Comparison between males and females on the effect of PNF hold relax stretching over rectus femoris flexibility

Rayamajhi S,[1] Khanal D[1], Dhakshinamoorthy P,[2] Raghuveer R,[2]

[1]Department of Physiotherapy, Sardar Bhagwan Singh Post-Graduate Institute of Biomedical Sciences and Research, Dehradun, India. [2]Department of Health and Well being, Sheffield Hallam University, Sheffield, United Kingdom.

ABSTRACT:

The concept of stretching is to increase the range of motion of a joint. Theoretical evidence suggests that the in vivo properties of tendon are different between men and women. There exist gender differences in the viscoelastic properties of a tendon too. This suggests that stretching affects the properties of a muscle and because male and female tendons have different viscoelastic properties, the effect of stretching should also vary accordingly. However, no experimental study has been conducted till date to verify these theoretical constructs. Therefore, the objective of this study was to demonstrate any difference between male and female Rectus Femoris muscle flexibility following application of Proprioceptive Neuromuscular Facilitation hold relax stretching. An experimental comparative study was conducted among 30 students in a physiotherapy college using purposive sampling. Mean values of all the readings of active knee flexion range of motion (AKFROM) at 0, 3rd and 7th day were taken for both the groups. No significant difference was observed between 0 - 3rd and 0 - 7th day but statistically significant results were found between 3rd - 7th day. These findings were more significant among females. It was therefore concluded that the PNF hold-relax stretching has a positive effect on improving Rectus femoris muscle flexibility and this effect is more prominent in females.

Keywords: Flexibility, Stretching, Hold Relax, Proprioceptive Neuromuscular Facilitation (PNF), Active Knee Flexion Range of Motion (AKFROM)

INTRODUCTION

Flexibility of a muscle has been defined as the ability of a muscle to lengthen allowing one or more than one joint in a series to move through a range of motion.[1] Muscle flexibility allows the muscle tissue to accommodate imposed stress better and ensure efficient and effective movement.[1] Colby and Kisner have stated that the Elastin fibers in muscles provide extensibility, and therefore increase flexibility.[2] Also, innumerable studies have concluded that the in vivo properties of tendons are different in men and women and there exist gender differences in the viscoelastic properties of a tendon too. Stretching has been found to work by exerting its effects on the viscoelastic properties of a tendon, whereby it decreases viscosity and increases elasticity which causes lengthening of a muscle.[2-5] These evidences suggest that stretching affects the properties of a muscle and because male and female tendons have different viscoelastic properties, the effect of stretching should also vary accordingly. However, these theories had not been proven till date. Therefore, a need for an experimental study to identify the validity of these theories was deemed important.

MATERIALS AND METHODS

Sample selection was done at the physiotherapy department of SBSPGI (Sardar Bhagwan Singh Post Graduate Institute of Biomedical Sciences and Research) using purposive sampling. Thirty participants were included in the study following proper physiotherapy assessment. Males and females in the study were divided into 2 groups. Each group comprised of 15 participants. Students belonging to the age group of 18-25 years with tightness in their Rectus Femoris muscle were included. Amongst them, students with Iliopsoas muscle tightness, history of any injury in or around the Quadriceps muscle in the past one year, any history of neuromuscular disorder, any significant history of systemic disease in past, recent fracture or dislocation in the lower limb and muscular weakness of the lower limb were excluded.

Each participant was provided with a detailed explanation about the nature of this study, the procedures to be performed and the parameters to be measured. Informed consent was taken prior to the study after confirming their willingness to participate. Confidentiality was maintained at all times whereby, all the information collected during the study were anonymized and protected under lead researcher's supervision. Ethical approval was obtained from the Institutional Ethical Review Board prior to the commencement of the study.

