Immediate changes in pressure pain threshold in the Iliotibial band using a myofascial (foam) roller

Immediate changes in pressure pain threshold in the iliotibial band after using a myofascial (foam) roller.

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Section: Research

ABSTRACT

Context

Foam rolling is used as a self-release myofascial technique that can be applied to a variety of tissues. Previous studies have demonstrated physiological changes in range of motion and arterial stiffness with the application of a foam roller. However no studies have investigated the change in pain levels using a semi-objective measure.

Objective

The present study investigated the application of a foam roller for three minutes to the right iliotibial band (ITB) of asymptomatic participants.

Design

Repeated measures design.

Setting

University teaching clinic.

Participants

Eighteen asymptomatic participants.

Interventions

Participants completed questionnaire and their height and mass measured. Three points on the ITB were marked. The pressure pain threshold was measured at each point using a pressure algometer. Measurements were undertaken pre-intervention, post-intervention and 5 minutes post-intervention. The participant completed a single 3-minute bout on the foam roller.

Main outcome measures

Pressure pain threshold.

Results

Results demonstrated a statistically significant increase ($p<0.05$) in the PPT at the lower thigh immediately post-bout however the difference was ameliorated five minutes later.

Conclusions

Foam rolling the ITB produces an immediate increase in the PPT in asymptomatic participants at the lower part of the ITB. Further research is required to develop an evidence base for the use of foam rollers in clinical practice. In the future, research should investigate the application of foam rollers to different tissues, for different lengths of time and over a period of time.

KEYWORDS

myofascial release; foam rolling; iliotibial band; pressure algometry

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ABSTRACT

Background

Foam rolling is used as a self-release myofascial technique that can be applied to a variety of tissues. Previous studies have demonstrated physiological changes in range of motion and arterial stiffness with the application of a foam roller, however no studies have investigated the change in pain levels. The present study investigated the effect on the pressure pain threshold (PPT) following the application of a foam roller for three minutes to the right iliotibial band (ITB) of asymptomatic participants.

Methods

Participants completed a questionnaire and had their height and mass measured. Three points on the ITB of the right leg were marked. The PPT was measured at each point using a pressure algometer. Measurements were taken pre-intervention, post-intervention and 5 minutes post-intervention. The participant completed a single 3-minute bout on the foam roller.

Findings

Results demonstrated a statistically significant increase ($p<0.05$) in the PPT at the lower thigh immediately post-treatment, however, the difference was ameliorated five minutes later.

Conclusions

Foam rolling the ITB produces an immediate increase in the PPT of the lower thigh in asymptomatic participants.

Key words: myofascial release; foam rolling; iliotibial band; pressure algometry

INTRODUCTION

Iliotibial band syndrome (ITBS) often presents with pain over the lateral aspect of the lower thigh and knee. Statistics indicate that ITBS effects between 5 and 14% of runners (van der Worp et al, 2012) and has been reported to effect other athletic populations including cyclists (Holmes et al, 1993) and competitive rowers (Rumball et al, 2005). Treatment for this complaint is varied and the literature inconsistent with regard to the most effective treatment strategies (Falvey et al, 2010; van der Worp et al, 2012). There is agreement however, that the conservative management in the acute phase of ITBS should be directed towards pain reduction (Lavine 2010; Baker et al, 2011). Current research suggests that a combination of advice on running gait, hip muscle strengthening, anti-inflammatory medications, in addition to addressing the flexibility of the iliotibial band (ITB), can assist in alleviating the pain associated with ITBS (Baker et al, 2011; van der Worp et al, 2012).

A possible method by which the flexibility of the ITB can be improved is through the use of a myofascial foam roller (Strauss et al, 2011). Myofascial foam rollers are widely used in sport and rehabilitation settings to achieve changes in muscle tone, restore tissue extensibility (Curran et al, 2008; MacDonald et al, 2013), and increase range of motion (MacDonald et al, 2013). The effect of foam rolling has been proposed to be similar to that of other myofascial release techniques in that it has an autonomic effect on the soft tissue (Schleip 2003) and potentially creates mechanical or histological changes in the myofascial structures (Sefton 2004).

Previous work on the use of foam rollers applied to a variety of tissues has demonstrated foam rolling reduces arterial stiffness and improves vascular endothelial function (Okamoto et al, 2013), and produces conflicting results for improvements in range of motion (Miller and Rockey 2006; MacDonald et al, 2013; Sullivan et al, 2013). Healey et al. (2014) also used short 30-second bouts on multiple muscle groups and demonstrated no gain in vertical jump height and power, isometric force production, and agility. The equivocal results of these studies suggest that investigation of the physiological effect of the application of a foam roller, beyond increasing ROM, is warranted.

