ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 03, pp.19654-19659, March, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

ACTIVE STRETCHING OF HIP FLEXORS INCREASES HIP EXTENSION RANGE OF MOTION MORE THAN PASSIVE STRETCHING

[1*]Shilpa Jain, [2]Abdul Majeed Bhat and [3]Rajiv Kumar Tonk

[1]Associate Professor, Deptt. of Pharmaceutical Chemistry, School of Pharmaceutical Sciences, Delhi
[2]Pharmaceutical Sciences & Research University
[3]Senior Consultant Physiotherapist, Active Ortho, New Delhi

ARTICLE INFO

Article History:
Received 19th December, 2017
Received in revised form
17th January, 2018
Accepted 20th February, 2018
Published online 30th March, 2018

Key Words:
ROM, Goniometer,
Stretching,
Sherington's principle.

ABSTRACT

Objective: To determine the effect of active stretching versus passive stretching in subjects with hip extensor muscle tightness.
Design: Pretest- Posttest Experimental design.
Subject: Total 30 subjects were taken for the study. Subjects were randomly divided into two groups. Group A: (n=15) Active stretching. Group B: (n=15) Passive stretching.
Methodology: In Active stretching group (Winter *et al*., 2005) group A, stretching is first done with bending knee (5 reps) and then done with knee extension. In group A, stretches were done for 10 repetitions each in a single daily session for 5 days in a week; each stretch was held for 30 seconds with up to a 30 second rest period between repetitions. In the passive stretching group, i.e. group B, stretch was given for 10 repetitions each in a single daily session for 5 days in a week. Each stretch was held for 30 seconds, with an 8-seconds rest period between repetitions (Winter *et al*., 2005). The subjects were assessed two times during research period i.e. at 1st session which was at the start of study to collect the baseline data and at the end of the study to get the progressions, respectively. All the recordings and progressions were documented.
Main outcome measure: Range of motion of hip extension.
Result: The ROM improved significantly in both the groups as compared to pretest value but there was no significant difference between the two groups at the end of the intervention.
Conclusion: This study proposes and provides the evidence that active and passive stretching of hip flexors; both are equally good and effective in increasing hip extension range of motion.

Citation: Shilpa Jain, Abdul Majeed Bhat and Rajiv Kumar Tonk, 2018. "Active stretching of hip flexors increases hip extension range of motion more than passive stretching", *International Journal of Development Research*, 8, (03), 19654-19659.

INTRODUCTION

Limited hip extension range of motion presumably due to hip flexor muscle tightness is a common problem that has been reported in subjects, leading sedentary life style. Hip flexor muscle tightness can be defined as the inability to achieve full hip extension (Kendall *et al*., 1993) but there is no evidence indicating the decrease in range of motion is only due to lack of extensibility. People often have less or no physical work due to advancement of science and technology. Thus they adapt themselves in sedentary lifestyle and get tight muscles out of which hip flexors are most common.

Corresponding author: **Shilpa Jain,**
Associate Professor, Deptt. of Pharmaceutical Chemistry, School of Pharmaceutical Sciences, Delhi

More the hip flexors tightness more the anterior pelvic tilt, ultimately leading to many secondaries. So, stretching can be useful to deal with this problem.In fact, these problems are more common in females as compared to males because of broader pelvis; they have more anterior tilt of pelvis and hence resulting in tightness of hip flexors. Stretching[3] is the term is used to describe any therapeutic maneuver designed to increase mobility of soft tissues and subsequently improved Range Of Motion by elongating structures that have adaptively shortened and have become hypo mobile over time. An active stretch (Bradford D. Appleton, 1993) is one where a position is assumed and it is held there with no assistance other than using the strength of antagonist muscles. The tension of antagonists in an active stretch helps to relax the muscles being stretched (the antagonists) by reciprocal inhibition (Bradford D. Appleton, 1993).

