Effect of Massage on Clinical and Physiological Variables During Muscle Fatigue Task in Participants With Chronic Low Back Pain: A Crossover Study

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Abstract

Objective: The purpose of this study was to determine if a reduction of short-term physiological and clinical effects of muscle fatigue can be seen after a session of massage in nonspecific chronic low back pain (cLBP) individuals and to study the possible association between physiological and clinical changes induced by massage.

Methods: Thirty-six cLBP individuals participated in 2 experimental sessions. In one session, the Sorenson protocol was preceded by a 30-minute massage, but in the other session, only the Sorenson test was performed by participants. Lumbar paraspinal muscle activity was recorded using surface electromyography, and maximal voluntary contraction force was measured using a load cell. Participants rated their lumbar pain intensity before and after massage and after the Sorensen protocol. A 2-way repeated-measures analysis of variance was conducted to test the effect of massage on both variables for both conditions. Pearson correlation analyses were conducted to determine the linear association between physiological and clinical responses to massage.

Results: Results showed that pain perception was significantly reduced after massage ($P = .004$) but did not seem to influence pain score increases occurring after the Sorensen protocol. Individuals with a high score of low back pain–related disability showed lower back muscle endurance time (r = -.35). Massage yielded no significant effect on fatigue-related physiological variables.

Conclusion: The perception of pain in cLBP individuals was reduced after massage. Although massage yielded some positives clinical effects, they were not explained by a reduction in physiological effect of muscle fatigue.
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Key Indexing Terms: *Massage; Low Back Pain; Electromyography; Muscle Fatigue*

Introduction

Low back pain (LBP) ranks first in years lived with disability among other musculoskeletal conditions, according to the 2015 Global Burden of Disease study.[1] Low back pain is characterized by ache or muscle tension located below the costal margin and above the inferior gluteal folds, which can also be associated with leg pain.[2,3] The mean lifetime prevalence of LBP is estimated at 38.9% ± 24.3%,[4] and the prevalence of chronic low back pain (cLBP) ranges from 9.3% to 11%.[5]

Individuals with cLBP present alterations in several physiological mechanisms often associated with psychological components, such as catastrophizing and kinesophobia.[6] For instance, individuals with cLBP usually present poor endurance and strength of their back muscles.[7] Furthermore, cLBP is characterized by the presence of excessive fatigability of lumbar paraspinal muscles.[7] Mannion et al (1999) reported in a review that lumbar muscles of individuals with severe LBP show a significantly higher proportion of type II fibers than muscles of individuals without LBP. The higher proportion of type II fibers could result in more fatigable muscles and has been suggested as a potential risk factor for LBP.[8]

Individuals with cLBP usually seek care to reduce their back pain symptoms but also to improve their functional capacity[3] and overall well-being.[9] Although complementary and alternative medicines are increasingly popular among patients with musculoskeletal-related disability, only a few noninvasive approaches are actually recommended in the treatment of cLBP. In recently published clinical practice guidelines dedicated to the treatment of

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LBP, massage therapy either as a standalone therapy or combined with other conservative approaches is recommended for patients with cLBP.[10-12]

Massage is defined as the manipulation of the whole body soft tissues to bring general health improvement.[3] It is perceived as a safe therapy for the management of musculoskeletal conditions[13] and is recommended by the Chartered Society of Physiotherapy.[14] In a recent international systematic review of massage therapy studies, it was reported that up to 20% of individuals from the general population visit a massage therapist over a 1-year period mostly for health care.[15] A study by Mori et al (2004) reported that a single 5-minute massage session directed at the lumbar and sacrum regions decreases muscle fatigue perception and improves blood flow compared to a prone rest position in a healthy population.[16] In a similar protocol, Tanaka et al assessed the effect of massage on physiological parameters such as paraspinal muscle activity recorded by electromyography (EMG). Using a 90-second back extension movement assessment, the authors failed to identify any changes in paraspinal muscle activity amplitude and frequency domain.[17] Other studies concluded that there was no effect on muscular activation when massage is applied to lower limb muscles such as biceps femoris[18] and knee extensors.[19] Overall, current evidence suggests that massage therapy can yield positive clinical outcomes such as reduction of clinical pain in individuals with cLBP. However, there is no clear evidence concerning the effect of massage on muscle fatigue physiological variables. Given the limited knowledge regarding specific mechanisms underlying the clinical effects of massage therapy on muscle fatigue, more rigorous scientific research is needed to better understand the effects of this therapy on cLBP.