The construction of the foam roller itself requires consideration. Curran et al (2008) investigated the pressure applied to the lateral thigh by two types of foam roller; a cylindrical polystyrene foam; and a roller consisting of a hollow polyvinyl chloride core with a neoprene outer layer. Data suggest that the hollow roller exerted a higher pressure and lower contact area when compared to the polystyrene roller and may be appropriate to address deeper myofascial structures. It is these deeper myofascial structures that may play a neurophysiologic role in increases in the PPT (Mense 2000).

Foam rollers are used as part of the rehabilitation of a number of musculoskeletal complaints, where one of the commonly desired outcomes is a reduction in pain. An objective method for assessing changes in pain level is pressure algometry (Ylinen 2007). Pressure algometry allows the determination of the pressure pain threshold; the minimum amount of pressure which induces pain or tenderness (Fisher 1987; Nussbaum and Downes 1998). Pressure algometry is a repeatable tool for the quantification of pain and tenderness in a variety of tissues (Reeves et al, 1986; Fisher 1987; Vanderweeen et al, 1996; Frank et al, 2013). At a neurophysiological level, the PPT "…reflects noiceptive sensitivity in superficial and deep tissues" (Rollman and Lautenbacher 2001) and is one of the most sensitive tests for investigating the mechanisms of musculoskeletal pain (Rollman and Lautenbacher 2001). At present, no studies have investigated the changes in pain level with the use of a foam roller. The aim of the present study is to investigate the immediate effect on the PPT of the application of a foam roller to the ITB.

METHOD

The study was approved by the Victoria University (VU) Human Research Ethics Committee.

Participants

Potential participants were recruited from the student population of the VU osteopathy program. Exclusion criteria were a history of manual therapy to the lower extremity in the past week, current low back, right hip or right knee pain, popping/clicking/locking of the right knee, currently taking pain-relieving or anti-inflammatory medications or their right lower extremity being operated on in the last 12 months. Participants were also excluded if they currently had, or previously had a bleeding disorder, fibromyalgia, chronic fatigue syndrome or myofascial pain syndrome.

Equipment

Foam roller

A Comffit Pilates foam roller with medium density foam (90cm length, 15cm diameter) was used (available www.sportstek.net).

Pressure algometer

A hand-held electronic pressure algometer (Somedic Algometer Type II, Sweden) was used to measure the PPT. This device has been previously used by the authors investigating device validity and the repeatability of PPT measures with 95% confidence intervals ranging from 0.968 to 0.988 (Vaughan et al, 2007) and 0.676 to 0.958 (Frank et al, 2013). The author (BV) has used the device in a previous study (Vaughan et al, 2007) and conducted two practice sessions with willing participants prior to this study.

Procedure

Participants were asked to complete a questionnaire detailing their age, gender and dominant leg. Height and mass measurements were taken using electronic scales and a stadiometer. Body mass index (BMI) was subsequently calculated. Each participant was asked to wear running shorts (or similar) to allow access to the lateral thigh. With the participant lying supine, the other author (PMc) measured and marked three points on the right lateral thigh: 10cm below the greater trochanter, 10cm above the lateral femoral epicondyle, and a point half way between these two marks. At each point, the circumference of the thigh was measured using a flexible measuring tape.

The pressure algometer was applied by the same investigator (BV) three times at each of the three marked points. Each application of the pressure algometer was stopped when the participant perceived a change in sensation from pressure to pain at the measurement point. The participant pressed a hand-held button to stop the reading and the maximum pressure reading (kPa) on the device was recorded on the screen which could not be seen by the researcher. Measurements were recorded by a research assistant. Participants then undertook a three minute session on the foam roller, slowly moving on the roller from the greater trochanter to lateral knee under the guidance of another research assistant (Figure 1). The PPT measurements were then taken immediately after the foam rolling session and after a 5-minute rest period. During the rest period the participant was required to sit still.

INSERT Figure 1 here

Data analysis

All data from the pre-study questionnaire and PPT recording sheets were entered into SPSS Version 21 (IBM Corp, USA) for analysis. The mean PPT for each location at each time point was calculated with the first measurement removed. Previous research has shown that more than one measurement produces a reliable estimate of the PPT (Ohrbach and Gale 1989), particularly if the first measurement is removed (Nussbaum and Downes 1998; Persson et al, 2004). Three mixed plot ANOVAs were used (one for each location) to investigate any differences in the PPT between males and females across time (3) with alpha set at $p<0.05$. Circumference data were correlated to PPT measures using Pearson's *r* and also compared across gender. Pearson's *r* was interpreted according to Hopkins (2000): <0.10 (trivial); 0.10-0.30 (small); 0.30-0.50 (moderate); 0.50-0.70 (large); 0.70-0.90 (very large); 0.90-1.0 (perfect).