Active stretching increases active flexibility and strengthens the agonist muscles. A passive stretch (Brad ford D. Appleton, 1993) is one where one position is assumed and held with some other part of the body, or with the assistance of therapist or some other apparatus. A number of anatomical and physiological factors influence a normal person's flexibility (Condon and Hutton, 2008). It depends upon age, gender and joint structure but some are under our control such as activity level, muscle bulk and stretching exercises etc. There are several different types of joints in the human body. Some intrinsically have a greater range of motion (ROM) than others. The ball and socket joint of the shoulder for eg. has the greatest range of all the joints and can move in each of anatomical planes. Compare this with the ellipsoid joint of wrist and hinge joint of ankle which can move in saggital with frontal planes and saggital plane respectively (Condon and Hutton, 2008; Peter Brukner and Karim khan, 2007). Rom and flexibility decreases with age. This is due, in part to the fibrous connective tissue that takes the place of muscle fibres through a process called fibrosis. Females tend to be more flexible than males. Older individuals should take encouragement that just as strength and endurance, flexibility can also be increased at any age with training (Condon and Hutton, 2008). Deep connective tissues such as fascia and tendon can limit the range of motion. In particular its two characteristics elasticity and plasticity are related to range of motion. Ligaments do not seem to display any elastic properties. However, with exposure to stretching they may extend to a new length.

Hypertrophy of skeletal muscle can adversely affect range of motion. It may be difficult for overweight persons to complete a stretch. Resistance training can increase the flexibility although when heavy weights are used with limited range of motion can reduce flexibility (Condon and Hutton, 2008). The capacity of neuromuscular system to inhibit the antagonists (muscles being stretched) influences flexibility. During stretching it is best to avoid activation of muscle spindle and stretch reflex response as that would limit the motion. When golgi tendon organs is stimulated it produces a reflexive inhibition. If the relaxation occurs in the same muscle that is known as autogenic inhibition (Cynthia *et al*., 2001) and can facilitate the stretch. Reciprocal inhibition (Cynthia *et al*., 2001) occurs when the golgi tendon organs is stimulated in the muscle opposite to that being stretched (opposite muscle relaxes). This can be achieved by simultaneously contracting the opposing muscle group to the one being passively stretched.

Internal environment affects range of motion. For e.g. Mobility is decreased immediately upon waking after a night's sleep and ten minutes in a warm (40°c) bath increase body temperature and ROM. (Forster and Palastanga, 2002; Margaret Hollis and Phyl Fletcher, 2001). Injury to muscles and connective tissue can lead to a thickening or fibrosis on the affected area. Fibrous tissue is less elastic and can lead to limb shortening and reduced range of motion (Condon and Hutton, 2008). Low static or dynamic flexibility may be an intrinsic risk factor for some injury types (Forster and Palastanga, 2002). The effect of the pelvic position, i.e., anterior pelvic tilt vs. the posterior pelvic tilt, in a hamstring stretch significantly affect the range of motion at the hip joint (Bandyand Irion JM Baigller, 1997). (The anterior pelvic tilt proved to be the preferred anatomical position.) The implications of this research are clear.

Instructors who are knowledgeable in anatomy and kinesiology of muscle attachments and joint movements may have greater success in designing flexibility programs for their students.

Flexors of hip joint

Psoas Major
Iliacus
Tensor Fascia Lata
Rectus Femoris
Sartorius

Extensors of hip

Gluteus Maximus
Semitendinosus,
Semimembranosus,
Biceps Femoris

Statement of study

Active stretching of hip flexors increases hip joint range of motion more than that of passive stretching.

Aims and objectives

- To increase the hip range of motion by using both passive and active retching.
- To compare the effect of the both stretching.
- To find out which one is more effective.

Significance of study

- To evaluate the effectiveness of two types of stretching on range of motion.
- To find out weather antagonist stretching will improve the agonist's range of motion.
- To pave the path for further studies.

Experimental hypothesis

Active stretching of hip flexors increases hip extension ROM.

Null hypothesis:
Active stretching of hip flexors has no additional effect on hip extension range of motion as compared to passive stretching alone.

Operational definitions
Active Stretching[3]:
It is one where a position is assumed and it is held there with no assistance other than using the strength of antagonist muscle.

Passive stretching (Bradford D. Appleton, 1993)

It is one where one position is assumed and held with some other part of body or with the assistance of a partner/therapist or some other apparatus.

Flexibility (Forster and Palastanga, 2002)

It is ability to adapt to changes in a position or alignment.

Static flexibility (Forster and Palastanga, 2002)

It is described as the degree to which the joints may be passively moved to the end points of range of motion (Forster and Palastanga, 2002).

Dynamic flexibility: (Forster and Palastanga, 2002)

It is described as the degree to which a joint can be moved as a result of muscle contraction (Forster and Palastanga, 2002).

Extensibility: (Brad ford D. Appleton, 1993)

It is property of muscles that permits them to lengthen or to be elongated.

