ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 05, Issue 03, pp.3664-3667, March, 2018

RESEARCH ARTICLE

EFFECT OF GASTROSOLEUS STRETCHING ON HEART RATEIN NORMAL INDIVIDUALS WITH GASTROSOLEUS TIGHTNESS

[1]Neha Chikara, [2]Dr. Siddarth Senand *[3]Dr. Parul Raj Agrawal

[1]BPT student Sardar Bhagwan Singh University, Dehradun
[2]Associate Professor at DIPSAR
[3]Associate Professor at Sardar Bhagwan Singh University, Dehradun

ARTICLE INFO

Article History:
Received 17th December, 2017
Received in revised form
22th January, 2018
Accepted 09th February, 2018
Published online 30h March, 2018

Keywords:
Heart rate,
Gastrosoleus muscle tightness,
Muscle length testing

ABSTRACT

Background: The calf muscles pump is the primary mechanism to return blood from the lower limbs to the heart. During exercise, the calf muscles (gastrocnemius and soleus) contract and compress the intramuscular and deep veins. Calf muscles pump efficacy is dependent on the power of the moving ankle joint and flexibility of these muscles. Presence of gastrosoleus tightness may affect, alter the efficiency of this muscle in venous return thereby influencing heart rate. So this study aims to evaluate effect of gastrosoleus stretching on heart rate in normal individuals.
Methods: 70 subjects participated in the study aged between 18-40 years. Heart rate was taken as an outcome measure which was recorded prior to and after calf muscle stretching. Subjects were divided into two groups with experimental group received passive stretching and control group received passive ankle movement.HR was measured with the help of pulse oxymeter. Data was analyzed using SPSS version 16 software. Descriptive statistics was used to summarize the variable. Non parametric test was used to compare groups.
Results: Mean age of participant in group I and II was 22.1±2.7years and 21.6±2.7 years respectively. In group I the mean heart rate of the participants at base line was 76.4±11.07 beats/min. Following stretching of the gastrosoleus, HR changed to 78.6±10.6 (mean ±SD) beats/min showing improvement in HR by 2.2beats/min. In group II the mean heart rate at base line was 76.0±10.9beats/min which was increased to 77.7±10.8beats/min.
Conclusion: The present study concluded that gastrosoleus stretching was effective in improving heart rate in normal individual with tightness of the gastrosoleus. However, it was not statistically significant.

INTRODUCTION

The Gastrosoleus muscles are large powerful muscles of the back of leg. It is also known as the calf muscles. The gastrosoleus muscles play an important role in circulation. Contraction of these muscle help in venous return from the lower limb, the soleus particularly in this respect. The soleus is, therefore called the peripheral heart. These muscles are therefore known as “calf pump” (Chaurasia, 2013). The calf muscle pump is the primary mechanism to return blood from the lower limbs to the heart. During exercise, the calf muscles (gastrocnemius and soleus) contract and compress the intramuscular and deep veins, raising venous pressure and blood in the deep venous system to flow toward the heart. Calf muscle pump efficacy is dependent on two factors. The power of the moving ankle joint and competency of the veins (O'Brien *et al.,* 2012). Veins compress due to the contraction of surrounding muscles and compress as they relax (Chaurasia, 2013) Activity of the calf muscle pump significantly affects venous circulation in the lower extremity. It produces venous blood in both vertical and horizontal direction[3]. Effectiveness of the calf muscle pump may also be related to the range of motion of the ankle joint. Normal functioning of the calf pump depends on normal movement of the ankle joint, particularly ankle dorsiflexion (Dix *et al.,* 2003). Gastrocnemius muscle involve in ankle dorsiflexion with the knee in full extension. Soleus muscle is involved ankle dorsiflexion with the knee flexed to 90 degrees. The power of the moving ankle joint depends on strength and flexibility of muscle around ankle joint. Muscles generate the pumping force via the anatomic relation of the leg and the ankle (Heather *et al.,* 2001). The soleus and the gastrocnemius together eccentrically control dorsiflexion of the ankle. So shortness in the gastrosoleus may further limit dorsiflexion. Stretching of the gastrosoleus muscle increases ankle dorsiflexion range of motion (Radford *et al.,* 2006). In length tension relationship, when the muscle contracts isometrically, tension will be generated which is propropriate to the number of cross bridges between the actin and myosin proteins. The initial sarcomere length is 2.5µm, when the muscle contracts concentrically; actin molecules overlap thus reducing the number of cross bridges between the two proteins and sarcomere length reduces to 1.5µm. During eccentric contraction or when muscle is lengthened during stretching; the number of the cross linkage between the actin and myosin reduces and sarcomere length increase to 3.5µm. When the calf muscle contracts, venous blood is forced against

