EFFECTS OF MASSAGE ON POST-EXERCISE MUSCLE STIFFNESS: PRELIMINARY FINDINGS

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This study examined the effects of massage on post-exercise muscle stiffness. Six well-trained male runners underwent a 40-minute downhill run and had one leg massaged and the contralateral leg receiving a placebo treatment on the rectus femoris (RF) and tibialis anterior (TA). Muscle soreness perception and stiffness were assessed at baseline, post-run, post-treatment, 24, 48, 72, and 96 hours post-run. Muscle stiffness of the RF and TA increased and peaked at 24 hours after the downhill run before a gradual reduction in subsequent days. A more rapid recovery (decrease in stiffness) was observed in the massaged RF compared with the contralateral leg although soreness perceptions were similar between legs for both muscles. Massage might be effective in reducing stiffness of muscles that are larger in size and that experience greater soreness post-exercise.

KEYWORDS: myotonometry, visco-elastic, eccentric exercise, DOMS, soreness

INTRODUCTION: Massage is a common form of treatment practiced to help athletes recover from training- and competition-induced symptoms of muscle soreness and to enhance their subsequent sporting performance (Weerapong, Hume, & Kolt, 2005). The effects of massage on physiological (e.g., improved blood circulation), neurological (e.g., reduced neuromuscular excitability), and psychological (e.g., reduced muscle soreness) outcomes have been well studied (Weerapong et al., 2005); however, the evidence related to its effects on subsequent exercise performance is inconclusive. Furthermore, there is limited information on the mechanical mechanisms of how massage may influence muscle visco-elastic properties. To date, only three studies have investigated changes in properties of human muscles following massage. Muscle stiffness was found to be reduced after a bout of massage in two studies (Eriksson Crommert, Lacourpaille, Heales, Tucker, & Hug, 2015; Ogai, Yamane, Matsumoto, & Kosaka, 2008). Conversely, Thomson, Gupta, Arundell, and Crosbie (2015) found massage ineffective in reducing the stiffness of skeletal muscles. These studies only examined the short-term effects of massage on muscle visco-elastic properties (i.e., stiffness measured 30-minutes post-massage) and none were conducted after muscle damaging eccentric exercise. Given that exercise-induced symptoms of muscle soreness usually last for one to five days post-exercise (Armstrong, 1984), there is a need to adopt longer study durations to better understand the effects of massage on muscle visco-elastic properties.
Previous studies investigating the effects of massage on muscle visco-elastic properties utilised various techniques to measure muscle stiffness, including a durometer (Ogai et al., 2008), ultrasound shear wave elastography (Eriksson Crommert et al., 2015), and a footplate system (Thomson et al., 2015). These measurement methods may not be convenient for use in sports settings due to their lack of portability and/or complex procedures. Recently, myotonometry has become a popular technique to reliably assess mechanical properties of superficial muscles as it is non-invasive, portable, and easy to administer (Pruyn, Watsford, & Murphy, in press). With this technique, muscle stiffness is measured through a device which applies a brief mechanical impulse on the muscle belly. This technology is considered a more convenient method of quantifying muscle stiffness in sports settings.
Thus, the present study examined the effects of massage on post-exercise muscle stiffness using myotonometry. It was hypothesized that massage will be effective in enhancing the recovery of altered muscle stiffness induced by an eccentric bout of exercise.

METHODS: This study was approved by the Nanyang Technological University Institutional Review Board. Written informed consent was obtained from all participants prior to the experiment. This is part of a larger scale study; preliminary results of six well-trained male runners (mean [*SD*] age = 23.8 [1.8] yrs, height = 1.70 [0.03] m, mass = 61.0 [6.8] kg, 2.4 km run time = 8.2 [0.5] min) will be presented. This study adopted a within-participants design, beginning with a familiarization test trial, and having the actual trials spanning across five consecutive days with a total of seven measurement time points (Figure 1).

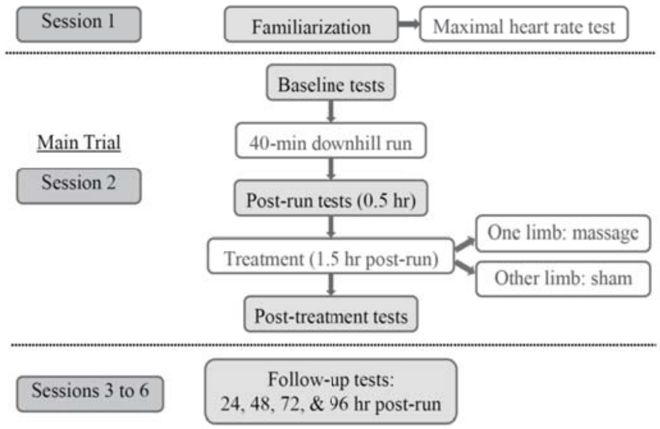


Figure 1: An overview of the research design.