On 0th day, before treatment session began, a complete assessment of hip and knee joint was done and AKFROM was measured using Modified Thomas Test.[6] Participants were instructed to lie on their back with their knees bent over the edge of the examining table. They were

asked to bend the left knee and hold it using their hands against the chest. The principal researcher ensured that the angle of the test knee (right knee was used as the test knee to maintain uniformity) remained at 90 degrees when the opposite knee was flexed to the chest. If it did not, tightness was suspected. The examiner attempted to passively flex the knee to see if it remained at 90 degrees of its own volition. The examiner also palpated for muscle tightness. Three angles were measured for the testing extremity using a hand held plastic goniometer.[6] The stationary arm of the goniometer was placed parallel to the long axis of the femur along a line extending from the greater trochanter to the lateral condyle, and the moveable arm was placed parallel to the long axis of the fibula in line with the head of the fibula and the lateral malleolus.[7] While performing hold relax procedure; the range limiting muscle was first lengthened to the point of d at 90 degrees of its own volition. The examiner also palpated for muscle tightness. Three angle limitation or to the extent that was comfortable for the patient. The patient was then asked to perform isometric contraction (patient contracts the muscle whereas the therapist resists the contraction so that the muscle length remains same but tone increases), followed by voluntary relaxation of the tight muscle. The limb was then passively moved into the new range as the range-limiting muscle was elongated.[2] Both groups were given hold-relax stretching with 6 seconds of isometric contraction. Stretching was given as per the protocol of 6 sessions per week.[8] On 0, 3rd and 7th day, AKFROM was measured using Modified Thomas Test. Paired t-test was applied to compare the improvement in AKFROM within the male and female group. Unpaired t-test was used to compare the improvement in AKFROM at 0 day and to compare the mean improvement values between the groups at 0-3, 3-7, 0-7 day. The significance level was kept at P less than or equal to 0.05.

RESULTS

15 males and 15 females with mean age of 21.1 and 20.6 years respectively participated in this study as displayed in Table 1. AKFROM were recorded at 0, 3rd and 7th day for both the groups as shown in Table 2. Mean values of all the readings of AKFROM at 0,3rd and 7th day were 69.70, 79.66 and 84.26 respectively for males and 54.90, 63.56 and 70.90 respectively for females. Unpaired t test was applied to compare the difference between the groups. Data was analyzed with mean difference of 0-3rd, 3-7th and 0-7th day. Result was non-significant for 0-3rd and 0-7th day but it was statistically significant for 3-7th day as shown in Table 3. Paired t test was applied to compare the difference within the groups. It was non-significant for males whereas, it was statistically significant for females as displayed in Table 4.

Table- 1: Age distribution among the participants (n = 30)

Gender	Number	Mean ± S.D (Years)
Male	15	21.1 ± 1.2
Female	15	20.6 ± 1.1

Table- 2: Comparison of Active Knee Flexion Range of Motion between male and female on 0th day

Gender	Mean ± SD(AKFROM)	P value
Male	69.7 ± 6.1	< 0.05
Female	54.9 ± 7.6	< 0.05

Table-3: Comparison of mean difference values of Active Knee Flexion Range of Motion between male and female (between the groups)

Characteristics	Gender		P value
Duration	Male	Female	
0-3rd day	9. 6± 5.9	8.9 ± 5.8	P > 0.05
3-7th day	4.6 ± 2.3	8.0 ± 4.7	P < 0.05
0-7th day	14.5 ± 7.3	16.0 ± 6.8	P > 0.05

Table-4: Comparison of mean difference values of Active Knee Flexion Range of Motion among male and female (within the group)

Gender	Session	P Value
Male	0 – 3 Day Vs. 3 – 7 Day	P > 0.05
Female	0 – 3 Day vs. 3 – 7 Day	P < 0.05

DISCUSSION

The findings from this study showed significant improvement in AKFROM among females more than in males after the application of PNF hold-relax stretching for a short time period of 7 days. Significant changes in the joint ROM values were seen across both the groups on the final day of assessment in comparison to their baseline mean values.

