركبة وتحسن واضح فى مقاييس المشى .