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Effects of compression at myofascial trigger points in patients with acute low back pain: A randomized controlled trial

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Abstract

Background: Although there is some evidence that massage therapy, especially compression at myofascial trigger points (MTrPs), is effective for sub-acute and chronic low back pain, the effectiveness of massage therapy with compression at MTrPs for acute low back pain has not been studied.
Methods: To evaluate the effectiveness of compression at MTrPs for acute low back pain, 63 patients with acute low back pain were randomly assigned to one of three groups: the MTrP group who received compression at MTrPs ($N = 23$), the non-MTrP group who received compression at non-trigger points ($N = 21$), and the effleurage massage group who received superficial massage ($N = 19$). The patients received the assigned treatment 3 times/week for 2 weeks. The subjective pain intensity in static and dynamic conditions and disability caused by low back pain were measured by the visual analogue scale (VAS) and Roland–Morris questionnaire (RMQ), respectively; along with the range of motion (ROM) at the lumbar region and pressure pain threshold (PPT) at trigger points before treatment (baseline), 1 week after the start of treatment, and 1 month after the end of treatment (follow-up).
Results: Static and dynamic VAS score, PPT and ROM were significantly improved in the MTrP group compared with those in the non-MTrP and effleurage groups.
Conclusions: These results indicate that compression at MTrPs is effective to treat acute low back pain compared with compression at non-MTrPs and superficial massage.
For this article, a commentary is available at the Wiley Online Library.

1. Introduction

Low back pain is one of the major health problems in modern society (Andersson, 1997). Low back pain develops in three phases: acute (within 4 weeks after the onset), sub-acute (4–12 weeks), and chronic (after 12 weeks) phases (Albright et al., 2001). Approximately, 90% of acute low back pain cases resolve within 6 weeks, (Koes et al., 2001; Waddell and Burton, 2001); however, low levels of pain and disability commonly persist for 3–12 months (Pengel et al., 2003). Furthermore, most people experience at least one recurrence within 12 months, and 2–7% of acute low back pain cases progress to chronic pain (Pengel et al., 2003). Accordingly, early intervention for acute low back pain prevented conversion from acute to chronic back pain and to reduce medical costs for the year following the pain onset (Gatchel et al., 2003).

Massage therapy has been used to treat non-specific low back pain, and is suggested to reduce muscle tone and improve local circulation to remove algesic substances (Cafarelli and Flint, 1992; Mori et al., 2004). The effectiveness of massage therapy was similar to that of certain exercises, and better than joint mobilization, relaxation therapy, physical therapy

What's already known about this topic?
- Compression at myofascial trigger points (MTrPs) is known to be effective for chronic low back pain.
- However, it is not known if compression at MTrPs can also improve acute low back pain.

What does this study add?
- This study shows that compression at MTrPs decreases subjective pain and increases the range of motion and pressure pain threshold at the lumbar region in patients with acute low back pain.

(e.g. thermotherapy, infrared and electrical stimulation), acupuncture therapy and self-education for subacute or chronic low back pain (Furlan et al., 2008). These therapeutic effects of massage therapy are dependent on specific stimulation sites; compression at specific points (acupoints) used in traditional medicine provided more relief from chronic low back pain than classic (Swedish) massage (Hsieh et al., 2006). When referring to the points targeted during massage therapy, the term 'myofascial trigger points' (MTrPs) has been coined in the West as an alternative to 'acupoints.' MTrPs are suggested to be responsible for musculoskeletal pain and are defined as: (1) a hypersensitive spot in a palpable taut band of skeletal muscle fibres and (2) a point that, when stimulated with palpation or needling induces pain in the stimulated spot as well as referred pain and a local twitch response (Simons et al., 1999). A pressure massage targeting the MTrPs was particularly beneficial to treat myofascial pain syndrome (Simons and Travell, 1983; Simons, 1984; Delaney et al., 2002). Compression at MTrPs was also effective for musculoskeletal pain such as chronic low back, neck, shoulder, and knee pain and fibromyalgia (Hains and Hains, 2000, 2010a; Hains, 2002a,b; Hains et al., 2010b). Furthermore, treatment of trigger points was more effective than superficial massage such as stroking and kneading (Rachlin, 1994). These findings suggest that massage focusing on specific trigger points is an important factor for the treatment of musculoskeletal pain.

However, evidence for the effectiveness of massage therapy for acute low back pain is currently lacking (Kinkade, 2007). Furthermore, no previous studies have investigated the efficacy of targeting specific sites (i.e. MTrPs) by introducing controls for MTrPs (i.e. non-MTrPs) for acute low back pain. To investigate these issues, we here compared the effects of 3 different massage therapies on acute low back pain: compression at MTrPs, compression at non-MTrPs and superficial massage (effleurage).

2. Methods

2.1 Study design

The present investigation was a randomized, open-label, blinded endpoint evaluation (PROBE), parallel-group trial performed between April 2011 and November 2013. The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee at the University of Toyama. This trial was registered at UMIN Clinical Trials Registry as UMIN 000005332.