Hypomobility: (Brad ford D. Appleton, 1993)
It is decreased mobility or motion.

Hypermobility: (Sullivan *et al*., 1992)

It is increased mobility of a joint than a normal ROM.

Range of motion: (Sullivan *et al*., 1992; Kendall *et al*., 1993)

It is the technique used for examination of movement and for initiating movement in to a program of therapeutic intervention.

Strength: (Forster and Palastanga, 2002)

The greatest force that can be put forth by a muscle against maximum resistance.

Stretch Reflex: (Brad ford D. Appleton, 1993)

It is the body's involuntary response to an external stimulus that stretches a muscle and causes a reflexive increase in muscular activity. It is muscle spindle that activates this response.

Reciprocal inhibition: (Brad ford D. Appleton, 1993; Condon and Hutton, 2008)

It occurs when golgi tendon organ is stimulated in the muscle opposite to that being stretched (so the opposing muscle relaxes).

Sherington's principle: (Brad ford D. Appleton, 1993)

This states that the use of active stretching as a means of increasing muscle flexibility subsequently improving the function of antagonist muscle.

Goniometer

It is an instrument which is having a stationary arm, a movable arm and a fulcrum between them with a protractor used in the measurement of angles created at human joints by the bones of the body.

Nature of study

The study was experimental in nature where subjects were assigned in either of two experimental groups. Method used was Active and Passive Stretching techniques. 6 weeks program was selected consisting of three sessions. The session started with pre-intervention measurement of Range of Motion using Goniometer.

Research setting

The study was conducted in Body Camp Gymnasium and Fitness Centre, Rohtak from March 10th 2008 to April 23rd 2008.

Consent and ethical approval

The owner of Body Camp Gymnasium and Fitness centre gave approval for this study. Each subject was examined by a registered medico to meet the inclusive criteria and certify that they are medically and physically fit for the study. Prior to being enrolled in study, the subjects were asked to read and sign an informed consent form which describes the risks, benefits and procedures of the study along with their right to discontinue involvement in the study.

Inclusion criteria

All the 30 subjects met the following criteria

Females Age between 18 years to 30 years Hip flexor muscle tightness Reduced hip extension ROM.

Exclusion criteria

Recent lower limb injuries Pregnancy Previous lower back or thigh muscles' injury Visual acute swelling of front and back or thigh Discomfort during physical assessment Soft tissue injury in hip, thigh or knee region Hip replacement/ fracture Systemic disorders (Fever, Hemophilia, Diabetes, etc.) Neurological deficit any psychological deficit.

Population

Only female patients coming to the Body Camp Gymnasium and Fitness Centre, Rohtak, Haryana, were formulated for the study. Females coming to the fitness centre were assessed for the hip flexor tightness. Differential diagnosis with other conditions mimicking hip flexors' tightness were established. Those subjects, who found to be with flexor muscle tightness, were checked for all inclusion and exclusion criteria. Subjects were included in study who fulfilled all the criteria. The parents and guardians were told about all the interventions and procedural details to be followed in the study by obtaining consent

SAMPLE AND METHOD OF SELECTION

Sampling

Convenient Sampling.

METHOD

Total 40 female subjects who volunteered to participate were selected; out of which 2-3 were expecting for discontinuation and some could not meet with the inclusion criteria. 30 subjects met the inclusive criteria with no exclusive criteria and assured for full participation and continuity in the entire program.

Variables of study

Dependent variable: Range of motion

Independent variables: Active stretching passive stretching

MATERIALS / INSTRUMENT USED

Universal goniometer
Couch

Pillows
Pen
Pencil
Timer (clock, wrist watch)

METHODOLOGY

Research Protocol

Subjects were randomly divided into two groups. Group A: (n=15) Active stretching Group B: (n=15) Passive stretching Subjects were fully explained and taught about the stretching techniques used in study. Prior to being enrolled in the study, all the subjects were advised of potential risks like muscle soreness. Prior to stretching program, hip flexor muscle tightness in limb of interest as well as in non-interest, was checked and ROM was recorded by goniometer. In Active stretching group (Winter *et al*., 2005) i.e. group A, stretching is first done with bending knee (up to 5 repeatitions) and then done with knee extension.