PNF hold-relax technique has been considered and widely accepted as a form of active stretching technique which works on two main principles.[9,10] The first principle focuses on increased turnover of cytoplasmic calcium within each sarcomere unit following individual stretching session that in turn enhances the extensibility of muscle. The second principle involves generation of passive static tension reducing muscle stiffness therefore increasing its pliability. However, these principles have only been proven in studies in which stretching was applied over a longer duration of 8 weeks or more.[11, 12] Reflecting on the findings of the current study, stretching effects were seen on both 3rd and 7th days which were lesser than the required 8 weeks to produce effects. These changes could be accounted for by neural mechanisms

such as stretch tolerance rather than to permanent mechanical adaptations and are consistent with a recent study by Beltrao which showed significant effect of PNF stretching on flexibility of hamstrings where effects were seen following single session of stretching .[13, 14]

The present study demonstrated significant improvement in AKFROM among females after the 7 days stretching protocol in comparison to males. These findings could be explained in close correlation to the justification provided by Kisner et al. [2] It has been proven that female muscles have a larger proportion of slow twitch fibers (Type I muscle fibers) than males. These slow twitch fibers which are slow oxidative, fast glycolytic and fatigue resistant are known to produce relatively low amount of tension but have a prolonged contraction and relaxation time.[8] It implies that relaxed muscles with relatively lesser amount of tension in females are easily stretched thereby producing significant results following stretching, justifying better effects seen in females in comparison to males in this study.[15]

Stretching also showed a significant effect in males in comparison to their baseline values (0 day versus 7th day) which has been verified by numerous studies looking at the effects of stretching on ROM in males following PNF stretching. [12, 16, 17] However, most of the studies which looked at the effect of stretching on ROM and muscle flexibility have used stretching for a longer duration of time which was not the case in this study. A recent study demonstrated that similar protocol of PNF stretching produced significant improvement in ankle dorsiflexion ROM which was attributed to an increased angle of pennation following 6 weeks of PNF stretching on healthy, young male participants.[18] Therefore, another important reason why male participants in this study showed lower improvement in AKFROM in comparison to females could be due to the lesser duration of stretching given as male muscles are more bulky and require greater energy and longer time period for transformation.[15] On the contrary, this greater energy generated could cause earlier relaxation allowing the stretching force to lengthen the relaxed muscle even better and this could be the reason for the improvement in AKFROM in males on the final day of assessment in comparison to baseline although lesser than in comparison to females.[19]

Thus, this study reported that hold relax stretching of Rectus Femoris muscle among male and female had an effect on Rectus Femoris flexibility as shown by the improvement in AKFROM. It was also observed that improvement was more in female which verified that PNF hold relax stretching produced better result in improving range of motion in female population. Also, these study findings supported the fact that there is a positive effect of stretching in reducing the muscle tightness which varied between male and female with a better effect seen in females. It was mainly due to the variation in the physiological properties of muscle fibers.[2-5].Hence; stretching protocol with longer duration can be used for treating male population whereas similar stretching protocol with lesser duration will be equally effective in females for the treatment of muscle tightness. Therefore, PNF hold relax stretching technique can also be used as the treatment of choice for patients suffering from muscular tightness and will be beneficial in training athletes to gain better performance. This study provided the experimental evidence regarding variation in the effect of stretching among male and female. So the result of our study will be helpful for other studies comparing different treatment techniques among males and females.

Major limitations of this study are in its use of convenience sampling and a small number of participants which could impact on the generalisability of its findings.[20] Comparative method used without a control group can introduce bias in interpretation of results and affect the reliability of findings.[21]However, the researcher performed each measurement 3 times with high intra-rater agreement which helped remove bias to some extent. Follow up was not done at a later date due to time restrictions and this could impact on the interpretation of sustainability of PNF stretching effects. But because the protocol used in this study has been justified in previous literature to show outcomes in a minimum duration of 7 days, documenting post intervention till the 7th day could be rationalized. Hence, there is a need for further studies to be conducted.

ACKNOWLEDGEMENTS

We would like to thank Sardar Bhagwan Singh Postgraduate Institute of Biomedical Sciences and Research (SBSPGI) for the facilitation of this research work. We express our sincere gratitude to Prof. Manish Arora, HOD, Department of Physiotherapy, SBSPGI for encouraging our work. Our heartfelt thanks to the students of SBSPGI for participating in this study. Last but not the least, we would like to thank our teachers and other faculty members of Department of Physiotherapy for their constant support and cooperation.