2.2 Participation

The 63 patients suffering from acute low back pain aged between 16 and 65 years were recruited from 3 Judo therapy clinics in Japan. The ratio of athletes among the patients was 12.7%. We defined low back pain as 'pain and discomfort, localized below the costal margin and above the inferior gluteal folds' (van Tulder et al., 2006). The practitioners palpated the backs of all the patients to identify MTrPs, performed some neurological tests (see below) and took medical histories from the patients. The inclusion criteria for patient selection were as follows: (1) acute low back pain within 4 weeks from the onset of pain and (2) patients without drug prescription, or patients who took drugs (e.g. for chronic conditions such as cardiovascular and endocrinological disorders) for more than 1 month if the dosage and kinds of drugs were kept constant during the investigation period. The exclusion criteria for patient selection were as follows: (1) patients with a history of spinal surgery; (2) patients with spinal fracture or dislocation; (3) patients with neurological signs (i.e. 1. positive signs in straight leg raising test, femoral nerve stretch test, Jackson test, or Spurling test; 2. muscle weakness; 3. Paresthesia; and 4. abnormal reflexes); (4) patients who took analgesic drugs; (5) patients who developed systemic pain, rheumatoid arthritis, fibromyalgia, tumour, or infection in the spinal cord and intervertebral disc, and other diseases inducing systemic pain; (6) patients with neck or low back pain due to heart diseases; (7) pregnant subjects; (8) patients with a malignant tumour or a history of malignant tumour; (9) patients with psychiatric disorders; (10) patients with

severe osteoporosis; (11) patients who complained of weight loss or fever of unknown causes; (12) patients who received treatments such as massage, acupuncture and nerve block, for their back pain at other hospitals or clinics within 1 month from the start of the study; (13) patients with a history of whiplash injury due to traffic accidents; and (14) patients who were recognized as inadequate at the discretion of the authors. Written informed consent signed by the patients or their guardians was obtained from all patients.

2.3 Intervention

After assessment of the baseline characteristics of all the patients, the patients were assigned to one of the three groups. All patients received one of three treatments based on the groups: compression at MTrPs, compression at non-trigger points (non-MTrPs), or effleurage massage. Each patient received a 15-min treatment 3 times/week for 2 weeks. The patients could stop the treatment 1 week after starting if they felt that their pain was greatly improved. A well-trained, clinically experienced massage practitioner with a national license conducted the treatments.

2.3.1 Compression at myofascial trigger points (MTrP group)

The practitioners identified the MTrPs using the minimal diagnostic criteria by Gerwin et al. (1997) and Simons et al. (1999) as follows: (1) presence of a palpable taut band in the low back muscles; (2) presence of hypersensitivity tender points in the taut band; (3) induction of pain similar to usual low back pain by compression at the MTrPs; and (4) induction of pain by stretching the muscle, including the MTrPs. Up to 6 MTrPs were identified in each patient in not only the MTrP but also other groups (i.e. the maximum number of MTrPs was 6 among all patients). Compression was applied over all MTrPs only in the MTrP group according to the technique described by Simons et al. (1999) known as 'ischemic compression.' Constant pressure stimulation by the thumb was intermittently applied to each MTrP for a period ranging from 30 s to 2 min. This sequence of compression was repeated several times. The intensity of pressure was controlled to a level at which each subject reported 'comfortable pain' (Hou et al., 2002; Takamoto et al., 2009). MTrPs were compressed at an intermediate compression intensity between that for pain threshold and that inducing maximally tolerable pain (Hou et al., 2002).

2.3.2 Compression at non-trigger points (non-MTrPs group)

The non-MTrP group received compression at non-trigger points (non-MTrPs) located 30 mm away from the MTrPs in the same muscle. The non-MTrPs had no palpable taut muscle band, and no tenderness was induced by compression. The treatment procedures were the same as those for the MTrP group except the different compression points. The intensity of pressure was controlled to a level at which each subject reported 'comfortable pain' in the same way as in the MTrP group.

In our previous study, non-MTrPs were defined as the locations that were 20 mm away from the MTrPs (Takamoto et al., 2010). The study indicated that needle stimulation at non-MTrPs elicited significantly less subjective sensation compared with the stimulation at the MTrPs. To minimize an influence on MTrPs when non-MTrPs were treated by hands, we defined the non-MTrPs as locations 30 mm away from MTrPs.

2.3.3 Effleurage (effleurage group)

The effleurage group received treatment on the back between the posterior superior iliac spine and C7. The effleurage technique is based on slow rhythmic stroking movements using the palm. The pressure used in this study affected the skin and subcutaneous tissue, and was not sufficient to reach the pain threshold of the patients (Chatchawan et al., 2005). This technique is a classical massage technique believed to reduce muscle tone, induce a general state of relaxation that relieves muscle spasm, and accelerate blood and lymph flow, which improves tissue drainage and thus reduces swelling (Goats, 1994).