Consequently, the main objective of the present study was to determine if short-term physiological (force and endurance) and clinical (pain intensity) outcomes of muscle fatigue can be modified after a single session of massage therapy in nonspecific cLBP individuals. The second objective was to study the association between physiological and clinical changes induced by massage therapy. The main hypothesis was that massage would limit the development of muscle fatigue and its effect on endurance and strength. Moreover, it was hypothesized that reduction in physiological adaptations would be correlated to changes in clinical outcomes.

Methods

Participants

Thirty-six participants with nonspecific cLBP (20 men and 16 women), aged between 18 and 65 years, were recruited in the local community between May and November 2016. In this study, cLBP means pain located below the costal margin and above inferior gluteal folds present for more than 3 months[3,20] without an exact origin of pain.[21] The sample size was determined based on the possibility to detect a statistically significant (P <.05) change of 25% in EMG muscle fatigue indices, a power of $\beta = 0.80$ and considering a 10% loss in data (for example, poor-quality EMG recordings or lost to follow-up participants). Participants were included if they had cLBP present for at least 12 consecutive weeks.[22] Participants presenting any of the following conditions were excluded from the study: rheumatic inflammatory disease, infectious disease, neuromuscular disease, vascular disease, connective tissue disease, severe disabling pain with a score on the Oswestry Disability Questionnaire (ODQ) ≥41%, neurologic signs and symptoms, and pregnancy. A clinical interview was conducted by a certified massage therapist to determine participants' eligibility. Once included, all participants provided informed written consent before participation in this study according to the certification obtained from the Université du Québec à Trois-Rivières ethics committee (CER-15-217-07.01). The study was registered at clinicaltrials.gov (NCT03124238).

Baseline Evaluation and Clinical Outcomes

Using a crossover design, participants with cLBP were assessed on 2 days separated by 48 to 72 hours at the University's Neuromechanics and Motor Control Laboratory. The 2 sessions (massage and control sessions) were separated by 48 to 72 hours to ensure that no residual effect of the fatigue task[23] or the massage protocol was present on the second assessment. A baseline evaluation conducted at the initial session included the following questionnaires: the modified ODQ,[24] STarT Back,[25] Fear-avoidance Beliefs Questionnaire (FABQ),[26] and Pain Catastrophizing Scale (PCS).[27] The STarT Back Screening Tool is a questionnaire used to identify the back pain disability of patients with potential treatment-modifiable prognostic indicators.[28] Also, it suggests the presence of cutoff scores for subgrouping patients into 1 of 3 categories of poor prognosis risk.[28] This questionnaire was used as a mean of assessing potential psychological risk factors as part of a biopsychosocial approach. Participants' baseline characteristics were obtained verbally, and body mass index (BMI) was calculated with body weight and height squared ($BMI = kg/m^2$).[29]

Finally, clinical pain intensity of the lumbar region was assessed at different points during the 2 sessions using a visual analog scale (10-cm scale)[30]: baseline evaluation, after massage (for appropriate session), and after the experimental protocol (maximal voluntary contraction [MVC] and modified Sorensen test). Peak pain intensity over the last 6 months was also assessed.

Massage and Control Sessions

The massage protocol consisted of a 30-minute massage of the back muscles separated into 2 types: 16 minutes of superficial massage and 11 minutes of deeper massage of the global back muscle region. The 2 minutes that remained

Table 1. *Complete Massage Protocol*

Massage Type/Techniques	Duration
Superficial massage	
Effleurage using the palm of the hand	1 m 30 s
Petrissage using side edge of the hand	1 m 30 s
Circular friction	1 m 30 s
Gliding	1 m 30 s
Palm stroking	2 m 00 s
Hands resting on each side of the lumbar spine	1 m 00 s
Deeper massage	
Muscle stripping (from spine toward the outside by maintaining pressure with 1 thumb at the spinous process)	1 m 00 s
Trigger points using thumbs	2 m 00 s
Muscle approximation (caudal to cephalic direction using muscles' line of action)	2 m 00 s
Hands resting on each side of the lumbar spine	1 m 00 s