In group A, stretches were done for 10 repetitions each in a single daily session for 5 days in a week; each stretch was held for 30 seconds with up to a 30 second rest period between repetitions. Subjects who are unable to hold a stretch, instructed to hold the stretch as long as possible with the goal being 30 seconds. In the passive stretching group, i.e. group B, stretch was given for 10 repetitions each in a single daily session for 5 days in a week. Each stretch was held for 30 seconds, with an 8-seconds rest period between repetitions.[2] Subjects were also instructed to end the stretching session if they feel exhausted before 10 repetitions or they could no longer perform the stretch correctly (Winter *et al*., 2005). The subjects were assessed two times during research period i.e. at 0 session and 1st session which were, at the start of study to collect the baseline data and at the end of the study to get the progressions, respectively. All the recordings and progressions were documented.

PROCEDURES

Active Stretching (Winter *et al*., 2005)

The subjects allotted in Group A were given Active Stretching (Kendall *et al*., 1993; Winter *et al*., 2005; Brad ford D. Appleton, 1993)**.**

Position of Patient: Prone lying.

This group did prone leg lifts with the knee bent and straight. For the leg lifts with the knee bent, subjects were instructed to assume a prone position with the ipsilateral knee was fully flexed, relax their hamstring muscles and squeeze their gluteal muscle as much as possible to lift the thigh. Pillows were placed under the abdomen as needed for comfort. Same was asked to repeat with knee straight (5 repetitions)

Passive Stretching

The subjects allotted in group B were given Passive stretching **(Kendall *et al*., 1993; Winter *et al*., 2005; Sullivan *et al*., 1992)**

Position of Patient (Brad ford D. Appleton, 1993)

Have the patient close to the edge of treatment table so that the hip being stretched can be extended beyond neutral.

Opposite hip and knee are flexed towards the patient's chest to stabilize the pelvis and spine

Position of therapist (Brad ford D. Appleton, 1993)

Standing aside to the patient's leg that to be stretched.

Hand Placement and procedure (Brad ford D. Appleton, 1993)

Stabilize the opposite leg against the patient's chest with one hand, or if possible have the patient assist by grasping around the thigh and holding it to the chest to prevent and anterior tilt of pelvis during stretching. Move the hip to be stretched[3] in to extension or hyperextension by placing a downward pressure on the anterior aspect of the distal thigh with the other hand. Allow the knee to extend so that the two joint Rectus Femoris doesn't restrict the range Measurement of hip extension range by using Goniometer.

Goniometer (Sullivan *et al*., 1992)

It is an instrument which is having a stationary arm, a movable arm and a fulcrum between them with a protractor used in the measurement of angles created at human joints by the bones of the bodyMotion occurs in sagittal plane around a medial-lateral.

Position of patient

Position the subject prone, with the hip in 0 degrees of abduction, adduction, and rotation. The knee is extended. If the knee is flexed, tension in the rectus femoris muscle will restrict the motion. No is placed under the head.

Stabilization

Stabilize the pelvis to prevent rotation or anterior tilting. The subject's lower extremity at the end of hip extension ROM. The examiner's left hand supports the distal femur and maintains the hip in extension while right hand range of motion occurs when movement of the femur produces anterior tilting of pelvis. Because right hand is on the subject's pelvis, the examiner is able to detect pelvic tilting. (See fig. page 68)

Normal End- Feel (Brad ford D. Appleton, 1993)

The end-feel is because of tension in the anterior joint, iliofemoral, and to lesser extent, the ischiofemoral and pubofemoral ligaments. On occasion, tension in various muscles that flex the hip, such as the iliopsoas, sartorius, etc. may contribute to the firm end- feel.

Alignment of goniometer: (Sullivan *et al*., 1992)

- Place the fulcrum of goniometer over the lateral aspect of the hip joint using the greater trochanter of the femur for reference.
- Align the proximal arm with the lateral midline of pelvis.
- Align the distal arm with the lateral midline of the femur using lateral epicondyle of femur as reference.

Reliability and Validity

Instrumental

Goniometer: ROM of hip joint was measured by goniometer. It is the preferred instrument for measuring hip extension range of motion.

Studies of the hip measurements have included both active and passive motion and different type of measuring instruments. Clapper and Wolf found that the universal goniometer was more reliable than any other instrument. Pandya *et al*., five physical therapists using universal goniometer measured passive joint motions for hip including hip extension in children and adult patients of Duchene Muscular Dystrophy. The intratester and intertester reliability found to be good and fair respectively in hip extension.