2.4 Outcome measures

The primary outcome measure in this trial was pain intensity assessed by the visual analogue scale (VAS), and the VAS score during movement (move-VAS). VAS and move-VAS were assessed before (baseline), immediately after the first treatment, 1 week after the first treatment, and 1 month after final treatment (follow-up). The patients were asked to rate the intensity of their back pain in a static condition (VAS) and in a dynamic condition during motion of the low back muscles (move-VAS) on a 100 mm line ranging from no pain (0) to the worst pain they could possibly feel (100).

Secondary outcome measures were disability due to low back pain assessed by the Japanese version of the Roland–Morris questionnaire (RMQ), pressure nociception at the trigger points (pressure pain threshold, PPT) and joint motion in the thoracolumbar spine (range of motion, ROM). These three measurements were assessed before the first treatment (baseline), 1 week after the first treatment and 1 month after final treatment (follow-up). The RMQ consisted of 24 self-administered questions that could be answered by yes or no (ranging from 0 to 24 points; the worst condition being 24). The reliability and validity of the Japanese version of the RMQ, which is translated into Japanese and is a culturally adapted questionnaire in Japan, have been established previously (Nakamura et al., 2003). PPT was measured in kg/cm^2 by pressing the skin over a primary MTrP with a pressure algometer (Matsumiya medical). A primary MTrP was defined as the most painful point. PPT was measured 3 times at intervals of 60-s rest periods. Pressure was applied at the rate of 1 kg/s and the patients were instructed to say 'now' when they felt pain. The reliability and validity of the PPT have been previously established (Reeves et al., 1986). In ROM assessment, flexion (anteflexion) and extension (retroflexion), and right and left lateral flexion in the thoracolumbar spine joints were measured using a goniometer.

2.5 Sample size determination

In this study, the primary outcome measure was VAS. Before the main study, we performed a pilot study to obtain VAS score mean and standard deviations for estimating the sample size. The mean VAS score and standard deviation at baseline was 51 ± 20. According to our preliminary test, we expected that VAS scores would be reduced 20 points 1 week after starting of the treatment in the MTrP group compared with the other groups. According to a significance level of 5% (two-tailed) and statistical power of 80%, 16 subjects would thus be required in each group. Considering the drop out and withdrawal rate, the adequate sample size was determined as 20 patients in each group in this study.

2.6 Randomization

The patients were randomly assigned to one of the 3 groups (MTrP, non-MTrP and effleurage groups) by the minimization method with three factors (Institution, VAS × quality of life score [≥500 vs. <500], and pain duration [onset of pain within 15 days vs. over 15 days]) as stratification factors. Following the baseline assessment, each independent operator, who was different from the practitioner and examiner in each clinic, conducted randomization by a computer-based online web communication with the study-coordinating centre at University of Toyama. The random allocation process was concealed from all the investigators because group assignment was determined by the computer program.

2.7 Blinding

All outcomes in this study were assessed by each independent examiner in each clinic, who was different from the practitioner conducting treatments and blinded to the treatment groups.

2.8 Statistical analysis

Outcome measures were presented as the mean and standard error (SE). All data analyses were performed using SPSS 19.0 (IBM Inc., New York, USA). Baseline differences among the groups were examined with one-way ANOVA for the analysis of normally distributed variables, and the χ^2 test in the analysis of categorical data. For each parameter, the mean changes from baseline were compared among the three groups by two-way repeated measures ANOVA with the treatment group and time as factors. Greenhouse-Geisser-adjusted degrees of freedom were used in case of violation of the sphericity assumption (Mauchly test of sphericity at $p < 0.20$). Tukey's method was used for *post-hoc* analyses. The statistical analysis was conducted at a 95% confidence level. A p-value <0.05 was considered statistically significant. A normal distribution of quantitative data was assessed by means of the Kolmogorov–Smirnov test ($p > 0.05$).

3. Results

3.1 Baseline characteristics

Sixty-three patients were randomized to receive treatment with either compression at MTrPs ($N = 23$), compression at non-MTrPs ($N = 21$), or effleurage ($N = 19$). Fifty-five patients completed the study as planned, whereas 8 patients withdrew during the course of the study. Details of subject assignment and the reasons for withdrawal are shown in the patient flow diagram (Fig. 1). All patients who participated in the experiment did not receive other treatments during the study.