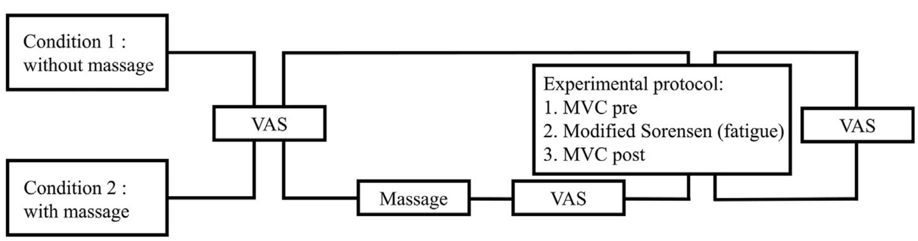

Fig 1. *Experimental procedure.* MVC*, maximal voluntary contraction;* VAS*, visual analog scale.*

were dedicated to preparation of the skin and the participant's and therapist's positioning. The participant was placed in a prone position on a massage table with a bolster pillow under their ankles and an optional bolster pillow under the lumbopelvic area. The complete massage protocol is presented in Table 1.

During the massage session, the experimental protocol was preceded by a 30-minute massage of the back region. Using a counterbalancing method to control for order effects, 18 of 36 participants received the 30-minute massage at the initial session, whereas the remaining participants received the same massage protocol at the second session. A complete experimental procedure is presented in Figure 1. No massage was provided during the control session.

MVC

During both sessions, participants were asked to perform 2 MVCs of back extensor muscles before and after a modified Sorensen protocol during which participants adopted a prone position on a Roman chair inclined at 45°.[31] Iliac crests were aligned with the edge of the chair cushion. Participants performed back extension MVCs against a belt installed over their shoulders before and after the modified Sorensen protocol. The belt was attached to a load cell (NTEP-87-057A3 class III; Artech, Riverside, California) permanently fixed to the ground by a cable. This load cell provided objective measures of back extensor muscle contraction force during the MVC. Participants lifted their trunk until they felt a tension in the belt (belt length was adjusted for each participant to ensure that their body remained in a straight position), then they were asked to perform 2 maximal isometric back extensions for 5 seconds.

Fatigue Protocol

The modified Sorensen protocol was chosen to trigger muscle fatigue and to assess endurance. Participants had to hold a horizontal position relative to the ground for as long as possible,[31] their arms crossed on the chest while holding a 11.36-kg standardized weight against their chest. Participants were asked to rate their perception of exertion immediately

Table 2. *Participant's Characteristics*

Characteristics	Mean ± SD		
N	36 (20 women, 16 men)		
Age (y)	41.4 ± 13.5		
Height (m)	1.72 ± 0.09		
Weight (kg)	76.2 ± 11.4		
BMI (kg/m^2)	25.6 ± 3.4		
STarTBack (/9)	2.4 ± 1.9		
STarT Back (/5)	1.2 ± 1.2		
FABQw (/42)	8.6 ± 7.3		
FABQpa (/24)	4.9 ± 5.0		
PCS (/52)	10.4 ± 8.1		
Baseline pain VAS (/10 cm)			
Control condition	1.8 ± 0.4		
Massage condition	2.0 ± 0.4		
Peak of pain [a] (/10 cm)	7.3 ± 2.1		
Conditions	1	2	*P* Value
ODQ (/100)	13.7 ± 10.4	12.1 ± 7.8	> .05

BMI, body mass index; *FABQpa*, Fear-avoidance Beliefs Questionnaire scores for physical activity; *FABQw*, Fear-avoidance Beliefs Questionnaire scores for work scale; *ODQ*, Oswestry Disability Questionnaire; *PCS*, Pain Catastrophizing Scale; *SD*, standard deviation; *STarT Back*, STarT Back screening tool; *VAS*, visual analog scale.

[a] Over the last 6 months.

after the fatigue task on a 6-to-20 scale.[32] A score of 6 was described as "no effort at all," whereas a score of 20 was described as "extremely difficult."