Corresponding author: **Dr. Parul Raj Agrawal,**
BPT student Sardar Bhagwan Singh University, Dehradun

gravity towards the heart. So Calf muscle pump depends upon the calf muscle contraction (Jain, 2012). The heart responds with increasing cardiac output when there occur increasing venous return known as frank- starling law. When systemic venous return is suddenly increased, right ventricular preload increases leading to an increase in stroke volume and pulmonary blood flow. If there is decrease in venous return to heart then there is equivalent increase in cardiac output to the systemic circulation (Daniel and Eric, 2011). As cardiac output is product of the function of the heart rate and stroke volume, variations in cardiac output can be produced by change in heart rate and stroke volume (Jain, 2012). Contraction of gastrosoleus plays a major role in venous return which is influenced by strength and flexibility of these muscles. Presence of gastrosoleus tightness may affect, alter the efficiency of this muscle in venous return there by influencing heart rate. So purpose of the study was to evaluate effect of gastrosoleus stretching on heart rate in normal individuals with gastrosoleus tightness.

METERIALS AND METHODS

It was an experimental study done on 70 subjects selected through purposive sampling. Sample size was calculated by estimation of mean formula. Prior to starting of the study, ethical approval was taken. Subjects aged between 18-40 years who presented with gastrosoleus tightness without any history of cardiac conditions and pathology which may alter heart rate was included in the study. Fracture of the tibia and fibula, varicose vein, any medical condition contraindicating the stretching of the gastrosoleus muscles and un-cooperative subjects were excluded from the study. Before taking any measurement subject were asked to lie down to relax following which muscle length testing was done. Resting heart rate was recorded using pulse oxymeter. Subjects were assigned to two groups using random allocation. Group I received passive stretching to shortened gastrocnemius and soleus. Group II received only passive movement to shortened gastrocnemius and soleus. Heart rate was measured following stretching of gastrosoleus in group I (within 30sec of stretching and 3rd minute) and following passive movement of gastrosoleus in group II. Muscle length testing was done using Goniometer.[9] Heart rate was used as outcome measure which was recorded from through pulse oxymeter (Iyriboz *et al.,* 1991).

RESULTS

Mean age of participant in group I was 22.1±2.7years. Mean age of participant in group II was 21.6±2.7years. The gender distribution in group I was 74.3% female and 25.7% male. Gender distribution in group II was 85.7% female and 14.3 % male (table 1). The mean right and left ankle dorsiflexion range (knee extension) in group I was 10.1±2.0 and 10.4±1.7 respectively. The mean right and left ankle dorsiflexion range with knee extension in group II was 10.1±1.9 and 10.2±1.8 respectively (Table 2).The mean right ankle dorsiflexion range (knee flexion) in group I was 19.6±2.2 and left ankle dorsiflexion range was 19.8±2.2. The mean right and left ankle dorsiflexion range (knee flexion) in group II was 20±2.1 and 20±2.3 (table2). In group I the mean heart rate of the participants at base line was 76.4±11.07 beats/min. Following stretching of the calf the mean heart rate changed to78.6±10.6 beats/min at 1st minute of recording. And at 3rd min the mean heart rate further changed to 77.3±10.7 beats/min (mean ±SD). This change in heart rate from base line to 1 min and 3rd min

Table1. Showing demographic characteristic of the participants

Demographic variables		Group I	Group II
Age in years (mean±SD)		22.1±2.7	21.6±2.7
Gender %	female	74.3	85.7
%	male	25.7	14.3

Table 2. Gastroncemius and soleus muscle length as measured through ankle dorsiflexion range of motion

Range of motion		Group I(Mean ± SD)	Group II (Mean ± SD)
AnkleDF	Right	10.1±2.0	10.1±1.9
(knee extension)	Left	10.4±1.7	10.2±1.8
Ankle DF	Right	19.6±2.2	20.0±2.1
(knee flexion)	Left	19.8±2.2	20.0±2.3

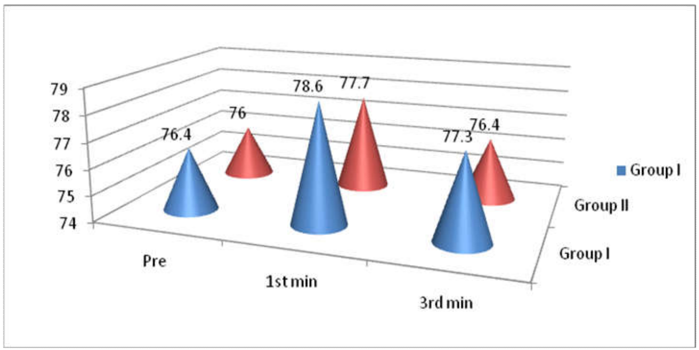
was highly significant statistically (p≤0.01). (table3) In group II the mean heart rate of the participants at the base line was 76.0±10.9beats/min. Following passive ankle movement of the ankle joint the mean HR changed to 77.7±10.8 beats/min at 1st minute of recording. And at 3rd min the mean HR further change to 76.4±10.8beats/min. (mean±SD). The observed changed in HR over a period in group II was highly significant statistically with p value less than 0.01. (table3) As seen in table3 there was no significant difference in the base line value of heart rate between the groups (p value 0.8). Also changed in heart rate at 1st min and 3rd min was not statistically significant between the groups (p value 0.7 and 0.6 respectively).