During the familiarization session, participants went through the procedures associated with muscle soreness and stiffness measurements. They then performed a maximal heart rate test on a treadmill to determine the downhill running speed to be used in the main trial. For the main trial, participants reported to the laboratory in the morning at 0800 h. Baseline measurements of muscle soreness perception and stiffness were assessed on two leg muscles on both sides: rectus femoris (RF) and tibialis anterior (TA). Leg muscle soreness perception was evaluated through a step-up-and-down test conducted on a 40-cm raised platform and measured using a 0- to 10-point numerical rating scale. Muscle stiffness was measured using the MyotonPro (Myoton AS, Tallinn, Estonia), with its probe positioned perpendicular to the surface of each marked site (Figure 2). To maintain the consistency in measurement, assessment points were marked on the skin with a permanent marker for the entire study period. The MyotonPro applies a brief (15 ms) mechanical impulse at a pre-determined force (0.3 to 0.4 N), followed by a quick release, eliciting damped oscillations from the muscle of interest, which were then registered by an in-built accelerometer (Pruyn et al., in press). Stiffness was calculated as the ratio of force applied to the maximum muscle deformation (in N/m). Two sets of five measurements were taken at each site, with the mean value used for analysis.

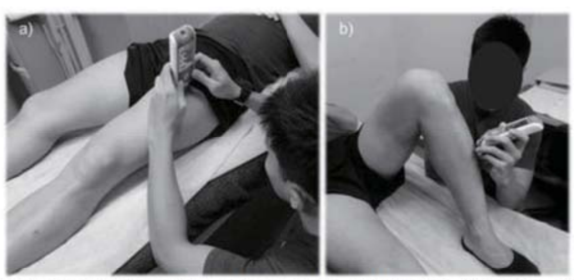


Figure 2: Myotonometric measurements of muscle stiffness for the a) rectus femoris and b) tibialis anterior.

To induce muscle damage, participants underwent a 40-minute downhill run (-10°) on a treadmill at a speed equivalent to 80% of their maximal heart rate during level running. Thirty minutes after the downhill run (post-run), measurements of muscle soreness perception and stiffness were taken as per baseline. Ninety minutes after the downhill run, participants underwent an 8 minute massage and 8 minute placebo treatment administered by a certified physiotherapist. One leg was randomly chosen to receive a massage treatment, comprising of four techniques lasting four minutes on each muscle site (Figure 3). The contralateral leg received a placebo treatment using a sham therapeutic ultrasound device for a similar duration per muscle site. The assignments of treatment orders were randomized, with some participants receiving massage first followed by placebo, and vice versa. Immediately after the treatment (post-treatment), muscle soreness perception and stiffness were re-assessed. Following the main trial, participants returned for the next four consecutive mornings for follow-up tests (24, 48, 72, and 96 hours post-run). Participants were asked not to participate in any exercises or engage in any recovery aids (e.g., wearing compression tights) from 48 hours before the main trial to the end of the study. Descriptive statistics were calculated for muscle soreness perception and stiffness. Data are expressed as group means (*SD*s). Due to the small sample size and the pilot nature of the study, no inferential statistics were used.

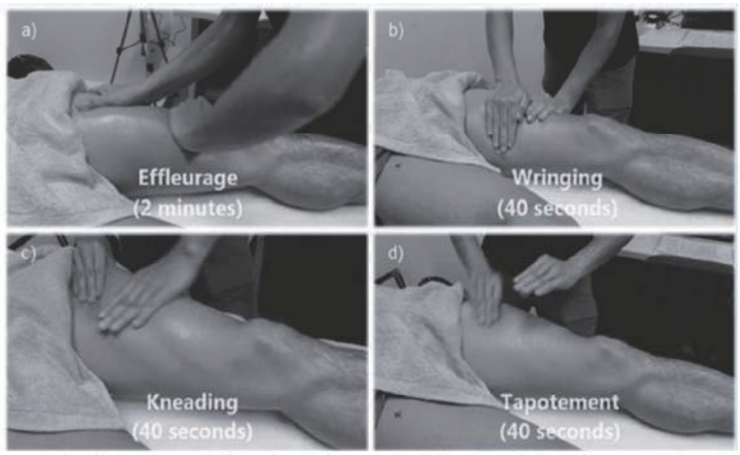


Figure 3: Massage techniques and the duration administered for the massage sites.