Conflict of Interest: None

Source of Funding: All costs involved were borne by involved researchers. No external funding was obtained.

REFERENCES

1. Zachezewski E, Scully RM, Barnes MR. Improving flexibility using Physical Therapy. Philadelphia: Lippincott Company; 1989.
2. Kisner C, Colby LA. Therapeutic Exercise. 5th ed. FA Davis Company; 2007.
3. Carroll CC, Dickinson JM, Haus JM et al. Influence of aging

on the in vivo properties of human patellar tendon. Journal of Applied Physiology. 2008; 110(2):1522-1601

4. Onambèl GN, Burgess K, Pearson SJ. Gender-specific in vivo measurement of the structural and mechanical properties of the human patellar tendon. Journal of Orthopaedic Research. 2007; 25:1635–1642.
5. Kubo K, Kanehwasa H, Kawakami Y, Fukunaga T. Influence of static stretching on viscoelastic properties of human tendon structures in vivo. American Physiological Society. 2000.
6. Magee DJ. Orthopaedic Physical Assessment. 5th ed. Elsevier Publication; 2009.
7. Gogia PP, Braatz JH, Rose SJ, Norton BJ. Reliability and Validity of Goniometric Measurements at the knee. Phys Ther. 1987; 67:192-195.
8. Hardy L. Improving hip flexion. Research Quarterly for Exercise and Sport. 1985; 56(2):111-114
9. Puentedura EJ, Huijbregts PA, Celeste S, Edwards D, In A, Landers MR et al. Immediate effects of quantified hamstring stretching: Hold-relax proprioceptive neuromuscular facilitation versus static stretching. Phys Ther Sport.2011; 12: 122-126.
10. Riley DA, Van Dyke J. The effects of active and passive stretching on muscle length. Phys Med Rehabil Clin N Am.2012; 23: 51-57.
11. Halbertsma JP, Van Bolhuis AI, Göeken LN. Sport stretching: effect on passive muscle stiffness of short hamstrings. Arch Phys Med Rehabil.1996; 77: 688-692
12. Halbertsma JPK, Goeken LNH. Stretching exercises: effect on passive extensibility and stiffness in short hamstrings of healthy subjects. Arch Phys Med Rehabil.1994; 75: 976-981
13. Beltrão NB, Ritti-Dias RM, Pitangui ACR, Araújo RCD. Correlation between Acute and Short-Term Changes in Flexibility Using Two Stretching Techniques. Int J Sports Med. 2014; 35(14): 1151-1154
14. Weppler CH, Magnusson SP. Increasing muscle extensibility: a matter of increasing length or modifying sensation? Phys Ther. 2010; 90: 438-449
15. Simoneau JA, Bouchard C. Human variation in skeletal muscle fiber-type proportion and enzyme activities. Am J Physiol. 1989; 257(4.1):E567-72.
16. Lim KI, Nam HC, Jung KS. Effects on hamstring muscle extensibility, muscle activity and balance of different stretching techniques. J Phys Ther Sci. 2014;26(2):209-13
17. Minshull C, Eston R, Bailey A, Rees D, Gleeson N. The differential effects of PNF versus passive stretch conditioning on neuromuscular performance. Eur J Sport Sci. 2014; 14(3):233-41.
18. Konrad AI, Gad M, Tilp M.Effect of PNF stretching training on the properties of human muscle and tendon structures. Scand J Med Sci Sports. 2014
19. Pilates R. Ross Pilates and personal training. Thunder Bay, Ontario, Canada:475-6918
20. Maher CG, Sherrington C, Herbert RD, Moseley A, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Physical therapy. 2003; 83 (8), 713-721.
21. Olejnik S, Algina J. Measures of Effect Size for Comparative Studies: Applications, Interpretations, and Limitations. Contemp Educ Psychol. 2000; 25(3):241-286.