DISCUSSION

The present study was conducted to see the effect of gastrosoleus stretching on HR. Total 70 subjects with gastrosoleus tightness participated in the study. Subjects were divided into two groups where first group received gastrosoleus stretching and other group was given passive movement of dorsiflexion and plantar flexion at the ankle. The mean age of the participants in both groups was similar (22.1±2.7). However, the number of female participants in group II was greater (85.7%) than group I (74.3%). The mean dorsiflexion range of both ankle with knee extension and knee flexion were similar in both the group suggesting minimal variation among the comparable groups. In a study conducted by Marcio M. Kawano et al, the author reported tightness of the gastrocnemius muscle in healthy subjects. The mean age of the participants was 21.2 years (SD=1.7) with equal number of female and male participants this is similar to our study reporting tightness of gastrocnemius muscle (Marcio *et al.,* 2010). We conducted study on healthy individual with gastrosoleus tightness. This is supported by S. Sharon wang, et al reporting tightness of gastrosoleus muscle in healthy subjects. Tightness was assessed with the help of muscle length testing. Gastrocnemius muscle length was tested by ankle dorsiflexion with the knee in full extension and soleus in the knee flexion position (Sharon *et al.,* 1993). Heart rate of the participants was recorded at baseline, 1st minute and 3rd minute of stretching. The mean heart rate of the participants at base line was similar in both groups (table3). In group I the mean heart rate of the participants at base line was 76.4±11.07 beats/min.

Table 3. Showing change in heart rate pre intervention, at 1st minute and 3rd minute within the groups and between the groups.

Heart rate	Group 1 mean±SD	P value with in group	Group 2 mean±SD	P value within group	Pvalue between group
Pre HR	76.4±11.07	<0.01	76.0±10.9	<0.01	0.8
1stminuteHR	78.6±10.6		77.7±10.8		0.7
3rd min HR	77.3±10.7		76.4±10.8		0.6



Graph 1. Showing change in heart rate pre intervention, at 1st minute and 3rd minute between the groups

Following stretching of the gastrosoleus, heart rate changed to 78.6±10.6 (mean±SD) beats/min showing improvement in heart rate by 2.2beats/min. In length tension relationship, when the muscle contracts isometrically, tension will be generated which is proportionate to the number of cross bridges between the actin and myosin molecules. The initial sarcomere length is 2.5µm, when the muscle contracts concentrically; actin molecules overlap thus reducing the number of cross bridges between the two proteins and sarcomere length reduces to 1.5µm. During eccentric contraction or when muscle is lengthened during stretching; the number of the cross linkage between the actin and myosin reduces and sarcomere length increase to 3.5µm (Jain, 2012; Richard and Jan Fride, 200). This increament in the sarcomere length causes lengthening in calf muscle length and thus muscle flexibility and efficacy of the contraction is improved. When the calf muscle contracts and pumps the blood, venous blood is increased and forced against gravity towards the heart. This increase in venous flow increases the cardiac output, resulting in an increased heart rate. We observed reduction in heart rate by 1.3beats/min at 3rd min of recording. This change in heart rate from base line till 3rd min was found to be statistically significant (p<0.01).

The slight reduction in the heart rate by 3rd minute might have been due to a limited time of stretching session and also due to reduction in the muscle flexibility which could have reduced the contraction and thus the venous return. A sustained stretch of more than 30 sec might yield better and permanent results. This was similar to the study conducted by O'Brien JA, Edwards HE et al, who reported that the efficiency of the calf muscle pump is dependent upon ankle joint mobility and the competency of the veins. The calf muscle pump is the primary mechanism to return blood from the lower limbs to the heart. During exercise, the calf muscles contract and compress the muscles and deep veins, increase venous pressure and blood in the deep venous system to flow towards the heart. When the gastrocnemius and soleus muscles contract, they expel more than 60% of venous blood into the large popliteal vein. Therefore, the moving ankle joint and the competency of the veins work together, helping the calf muscles to pump venous blood back up to the heart. This is supported by Heather L. Orsted, RN, et al reporting that factors that decrease the range of motion of ankle joint would affect the calf muscle pump (Heather *et al.,* 2001). Calf muscle pump performance is directly related to the calf muscle contraction, i.e. how stronger the contraction takes place and appropriate length of muscle to generate contraction. Thus improvement in length of calf muscle cause due to stretching in our study would have influence the heart rate (O'Brien *et al.,* 2012). In group II the mean heart rate at base line was 76.0±10.9 beats/min which was increased to 77.7±10.8beats/min immediately after passive movement (dorsiflexion and plantar flexion) of the ankle and then reduced to 76.4±10.8beats/min at 3rdmin. This change in heart rate from base line to 3rd min was also found to be statistically significant (p<0.01). The passive movement also leads to mild stretching of gastrosoleus which would have influence the muscle flexibility and efficacy of the contraction is improved. However the increase in heart rate is laser as compare to experimental group.