RESULTS & DISCUSSION: This study compared the effects of massage on post-exercise muscle stiffness over 96 hours. Figure 4 illustrates the changes in muscle stiffness over time between the massaged and placebo legs. In general, muscle stiffness of the RF and TA increased and peaked at 24 hours after an eccentric bout of exercise. From 24 to 96 hours post-run, a more rapid recovery (decrease in stiffness) was observed in the massaged RF compared with the placebo leg but no clear benefits of massage were seen in the TA. Previous studies reported contrasting results on the short-term effects of massage on muscle stiffness: some found massage effective in reducing muscle stiffness (Eriksson Crommert et al., 2015; Ogai et al., 2008) while others did not (Thomson et al., 2015). In our study, the immediate effect of massage on muscle stiffness was unclear, with an increase in RF but a slight decrease in TA (Figure 4, post-treatment). Given the different protocols used to quantify muscle stiffness, it is difficult to directly compare between studies.

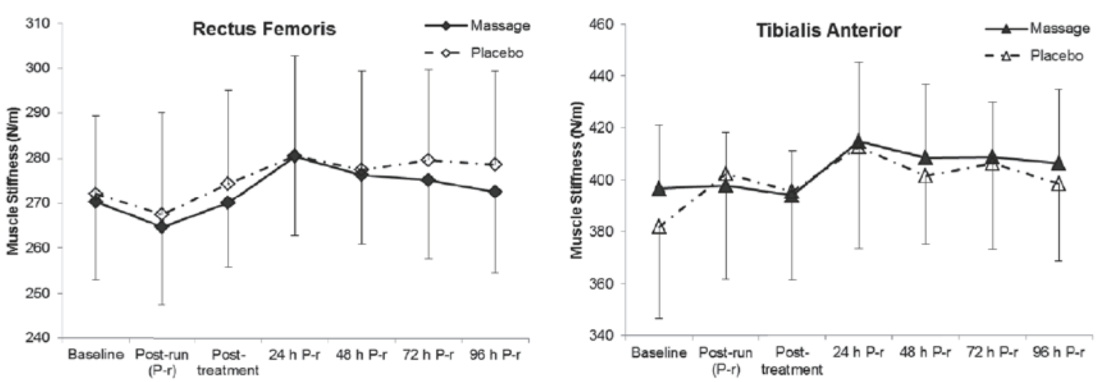
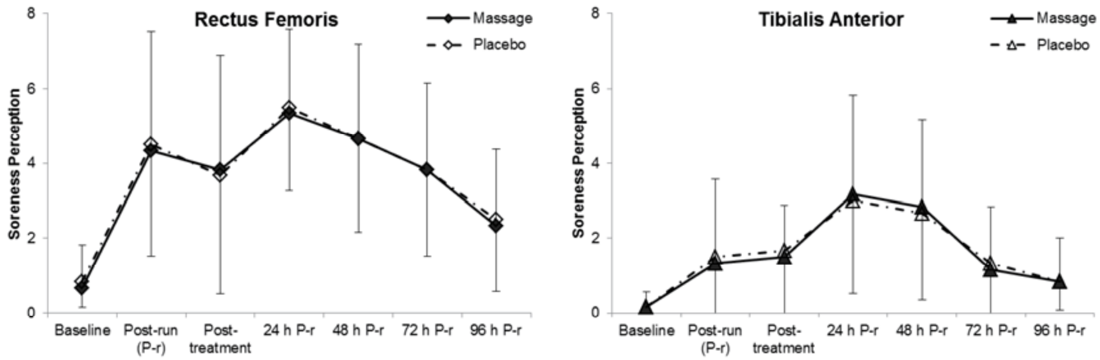


Figure 4: Mean stiffness (N/m) of the rectus femoris and tibialis anterior muscles in the massage and placebo legs over the 5 days.

The perceived soreness ratings were similar between the massage and placebo sides for both muscles, suggesting that the placebo treatment was successful in manipulating participants (Figure 5). Greater soreness perception was observed in the RF compared with the TA after the downhill run. Since a more rapid reduction in stiffness was only seen in the RF (Figure 4), it is possible that massage might be more effective on muscles that are inherently larger in size and that experience greater perceived soreness post-run (Figure 5).



0 = no soreness at all; 10 = the worst imaginable soreness.

Figure 5: Mean perception of soreness in the rectus femoris and tibialis anterior muscles of the massaged and placebo legs over the 5 days.

It is noteworthy that both muscle soreness perception and stiffness increased and peaked at 24 hours after the downhill run before a gradual reduction in subsequent days. This suggests that an increase in muscle stiffness may be explained by similar mechanisms of exercise-induced delayed muscle soreness (Armstrong, 1984). Despite a faster reduction in muscle stiffness in RF after massage, no corresponding decrease in soreness was observed. This reflects that soreness might be influenced by factors other than muscle stiffness.

CONCLUSION: This study illustrated the potential usefulness of myotonometry to assess post-massage muscle stiffness. Preliminary results suggested that massage might be effective in reducing stiffness of muscles that are inherently larger in size and that experience greater soreness post-exercise. It is important to note that the group data presented in this preliminary investigation may not represent each individual response as variations among the six participants were present. Further studies with more samples are warranted.

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