Duration of Study

One and half month i.e. 6 week

Observation and Data Analysis

This chapter deals with the analysis of data, its interpretation, collected on goniometer for Range of motion of hip joint. Pre and post score of hip range of motion of 30 subjects measured with goniometer was interpreted with the techniques of inferential statistics. Parametric tests are used to interpret the data of different subject design, because if we are comparing responses to two different kinds of treatment and there is difference in responsiveness, then parametric tests serve as a more sensitive tool of statistical analysis than non- parametric tests.

Inter Group and Intra group T- test was used

Inter Group

Mean (M) = $\sum f_{x/} n$
Standard Deviation (S.D.) = $\sqrt{\sum x_1^2 + \sum x_2^2 / (n_1 - 1) + (n_2 - 1)}$
Standard Error of Mean Difference (SE_{MD}) = S.D.$\sqrt{\ n_1 + n_2 / n_1 \times n_2}$
Obtained value (T) = $M_1 - M_2 - 0 / SE_{MD}$

Intra Group

x = D – M
Standard Deviation of difference (SD_D) = $\sqrt{\sum x^2 / n-1}$
Standard Error of Mean Difference (SE_{MD}) = $SD_D / \sqrt{n}$
Obtained value (T) = M_D / SE_{MD}

RESULTS OF STUDY

GROUP A SUBJECTS- Showed a gain in Range of Motion.
GROUP B SUBJECTS- Also showed the increase in Range of Motion. The study showed a non – significant level of .4597 between Group A and Group B, -1.527 between Group A_1 and B_1 (Pre), 4.710 between Group A_1 and A_2 (significant) and 7.45 between Group B_1 and B_2 (significant). So, the study supports the null hypothesis that "Active stretching of hip flexors has no additional effect on ROM as compared to passive stretching alone."

DISCUSSION

The Subjects, who received either of the stretching with tight hip flexors, improved their hip extension range of motion over a 6- week period. The results show statistically non – significant relationship between Group A (Active Stretching) and Group B (Passive Stretching). Both stretching showed significant relationship among their respective group, in increasing hip extension Range of Motion. The change seen in the study was due to stretching program (in my view).

The reliability of the instruments used, considered to be acceptable. It was also verified that stretches learnt and done by them are correct or not. The reasons for such results could be because of the following. After passive stretching, there is usually increase in range of motion of the respective joint. With autogenic inhibition, muscles being stretched is inhibited and is thought to simultaneously relax, however, that muscle relaxation is due to stress applied not due to autogenic inhibition, which is responsible for any improvement observed with passive stretching. Active stretching also places a tensile stress on the muscle being stretched, but in addition, is thought to be achieved through relaxation via reciprocal inhibition.[2] But tensile stress is common to both type of stretching and is probably the primary factor for increasing muscle flexibility, this explained that why the active and passive stretching regimens were equally effective in improving range of motion over time.

Overall the result of our study could be of following reasons or limitations.

- Sample size was small
- Could not tell about the increase in strength of antagonist muscles during active stretching.
- Only female subjects were studied
- Less adherence to subjects

As studied on young females with flexor tightness, the results are limited to that only, could not tell the effects on older population with primary hip disorders and samples with muscle tightness other than hip flexors tightness, who may or may not respond in the same way. Lower back pain due to tight hip flexors, by causing the pelvis to tilt forward[1], both active and passive stretching have proved to be significant in reducing pain by reducing pelvic tilt(Winter *et al*., 2005). There might be an important reason also for this result, as I have taken only female subjects who respond to stretch comparatively less than males because the ratio of adipose tissue is more in females than in males. Adipose tissue as it is inelastic in nature, can't respond to stretching and due to hormonal differences also, males may show different results. As the result here, proved that both active and passive stretching are equally effective methods in increasing hip range of motion. Active stretching may improve the function of antagonist muscles, but we don't have data regarding the strength. So further work is required that overall which is better, active or passive.

Future Research

The study has to be carried out on a large number of subjects to confirm the findings. Time duration for the study must be longer, because response can be duration based and different subjects have different short term and long term effects. Assessment of subjects must be done at the end of every week because there can be good results at short term than long term.
As we cannot forget about the theory of reciprocal inhibition, so to study the effect of active stretching on the strength of antagonists, whether the strength increases or not. Study should be carried out on both male and female subjects because the response can be different in both subjects.
A control group should also be taken.