In addition to above finding when we compared the mean change in heart rate from base line to 1st min between the groups we did not find statistically significant difference (p value 0.7). Also at 3rd min we did not find any significant change in heart rate between the groups (p value 0.6). Our study had few limitations such as smaller sample size, absence of adjuncts which can be given prior to stretching of the muscle to get more effective result and short stretching duration which can be increased to yield better result. Future scope of the study was after giving a prolonged stretch of more than 30 sec, heart rate could be measured at 5th minutes and 10th minutes to check sustained effects of affecting length, In the study, percentage of the female participants were more than male participants and since the muscle tightness is more in males so a larger male population should be targeted in future studies to see the accurate effect change in muscle length.

Conclusion

The present study concluded that gastrosoleus stretching was effective in improving heart rate among normal individuals, with gastrosoleus tightness. However, statistically it is not significant.

REFERENCES

Cestmir Recek, 2013. Calf Pump Activity Influencing Venous Hemodynamics in the Lower Extremity. *International Journal of Angiology*; Volume 22 No (1): 23–30.

Chaurasia̓s. BD, 2013 .Human anatomy. Sixth edition. CBS publishers and distribution; volume 2:123-125.

Daniel A. Beard and Eric O. Feigl, 2011. Understanding Guyton's venous return curves. *America Journal Physiology Heart Circulation Physiology*; Sep 301(3):629–633.

Dix, F. P., Brooke, R. and McCollum, C. N. 2003. Venous Disease is Associated with an Impaired Range of Ankle movement. *Europium Journal Vascular Endovascular Surgery*; volume 25: 556-561.

Heather, L. Orsted, Lori Radke, and Richelle Gorst. 2001. The Impact of Musculoskeletal Changes on the Dynamics of the Calf Muscle Pump. *Ostmy Wound Management*; volume 47(10):18–24.

Iyriboz, Y., Powers, S., Morrow, J., Ayers, D. and Landry, G. 1991. Accuracy of pulse oxymeters in estimating heart rate at rest and during exercise. *Br J Sp Med*., 25(3):162-164.

Jain, A.K. 2012. Text book of physiology. 5edition. Avichal publishing company; volume 1: 170-171.

M. Paul Clapper. 1987. Comparison of the reliability of the orthoranger and the standard goniometer for assessing active lower extremity range of motion. *Physical Therapy*, Volume 68(2): 214-218.

Marcio M., Kawano, Gabriel Ambar, Beatriz I. R. Oliveira, Marcela C. Boer, Ana P. R. *et al.* 2010. The sit- and-reach test assessed by angular kinematic analysis. *Rev Bras fisioter*,volume 14(1):10-15.

Nancy Berryman and Willium D. Bandy. 2002. Joint range of motion and muscle length testing. W.B. Saunders Company; 360-363.

O'Brien, JA., Edwards, HE., Finlayson, KJ. and Kerr, G. June 2012. Understanding the relationships between the calf muscle pump, ankle range of motion and healing for adults with venous leg ulcers: a review of the literature. *Wound Practice and Research*; Volume 20 Number 2: 80-85.

Radford, J A., Burns, J., Buchbinder, R., Landorf, K. B. Cook, C. 2006. Does stretching increase ankle dorsiflexion range of motion? A systematic review. *Br J Sports Med*., volume40: 870–875.

Richard L. Gajdosik and Richard W. Bohannon, 1987. Clinical Measurement of Range of Motion Review of Goniometry Emphasizing Reliability and Validity. *Physical therapy*,Volume 67, Number 12: 1867-1872.

Richard, L.and Jan Fride´N. 2000. Functional and clinical significance of skeletal muscle architecture. *Inc. Muscle Nerve,* 23**:** 1647–166.

Sharon, S., Wang, Susan. Whitney, Ray G. Burdett, lanine *E.* Anosky. 1993. Lower Extremity Muscular Flexibility in Long Distance Runners. *Journal of Orthopaedic and Sports Physical Therapy***,** Volume 17 (2):102-107.

****