FINDINGS

Eighteen participants (n=10 males) were recruited for the study with a mean age of 26.1±6.7 years, mean mass of 68.9±12.9kg and mean BMI of 22.9±3.2. Females recorded significantly smaller leg circumferences at the mid-thigh (female 49±3cm vs male 53±3cm; p=0.01) and lower thigh (female 39±3cm vs male 43±4cm; p=0.046) but there was no significant difference between gender for upper thigh circumference (female 55±4cm vs male 59±4cm; p=0.11).

There were no significant differences in PPT between each time point for the upper ($F_{(2, 32)} = 0.6$, $p = 0.57$, $1-b = 0.14$) and mid-thigh ($F_{(1.63, 26)} = 0.94$, $p = 0.4$, $1-b = 0.18$). A significant difference in PPT for the lower thigh was demonstrated ($F_{(1.54, 24.6)}=3.72$, $p = 0.049$, $1-b =0.56$) with the difference existing between the initial PPT measure and the PPT taken immediately after use of the foam roller (Table 1).

INSERT Table 1 here

Of interest, there was a significant difference between males and females within the sample for the PPT at the mid-thigh with the males recording a significantly higher value immediately after use of the foam roller (p=0.03). Mid-thigh circumference was significantly correlated to the post treatment PPT measures across the sample (immediately post r=0.55, p=0.019; 5 minutes post r=0.56; p=0.015) but not to pre-treatment PPT values (r=0.33, p=0.18). There were no other significant relationships between thigh circumference and PPT measures.

The PPT of the males was generally higher at all locations than the females and there is a trend towards an immediate, but non lasting, effect of the foam roller on PPT (Figure 2). The larger (by circumference) thighs of the males respond better to 3 minutes of foam rolling than the smaller thighs of the females.

INSERT Figure 2 here

CONCLUSIONS

This study investigated the immediate changes in PPT following a short bout of foam rolling. The results suggest that there is an immediate significant increase in the PPT post-foam rolling for the lower thigh however this increase is not present 5 minutes later. Whilst this increase in PPT was demonstrated for the upper and mid-thigh measurements, there were no significant differences across time for these locations. A possible mechanism to account for this immediate increase in PPT is proposed in the work of Mense (2000) who suggest that the descending antinoiceptive systems are more responsive to inputs from muscle noiceptors than from skin noiceptors. It is possible that the foam roller is stimulating both the skin and muscle noiceptors, and activating the descending antinoiceptive systems to produce an increase in the PPT.

Although Strauss et al (2011) have recommended the use of a foam roller to break up ‘adhesions’ in the ITB as part of the management of ITB syndrome, they provide no guidance on the length of time it should be used for. The 3-minute bout in the present study is longer compared to previous studies (MacDonald et al, 2013; Sullivan et al, 2013) and more reflective of how a patient would use a foam roller in their home or in a rehabilitation setting. Whether this length of time is optimal for increasing the PPT in the ITB requires further investigation.

Further research should be directed towards the potential for a cumulative effect of foam rolling over time. Most patients will not use the foam roller as a once-off, instead using it daily or as part of a warm-up/down routine. It may be that using the foam roller on the same tissue daily, or multiple times in a day, produces a longer lasting effect, providing the change in sensation in the tissue that patient’s anecdotally report. Such a result is plausible given MacDonald et al. (2014)

demonstrated a subjective decrease in muscle soreness over a 48-hour period. Participants in this study completed single 60-second bouts rolling the thigh bilaterally (10 minutes overall) following a 10 x 10 back squat program. Healey et al (2014) have also presented an alternative hypothesis for the subjective benefit of foam rolling. These authors suggest the decrease in perceived muscle fatigue with foam rolling may be psychological. These authors demonstrated that when compared to a plank exercise, athletes who used a foam roller as part of their warm up perceived less muscle fatigue even though there was no difference in athletic performance between the groups. This between group difference in perception could influence the PPT. Further research with a control intervention is required in order to investigate this effect.