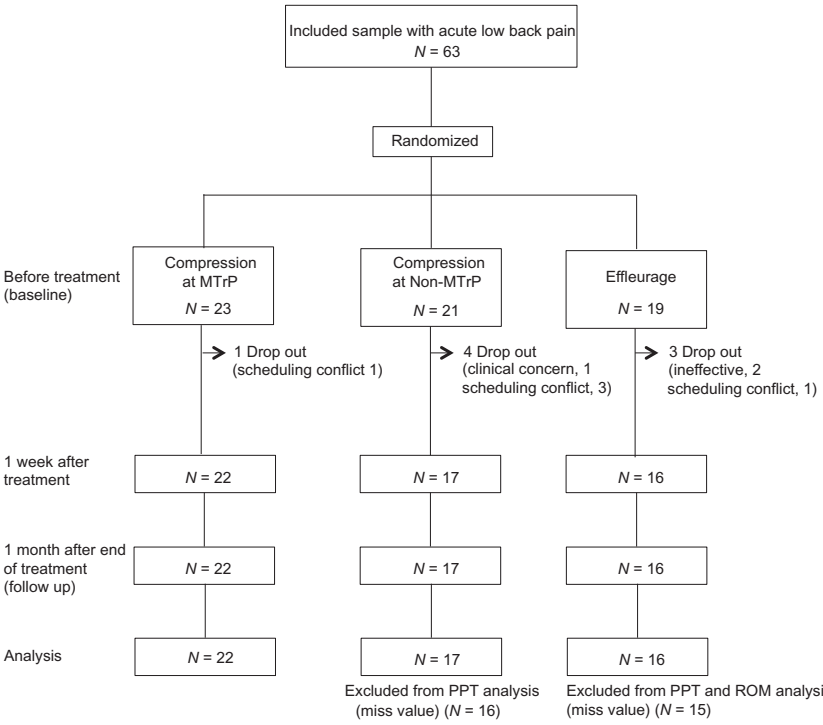

Figure 1 Study flow diagram. Eight patients dropped out from the study and were excluded from the analysis. One patient was excluded from pressure pain threshold (PPT) data analysis because of missing values. Two patients were excluded from range of motion (ROM) data analysis because of missing values. MTrP, myofascial trigger point.

The patient demographics are shown in Table 1. MTrPs were identified in all patients. There were no significant differences in any of the baseline characteristics including number of MTrPs among the three groups (one-way ANOVA and χ^2 test, $p > 0.05$).

3.2 Primary outcome

The changes in the VAS scores from baseline are shown in Fig. 2A and Table S1. The VAS data were analysed by two-way repeated measures ANOVA with the treatment group (MTrP, non-MTrP, and effleurage) and time (immediately after first treatment, 1 week after start of treatment, and 1 month after end of treatment) as factors. The results indicated that there were significant main effects of treatment group (F [2, 52] = 17.6, $p < 0.05$) and time (F [1.4, 74.5] = 19.0, $p < 0.01$]. However, there were no significant interactions between the treatment group and time (F [2.9, 74.5] = 1.8, $p = 0.16$). *Post-hoc* tests revealed that VAS (pain) changes in the MTrP group were significantly larger compared with the non-MTrP (mean [95% CI]: −32.2 [−45.9 to −18.6],) and effleurage (−22.6 [−36.4 to −8.7]) groups (Tukey test, $p < 0.01$).

Changes in the move-VAS scores from baseline are shown in Fig. 2B and Table S1. Statistical analysis by two-way repeated measures ANOVA indicated that there were significant main effects of treatment group (F [2, 52] = 21.2, $p < 0.01$) and time (F [1.6, 83.4] = 50.9, $p < 0.01$), and a tendency of an interaction between the two factors (F [3.2, 83.5] = 2.6, $p = 0.054$). *Post-hoc* tests revealed that VAS changes in the MTrP group were significantly larger compared with the non-MTrP (mean [95% CI]: −33.9 [−47.1 to −20.8],) and effleurage (−24.6 [−38.0 to −11.2]) groups (Tukey test, $p < 0.05$), These results indicated that compression at MTrPs more effectively reduced VAS and move–VAS scores compared with compression at non-MTrPs and superficial massage.

3.3 Secondary outcomes

The RMQ changes from baseline are shown in Fig. 3A and Table S1. Statistical analysis by two-way repeated measures ANOVA indicated that there was a significant main effect of time (F [1, 52] = 15.3, $p < 0.01$), but no significant interaction between the two factors (F [2, 52] = 0.18, $p = 0.83$). Moreover, there was a tendency of a main effect of treatment group (F [2, 52] = 2.6, $p = 0.082$).

The PPT changes from baseline are shown in Fig. 3B and Table S1. Two patients with missing values were excluded from this analysis. Statistical analysis by two-way repeated measures ANOVA indicated that there were significant main effects of treatment group (F [2, 50] = 8.6, $p < 0.01$) and time (F [1, 50] = 13.9, $p < 0.01$), but no significant interaction between the two factors was observed (F

Table 1 Baseline characteristic in the three groups.

Characteristics	Compression at MTrP (*N* = 22)	Compression at non MTrP (*N* = 17)	Effleurage massage (*N* = 16)
Age (years)	38.0 ± 3.0	38.1 ± 3.8	35.6 ± 3.0
Gender, *n* (%)			
Male	10 (45.4)	8 (47.1)	6 (37.5)
Female	12 (54.6)	9 (52.9)	10 (62.5)
Height (cm)	163.5 ± 1.7	162.5 ± 2.1	163.7 ± 2.2
Weight (kg)	61.0 ± 2.9	61.9 ± 2.9	53.7 ± 2.6
Pain duration (day)	8.0 ± 3.4	8.9 ± 3.6	12.4 ± 4.4
Number of MTrP (points)	2.3 ± 0.2	2.5 ± 0.1	2.2 ± 0.2
Number of patients based on treatment period			
Within 1 week[a]	8	4	2
Over 1 week	14	13	14
Baseline VAS (mm)	54.3 ± 4.5	46.9 ± 5.2	56.1 ± 5.0
Baseline move-VAS (mm)	63.5 ± 4.4	62.3 ± 5.7	70.3 ± 5.0
RMQ (points)	7.1 ± 0.9	6.0 ± 1.0	6.8 ± 1.3
Baseline VAS × RMQ	432.2 ± 63.9	309.9 ± 79.9	423.9 ± 97.5
PPT (kg/cm^2)	33.2 ± 2.7	35.4 ± 2.4	33.8 ± 2.1
ROM-flexion (degree)	75.4 ± 3.7	82.4 ± 3.8	76.8 ± 5.0
ROM-extension (degree)	28.9 ± 2.7	41.6 ± 3.0	35.7 ± 4.2
ROM-right lateral flexion (degree)	32.1 ± 2.0	36.0 ± 1.8	37.5 ± 3.1
ROM-left lateral flexion (degree)	32.2 ± 2.1	36.8 ± 1.7	36.9 ± 2.5