Muscle Fatigue EMG Parameters

Surface EMG was collected using bipolar disposable surface Ag/AgCl electrodes (Bortec Biomedical, Calgary, Alberta, Canada) applied on both sides of the spine over the right and left lumbar paraspinal muscles (L1 and L5). The EMG electrodes were not placed on the participants' back during the massage protocol to allow the therapist to perform the massage without constraint. They were placed after the massage protocol (massage condition) and remained in place during the MVC and the modified Sorensen. For both sessions, the EMG electrodes were placed by the same assessor. The EMG activity was recorded using the Bortec Biomedical acquisition system (AMT-8, common mode rejection ratio of 115 dB at 60 Hz, input impedance of 10 GΩ) and sampled at 1000 Hz with a 12-bit analog to digital converter (PCI-6024E; National Instruments, Austin, Texas).

Data Analysis

The EMG data was filtered digitally by a 10- to 450-Hz band-pass, zero-lag, and fourth-order Butterworth filter. Muscle fatigue during the modified Sorensen test was assessed through EMG amplitude (RMS value), and power spectral analysis was calculated from successive non-overlapping windows of 500 milliseconds. Median power frequency (MF) was obtained using fast Fourier transformation. Least square linear regression analysis was applied to RMS and MF time series (RMS and MF as a function of time) to estimate the rate of change (RMS and MF time slope). We had to exclude 1 electrode for 1 individual from the control condition for the analysis of RMS during the modified Sorensen test owing to the poor quality of myoelectric signals.

Statistical Analyses

Normality of data sets was verified and confirmed by visual inspection of data distribution and the Shapiro-Wilk test to provide graphical and numerical normality assessment. In this crossover repeated-measures design, all variables were submitted to a 2-way repeated-measures

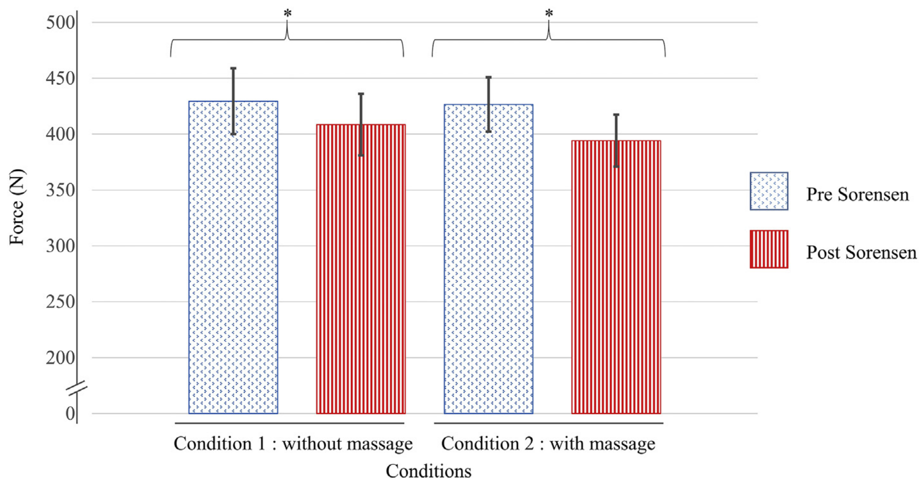

Fig 2. *Back muscle extensors (maximal voluntary contractions) before and after the modified Sorensen test.*

analysis of variance (ANOVA) to test for the effect of control and massage conditions on both physiological (force and endurance) and clinical (clinical pain intensity) variables. Pearson correlation analyses were conducted to assess the linear association between physiological and clinical responses to massage therapy. Statistical significance was set, for all analyses, at $P < .05$. The statistical package used was Statistica, version 13.2 (Dell Inc, Tulsa, Oklahoma).

Results

Participants' Characteristics

All participants completed the entire study. Mean ODQ scores indicate that participants presented disability levels ranging from minimal to moderate.[33] Oswestry Disability Questionnaire scores were not different at the control (13.7 ± 10.4) and massage (12.1 ± 7.8) conditions (P >.05). During the evaluation corresponding to the control condition, ODQ scores ranged from 2 to 44, and during the massage condition, ODQ scores ranged from 0 to 36. The mean STarT Back score (<3)[28] and mean PCS score (<20)[34] show that our participants were characterized by a low risk of poor prognosis (patients with few negative prognostic indicators, suitable for primary care management according to best-practice guidelines).[28] Furthermore, the mean FABQ scores for work scale (<34)[35] and physical activity scale (<15)[36] indicated that participants with LBP were less prone to have prolonged disability owing to fear-avoidance beliefs.[37] Participants' baseline characteristics are presented in Table 2.