The amount of time spent foam rolling a tissue also requires investigation. In the present study, participants completed a 3-minute bout on the foam roller. This may have been too much time for some participants, and not enough for others, to achieve changes in tissue sensitivity. It may also be that a fixed length of time is not relevant. The time spent on the foam roller could be directed by the patient's own response, that is, once they cease feeling pain in the tissue being rolled it is time to stop. Change in pain level experienced by the patient could indicate a change in the underlying tissue, therefore further use of the foam roller may have no additional benefit. This assertion requires further investigation. A moderate positive relationship was identified between thigh circumference and the post-intervention PPT measures. We can speculate that this may be due to the presence of a more muscular thigh, with minimal superficial fat, meaning that the foam roller is effectively stimulating the muscle noiceptors and activating the descending antinoiceptive mechanisms (Mense 2000). Whether the soft tissue composition of the thigh, and an associated increase or decrease in thigh circumference, plays a role in the outcome of foam rolling the ITB should be studied further.

Gender differences were also demonstrated in the present study. The results presented here confirm the findings of both Chesterton et al (2003) and Garcia et al (2007), and are supported by a commentary from Rollman and Lautenbacher (2001). These authors have previously demonstrated that females exhibit lower PPT values compared to males. The female participants in the present study recorded lower PPT values and smaller thigh circumference data. Whilst the males tended to respond better to foam rolling for three minutes, it may be a difference in pain tolerance rather than a change in underlying tissue that creates this effect. This assertion is supported by research suggesting women have a greater sensitivity to pain, particularly when pressure pain is the applied stimulus (Riley III et al, 1998). Further research using pressure algometry may need to be conducted on a gender specific basis, with control and experimental groups of matched participants of the same sex. Based on the findings of this study, it is difficult to discern how a clinician would advise a female patient compared to a male patient on the length of time to use a foam roller.

The limited sample size may have impacted on the ability to detect changes at the three time points and future research should include greater participant numbers. Data output suggests that the study was underpowered and correlation values were small to medium. All of the participants were symptom-free and the results may be different in symptomatic populations. Foam rolling is also used on other muscle groups and further research should ascertain whether the PPT also changes at other sites.

This is the first study to investigate the changes in PPT following a bout of foam rolling. Measurement of the PPT allows the practitioner to ‘objectively’ measure changes post-intervention.

Given that decreasing the sensation of pain in a tissue is a goal of foam rolling, pressure algometry provides an avenue to investigate the changes. This study also replicated more closely how foam rolling would be applied to the ITB in clinical practice. An immediate increase in the PPT was demonstrated post-bout however this difference was ameliorated 5 minutes later. Future research should investigate PPT changes in other tissues along with investigating the cumulative effect of foam rolling over time.

KEY POINTS

- Foam rollers are widely used in physical and manual therapy but there is little literature on their effectiveness, particularly in relation to pain reduction
- Previous research on foam rollers has demonstrated small improvements in range of motion post-foam roller application
- Pressure pain threshold increases immediately post-foam roller application but the change is not maintained
- Differences in the effect of foam roller use were observed for gender however further research is required
- Further research into repeated applications of a foam roller is required, at varying time intervals as well as with symptomatic participants

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CONTRIBUTORSHIP

Both authors conceived the study. PMcL undertook the data analysis. Both authors undertook the literature review and development of the manuscript. Both authors approved the final version of the manuscript.

FUNDING

The authors received no funding to conduct the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest in relation to this manuscript.

Figure 1. Foam rolling the iliotibial band.