Data are presented as mean ± SE. VAS, visual analogue scale; RMQ, Roland-Morris questionnaire; PPT, pressure pain threshold; ROM, range of motion.

[a]Patients stopped the treatment within 1 week after starting treatment since they felt that their pain was greatly reduced (within 1 week).

[2, 50] = 1.5, $p = 0.24$). *Post-hoc* tests revealed that the PPT changes from baseline in the MTrP group were significantly increased compared with the non-MTrP (mean [95% CI]: 12.3 [4.6 to 20.0]) and effleurage (9.7 [1.9 to 17.6]) groups (Tukey test, $p < 0.05$). These findings indicate that compression at MTrPs more effectively reduced RMQ and increased PPT compared with compression at non-MTrPs and superficial massage.

The ROM changes from baseline are shown in Fig. 4 and Table S2. One patient with missing values was excluded from this analysis. In ROM changes in flexion, statistical analysis by two-way repeated measures ANOVA indicated that there was a significant main effect of treatment group (F [2, 51] = 7. 2, $p < 0.01$), but no significant main effect of time (F [1, 51] = 0.1, $p = 0.71$) or significant interaction between these two factors (F [2, 51] = 0.3, $p = 0.74$). *Post-hoc* tests revealed that ROM changes in flexion in the MTrP group were significantly improved compared with those in the non-MTrP (mean [95% CI]: 14.9 [5.1 to 24.5]; Tukey test, $p < 0.01$), and tended to be improved in the MTrP group compared to in the effleurage group (9.7 [−0.3 to 19.8]; Tukey test, $p = 0.06$). In ROM changes in extension, there was a significant main effect of treatment group (F [2, 51] = 9.6 $p < 0.01$), but no significant main effect of time (F [1, 51] = 1.0, $p = 0.31$) or significant interaction between these two factors (F [2, 51] = 2.6, $p = 0.09$). *Post-hoc* tests revealed that the ROM changes in extension in the MTrP group were significantly improved compared with the non-MTrP (mean [95% CI]: 16.2 [7.1 to 25.2]; Tukey test, $p < 0.01$) and effleurage (9.4 [0.003 to 18.7]; Tukey test, $p = 0.05$) groups. In ROM changes in right extension, there was a significant main effect of treatment group (F [2, 51] = 6.3, $p < 0.01$), but no significant main effect of time (F [1, 51] = 2.81, $p = 0.1$) or significant interaction between the two factors (F [2, 51] = 0.3, $p = 0.75$). *Post-hoc* tests revealed that ROM changes in right flexion in the MTrP group were significantly improved compared with the non-MTrP (mean [95% CI]: 8.9 [2.1 to 15.7], $p < 0.01$) and effleurage (8.1 [1.1 to 15.1], $p < 0.05$) groups. In ROM changes in left extension, there was a significant main effect of treatment group (F [2, 51] = 6.5, $p < 0.01$), but not of time (F [1, 51] = 0.2, $p = 0.63$); and no significant interaction between the two factors was observed (F [2, 51] = 0.2, $p = 0.82$). *Post-hoc* tests revealed that the ROM changes in left flexion in the MTrP group were significantly improved compared with the non-MTrP group (mean [95% CI]: 9.4 [2.9 to 15.9]; Tukey test, $p < 0.01$), and tended to be improved compared with the effleurage group (6.1 [−0.6 to 12.8]; Tukey test,