Back Extensor Muscle MVC

The ANOVA revealed a significant main effect of time for the MVC indicating a change in MVC after the modified Sorensen protocol (Fig 2) ($F[1, 35] = 8.6$, P <.006). The mean MVC was higher before the modified Sorensen protocol (mean = 428.0 N; standard deviation [SD] = 26.0) than after the modified Sorensen protocol (mean = 401.3 N; SD = 24.6). The analysis revealed no effect of condition ($F[1, 35] = 0.4$, P >.05) nor any interaction effect ($F[1, 35] = 0.2$, P >.05). No significant differences were found in endurance time between the control (mean = 102 s; SD = 43.4) and the massage (mean = 109 s; SD = 44.7) conditions during the modified Sorensen protocol ($t = 0.9$, P >.05).

EMG Parameters

The MF slope values for both the control and massage conditions showed that participants were comparable regarding muscle fatigue generated during the modified Sorensen test (P > .05). This decrease in MF slope value suggests that participants in both sessions were subject to muscle fatigue after the modified Sorensen protocol. Results showed no statistical difference between the RMS values during pre- and post-MVCs for both the control and massage conditions (P >.05). Also, results showed no statistical difference between RMS values for both conditions ($t = 0.9$, P > .05). Participants' perceptions of exertion values were comparable for the control (mean = 16.3; P = 2.0) and massage conditions (mean = 16.2; P = 2.0) (P >.05). Complete EMG results are presented in Tables 3, 4, and 5.

Clinical Outcomes

No pain or any side effects were reported by the participants after the experimental protocol. The ANOVA indicated a significant effect of time on clinical pain intensity during the massage session only ($F[2,70] = 6.1$, P =.004). The Tukey post hoc test showed that clinical pain intensity was significantly lower after the massage protocol (mean = 0.9; SD = 0.2)

Table 3. *Lumbar Muscle EMG Parameter (MF) Results for Both Conditions During Modified Sorensen Test*

EMG	Conditions	Mean (slope) Hz/s	SD	t	df	*P* Value	- CI 95%	+ CI 95%
L1 left	Control	-0.047	0.06	± 0.7	35	.5	-0.007	0.01
	Massage	-0.043	0.05					
L1 right	Control	-0.079	0.05	± 0.7	35	.5	-0.007	0.02
	Massage	-0.075	0.04					
L5 left	Control	-0.086	0.05	± 0.3	35	.7	-0.009	0.006
	Massage	-0.087	0.05					
L5 right	Control	-0.083	0.06	± 0.3	35	.8	-0.01	0.009
	Massage	-0.084	0.06					

CI, confidence interval; *df*, degrees of freedom; *EMG*, electromyography; *MF*, median frequency; *SD*, standard deviation; *t*, t-statistic.
$P < .05$.

Table 4. *Lumbar Muscle EMG Parameter (Root Mean Square) Results for Both Conditions During Modified Sorensen Test*

EMG	Conditions	Mean (slope) Hz/s	SD	t	df	*P* Value	- CI 95%	+ CI 95%
L1 left	Control	0.24	2.70	± 0.43	34	.67	-2.96	1.93
	Massage	-0.27	7.60					
L1 right	Control	0.4	2.26	± 1.04	35	.31	-1.50	0.49
	Massage	-0.2	2.39					
L5 left	Control	-0.17	3.88	± 0.68	35	.50	-1.91	0.95
	Massage	-0.65	1.38					
L5 right	Control	-1.02	2.36	± -1.29	35	.20	-0.30	1.36
	Massage	-0.49	1.96					

CI, confidence interval; *df*, degrees of freedom; *EMG*, electromyography; *SD*, standard deviation; *t,* t-statistic.
$P < .05$.