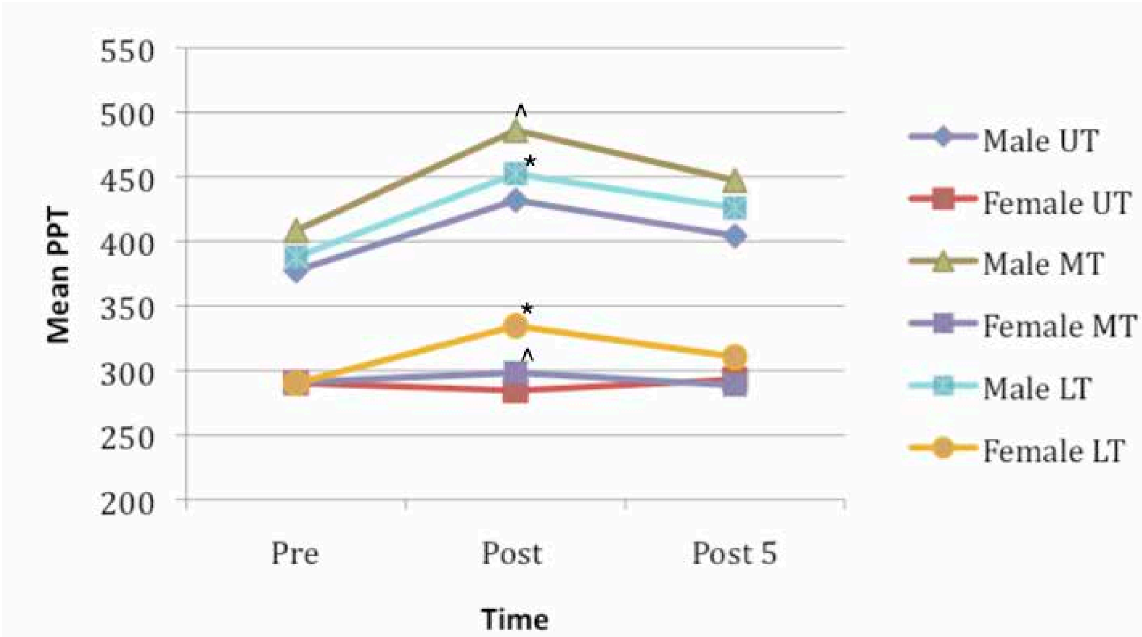

Figure 2. Mean PPT over time for males and females.

* significant difference between pre- and post-measurements for both genders (p=0.04)
^ significant difference between males and females immediately post foam roller use (p=0.04)

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Location of PPT measurement	Pre	Post	Post + 5 mins	RM p	Gender p
Upper thigh (UT)	339±179	366±222	355±210	0.47	0.23
Females	*291±116*	*285±105*	*293±84*		
Males	*377±215*	*432±271*	*404±267*		
Mid-thigh (MT)	356±166	403±185	377±178	0.32	0.04
Females	*291±146*	*298±87*	*289±92*		
Males	*409±170*	*486±204*	*447±202*		
Lower thigh (LT)	344±154*	400±134*	375±131	0.04	0.08
Females	*290±100*	*335±85*	*311±75*		
Males	*388±179*	*452±147*	*426±147*		

(mean ± standard deviation)
*Significant increase in PPT between pre and post measurements in the lower thigh (p=0.011)

Table 1. PPT measurements over the three time periods.

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Lower thigh (LT)	344±154*	400±134*	375±131	0.04	0.08

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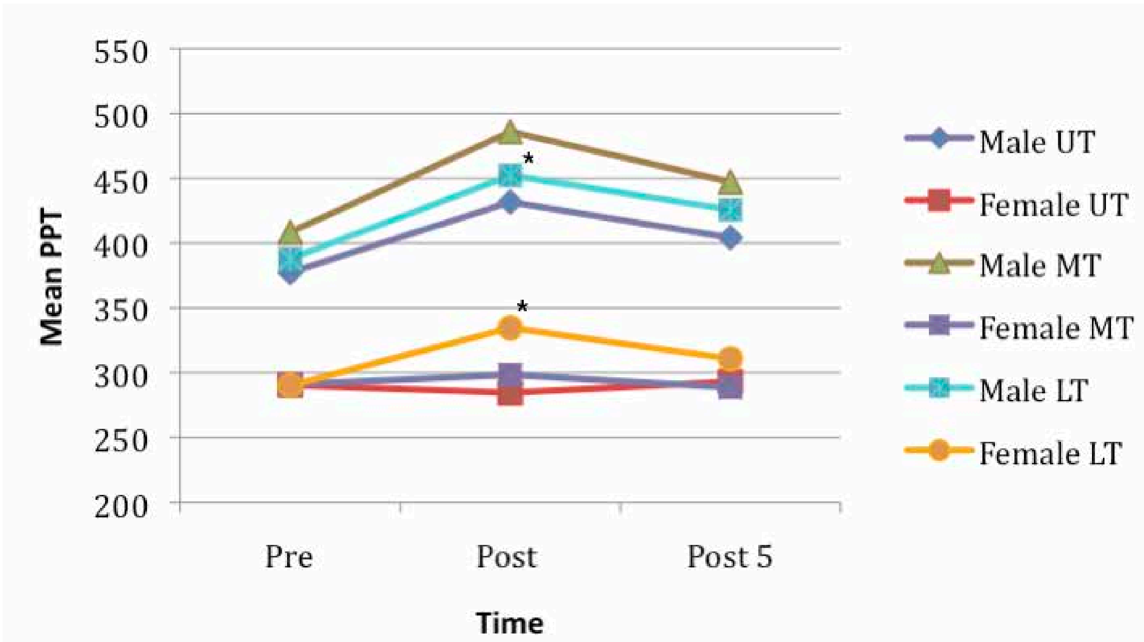
Figure 1. Foam rolling the iliotibial band.

Figure 2. Differences in PPT for males versus females.



* significant difference between pre- and post-measurements for both genders (p=0.04)