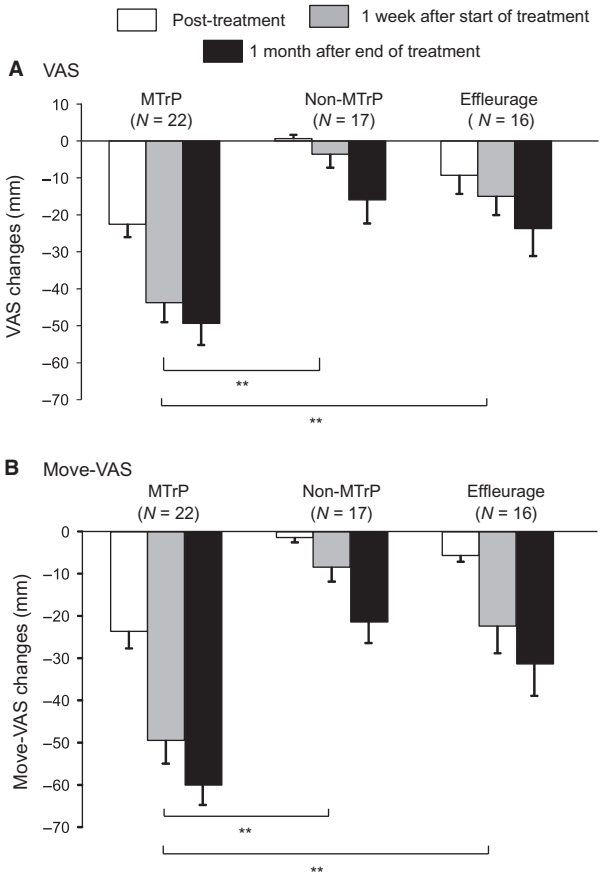

Figure 2 Comparison of changes in the visual analogue scale (VAS) (A) and move-VAS scores (B) from baseline among the three treatment groups. The VAS and move-VAS scores were significantly improved in the myofascial trigger point (MTrP) group compared with those in the non-MTrP and effleurage groups. Error bars indicate the standard error. *$p < 0.05$, **$p < 0.01$.

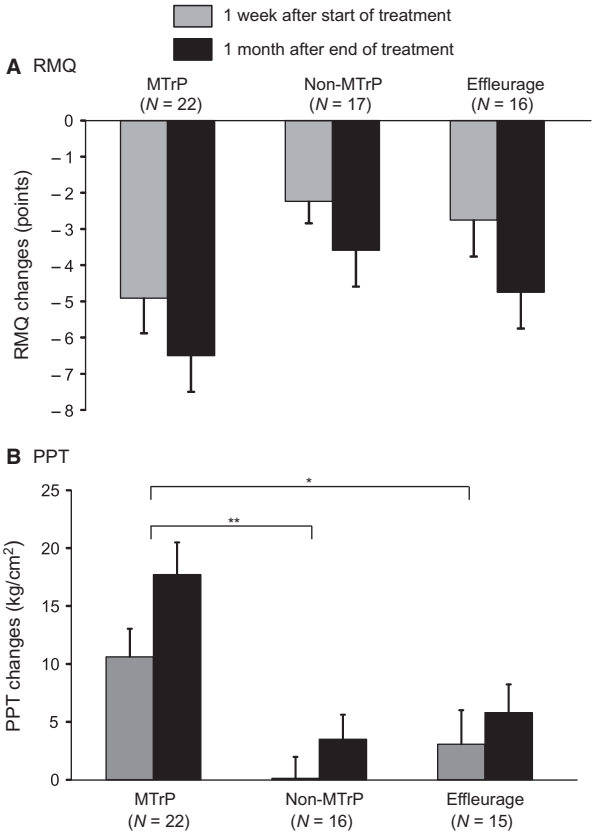

Figure 3 Comparison of changes of the Roland–Morris questionnaire (RMQ) scores (A) and pressure pain threshold (PPT) (B) from baseline among the three treatment groups. There were no significant differences in the changes of the RMQ score among the three groups. The PPT significantly increased in the myofascial trigger point (MTrP) group compared with the non-MTrP and effleurage groups. Error bars indicate the standard error. *$p < 0.05$, **$p < 0.01$. Two patients with missing values (non-MTrP group: 1, effleurage group: 1) were excluded from the PPT analysis.

$p = 0.08$). These findings indicate that compression at MTrPs more effectively increased the ROM in the waist compared with compression at non-MTrPs and superficial massage.

3.4 Adverse events

No patients were withdrawn from the study due to adverse events. No adverse effects were observed in this study.

4. Discussion

This study demonstrated that compression at MTrPs significantly improved VAS, PPT and ROM compared with other massage techniques in patients with acute low back pain, indicating that compression at MTrPs is more effective to treat acute low back pain.

4.1 Effectiveness of compression at MTrPs

Several clinical trials reported the effectiveness of compression at MTrPs. In healthy subjects, compression at latent MTrPs in the upper back, neck and soleus muscles immediately increased pain threshold of MTrPs in the upper back muscle, and improved ROM of the cervical rachis and ankle joint (Aguilera et al., 2009; Grieve et al., 2011; Gulick et al., 2011). In a previous study of patients with chronic neck pain, the pain VAS score, PPT, and ROM were significantly and immediately improved after compression at MTrPs (Hou et al., 2002). Furthermore, two randomized clinical trials also showed that compression at MTrPs in painful muscle regions significantly reduced pain and disability immediately after treatments, and after 1 and 6 months follow-up compared with the baseline in patients with