Implication of the Study

The study was performed on subjects who had tight hip flexors.

This might have clinical relevance in treating patients with tight hip flexors due to immobilization or inactivity, ultimately helps in treating low back patients. So stretching can be a valuable tool that can be used effectively in these types of patients or subjects.

Conclusion

This study proposes and provides the evidence that active and passive stretching of hip flexors; both are equally good and effective in increasing hip extension range of motion. The technique is simple, beneficial and allows active patience on the part of physiotherapist and patient. Further work is necessary to determine if the two methods are equally effective for improving flexibility of other muscle groups or if active stretching improves the function of the antagonist muscles more than does use of a passive stretching protocol.

REFERENCES

Bandy, WD. and Irion, JM. 2004. The effect of time on static stretch on the flexibility of hamstring muscles: *Phy Ther*., sep.; 74 (9) 72035- 001

Bandy, WD., Irion, JM. and Baigller, M. 1997. Effect of Static Stretching & Dynamic range of motion training on the flexibility of the hamstring muscles. *Phys.Ther*., 77

Bandy, WD., Irion, JM. and Briggler, M. 2017. The effect of time & frequency of static stretching on flexibility of the hamstring muscles. *Phys.Ther*., Mar; 78 (3): 321 – 2

Bradford D. Appleton, 1993. Physiology of Flexibility: increase your ROM.

Bradford D. Appleton, 1993. version: 118, last modified 94/ 10/ 12.

Cipriani, D., Abl, B. and Pirr Witz, 2003. A comparison of two stretching protocols on hip range of motion: Implication for total daily stretch duration. *J strength Cond Res.,* may; 17 (2): 274 – 8

Condon, S.M. and Hutton, R.S. 2008, Soleus muscle electromyographic activity and ankle dorsiflexion range of motion during four stretching procedures. *Physical therapy,* 67: 24- 30.

Cynthia, C. and Norkin, D. Joyce White Measurement of Joint Motion: A guide to Goniometry; 2nd Ed.

Cynthia, C., Norkinm, Ed D, PT., Pamela, K., Levangie and DSc, 2001. PT. Joint Structure & Function, A Comprehensive analysis; 3rd ed.

Davis, DS., Ashby, PE., McCale, KL., McQuain, JA. and Wine, JM. 2003. The effectiveness of three stretching and hamstring flexibility, using consistent stretching parameters.

Feland, JB., Myrer, JW., Schulthies, SS., Fellingham, GW. and Measom, GW. 2004. The effect of duration of stretching of the hamstring muscle group for increasing range of motion in people aged 65 years or older. *J Sports med Phys*., Fitness. Sep 44 (3) 258-61

Forster and Palastanga, 2002. Clayton's Electrotherapy Theory & Practice; 9th ed.

Godges, JJ., McRae, PG. and Englke, Effects of exercise on hip ROM, trunk muscle performance & gait economy

Herzo, W., Leonard, TK., Jousnaa, V. and Mehta, A, 2009. Mysteries of muscle contraction. *Faculty of kinesiology,*

Kendall, FP., Mc Creary, EK. and Provancem, PG. 1993. Tests for length of hip flexor muscles. In: Kendall FP, Mc Creary EK,1 993. Provance PG, Ed's muscles: Testing & Function. 4th ed. Baltimore, Md: Williams & Wilkins; 2768

Margaret Hollis and Phyl Fletcher, 2001. Cook; Practical Exercise Therapy; 4th ed.

Peter Brukner and Karim khan with colleagues; 2007. Clinical Sports Medicine; 3rd ed.,617.1027

Roberts, JM., Wilson, K. Br, 2015. Effect of stretching duration on active & passive range of motion in the lower extremity. *J Sports Med*.,Aug; 33 (4): 259 – 63

Sullivan, MK. Dejulia, JJ. and Worell, TW. 1992. 31, 32, 29, 30; Effect of Pelvic position & stretching method on hamstring muscles flexibility: *Med Sci Sports Exerc*., 24: 1383 -1389 IN 42667.

Vanden Tillan, R. 2011. Will whole body vibration training help in increasing the ROM of hamstrings? *J Athl D*.,

Winter, MV., Blake, CG. and Trost, JS. 2005. Passive versus active stretching of hip flexor muscles in subjects with limited hip extension: a randomized trial. *Phys Ther*., 84: 800-807.

****