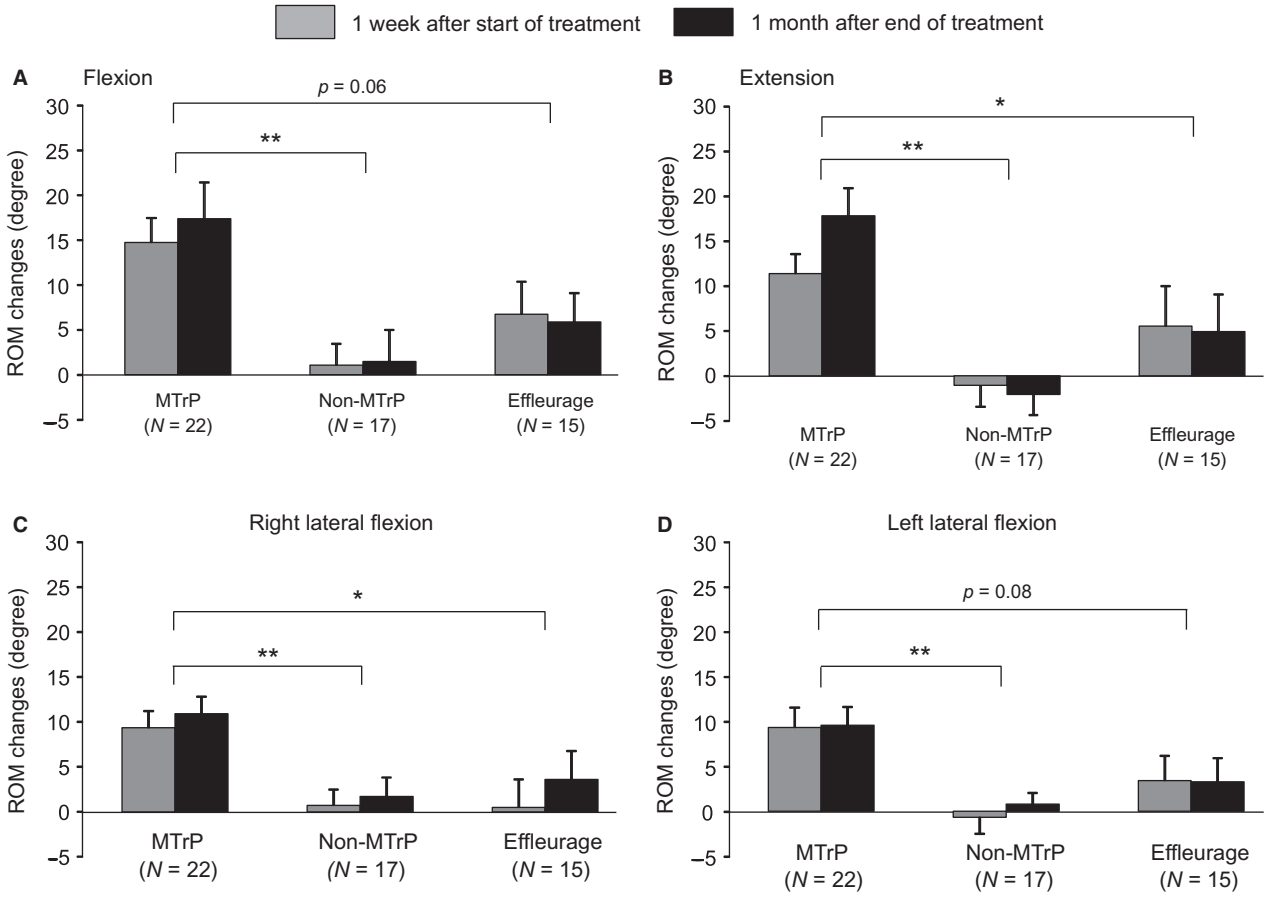

Figure 4 Comparison of range of motion (ROM) changes from baseline among the three treatment groups. ROM changes in flexion (A), extension (B), right lateral flexion (C), and left lateral flexion (D). Error bars indicate SEM. *$p < 0.05$. **$p < 0.01$. The data from one patient with missing values (effleurage group) were excluded from the ROM analysis. MTrP, myofascial trigger points.

chronic neck, shoulder and patellofemoral pain (Hains and Hains, 2010a; Hains et al., 2010b; Cagnie et al., 2013). Those results suggested that the compression at MTrP is effective in chronic musculoskeletal pain. However, to date, no studies have investigated the effects of compression at MTrPs in patients with acute low back pain. Thus, this study provides the first evidence that compression at MTrPs is also effective in the acute phase of low back pain.

In this study, compression at MTrPs was found to be more effective than compression at non-MTrPs and superficial massage. The acupoints have been reported to correlate anatomically with 71% of MTrPs (Melzack et al., 1977), and a previous randomized clinical trial reported that massage at acupoints provided more pain relief than classic massage in chronic low back pain (Franke et al., 2000). Moreover, clinical trials using acupuncture therapy indicated that deep needling to the MTrPs significantly improved pain and disability compared with needling to non-MTrPs and superficial needling in chronic low back pain (Itoh et al., 2004, 2007). While these findings all indicate that treatment on MTrPs is useful in chronic low back pain, Chatchawan et al. (2005) conversely reported that there was no significant difference in the effectiveness of reducing chronic low back pain with MTrPs between deep pressure massage and superficial massage. However, in their study, the authors applied deep pressure massage to the specific region in the back regardless of MTrPs; and therefore, the MTrPs might not have been effectively compressed. Altogether, the results of these previous studies suggest that compression at the specific regions (i.e. MTrPs) is an important factor to achieve therapeutic effects of massage therapy for musculoskeletal pain.

4.2 Mechanisms of pain relief in compression at MTrPs

Several hypotheses on the pathophysiological mechanisms in development of MTrPs have been proposed, including the energy crisis theory, which suggests that MTrPs are generated by hyperactivation of the muscle spindle or motor endplate (Simons, 1996). On the other hand, the integrated hypothesis proposes that acute or chronic muscle overload induces hyperactivation of the neuromuscular junction, which leads to excessive release of acetylcholine. This excessive acetylcholine release, which is characterized by continuous contractions, subsequently leads to formation of contraction knots in the muscle fibres. In turn, these contraction knots then lead to the development of local ischemia and hypoxia, and the loss of energy supply due to contraction causes a release of sensitizing noxious substances leading to increased local tenderness and pain (Simons, 2004). Furthermore, autonomic nervous activity can modulate acetylcholine release and contribute to the positive feedback cycle. Compression at MTrPs was found to induce reactive hyperemia in the MTrP region in one study (Simons et al., 1999), and reduce muscle spasm by spinal reflex mechanism in another (Patrick and Melzack, 1984). Furthermore, one study found that compression at MTrPs significantly increased parasympathetic nervous activity and improved fatigue (Takamoto et al., 2009), while yet another study reported that sympathetic nervous activity might increase acetylcholine release from the motor nerve terminals (Gerwin et al., 2004). These results suggest two mechanisms by which compression at MTrPs induces pain relief: 1) an increase in peripheral blood flow and subsequent removal of noxious substances, and 2) an increase in parasympathetic tone that blocks excessive release of acetylcholine.

4.3 Limitations of the study

In this study, the practitioners were not blinded to the treatment types, since the practitioners must identify MTrPs and non-MTrPs before conducting treatments. Therefore, we conducted the clinical trial with a PROBE design.

In this study, we conducted the clinical trial using patients with acute low back pain who visited the Judo therapist clinics in Japan. It is important to confirm whether the present results generalize in a wide range of patients with different baseline characteristics. As far as we know, no previous studies reported baseline characteristics of patients with acute low back pain in Japanese population. However, the mean baseline VAS scores in this study are comparable to those of patients with acute low back pain who consulted primary care practitioners in the United States (Carey et al., 1995). Furthermore, the mean baseline VAS and RMQ scores of the patients in this study seem to be similar to those of patients with chronic low back pain who visited orthopaedic clinics in Japan (Nakamura et al., 2003; Suzukamo et al., 2003; Aoki et al., 2012). Nevertheless, further studies using patients in different nations and clinics are required for the present results to generalize in a wide range of patients.

In this study, the assessment of the treatment results was limited to 1 month after the treatment. Sustained activation of MTrPs is suggested to change from acute to chronic pain since continuous inputs from peripheral muscle nociceptors lead to changes in the function and connectivity of sensory dorsal horn neurons via central sensitization (Mense and Simons, 2001; Shah et al., 2008). Strong pressure stimulation to MTrPs decreases neural inputs to the dorsal horn in the spinal cord and prevents sensitization (Hong, 2004); thus, early intervention to MTrPs is important in preventing conversion from acute to chronic pain. However, Hong (2006) proposed that etiologic lesions may generate MTrPs, and the therapeutic effects of MTrP manipulation may be temporary unless the underlying etiologic lesions are appropriately treated. Thus, the long-term effects of compression at MTrP need to be investigated in a future study.

In this study, 8 patients withdrew from the treatment during the course of the study. An intension-to-treat analysis could reduce potential bias in the treatment effects arising from missing data in randomized controlled trials. However, patients were more frequently withdrawn in the non-MTrP and effleurage groups compared to in the MTrP group in this study; and therefore, this pattern of withdrawal would not affect the efficacy of compression at MTrPs. Consequently, in this study, we performed the per-protocol analysis in which the data of the patients who dropped out were discarded.

4.4 Conclusion

This study demonstrated that compression at MTrPs in acute low back pain significantly improved the VAS score for pain intensity, PPT and ROM compared with compression at non-MTrPs and superficial massage. These findings suggest that

compression at MTrPs is beneficial for the treatment of acute low back pain.

Author contributions

H.N. was responsible for the procurement of funds, the study design, analysis, and interpretation of the data, and writing of the manuscript. K.T. was responsible for the study design, analysis and interpretation of the data, and writing of the manuscript. I.B. was responsible for data collection/processing. S.U., S.S., and T.O. were responsible for analysis and interpretation of the data, and writing of the manuscript. All authors commented on and approved the final manuscript.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Changes in the primary (VAS, Move-VAS) and secondary (RMQ, PPT) outcome measures.

Table S2. Changes in the secondary outcome measures (ROM).