compared with the baseline (mean = 2.0; SD = 0.4) ($P = .003$). No significant differences were observed between measurement after the experimental protocol and the following measures: at baseline ($P > .05$) and after the massage protocol (mean = 1.5; SD = 0.3) ($P > .05$). The ANOVA showed a significant interaction effect between time and condition for clinical pain intensity (F[1.35] = 9.7, $P = .004$). The Tukey post hoc test revealed a significant difference for clinical pain intensity after the modified Sorensen protocol (Fig 3) (F[1, 35] = 9.7, $P = .003$). During the control session, the intensity of pain increased after the modified Sorensen protocol (mean = 2.4, SD = 0.4) compared with the baseline evaluation (mean = 1.8, SD = 0.4) ($P > .05$). On the other hand, during the massage session, the intensity of pain decreased after the modified Sorensen protocol (mean = 1.5, SD = 0.3) compared with the baseline (mean = 2.0, SD = 0.4) ($P > .05$). Mean clinical pain intensity for both conditions is detailed in Table 6. No significant differences were found for questionnaires and EMG parameters during the modified Sorensen test (MF, RMS) and during the MVC (RMS) ($P > .05$).

Correlation

A significant negative correlation was found between the ODQ score and the endurance on the Sorensen test for the massage condition (r = -.35; $P = .038$) but not for the control condition (r = -.29; $P > .05$). This suggests that participants presenting higher disability (a higher score on the ODQ) were less resistant to fatigue. No other significant correlations were found between endurance and the other self-reported clinical outcomes (STarT Back, FABQ, and PCS).

Table 5. *Lumbar Muscle EMG Parameter (Root Mean Square) Results for Both Conditions During Maximal Voluntary Contraction*

EMG	Conditions		Mean (Slope) Hz/s	SD	t	df	*P* Value	- CI 95%	+ CI 95 %
L1 left	Control	Pre	0.46	0.38	± -0.16	35	.87	-0.09	0.10
		Post	0.47	0.41					
	Massage	Pre	0.57	0.45	± 0.18	35	.86	-0.13	0.10
		Post	0.56	0.42					
L1 right	Control	Pre	0.44	0.39	± -0.81	35	.42	-0.06	0.15
		Post	0.48	0.45					
	Massage	Pre	0.56	0.55	± 0.68	35	.50	-0.18	0.09
		Post	0.52	0.41					
L5 left	Control	Pre	0.29	0.23	± -0.64	35	.53	-0.06	0.12
		Post	0.32	0.33					
	Massage	Pre	0.39	0.37	± 1.13	35	.27	-0.21	0.06
		Post	0.31	0.24					
L5 right	Control	Pre	0.27	0.22	± -084	35	.40	-0.05	0.12
		Post	0.30	0.31					
	Massage	Pre	0.38	0.39	± 0.05	35	.96	-0.08	0.07
		Post	0.38	0.37					

CI, confidence interval; *df*, degrees of freedom; *EMG*, electromyography; *SD*, standard deviation; *t,* t-statistic.
P <.05.

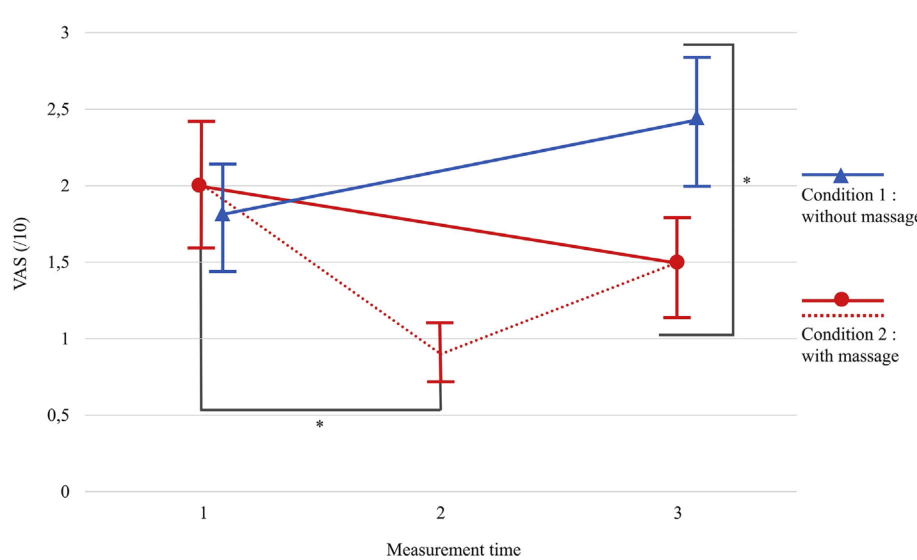

Fig 3. *Representation of the evaluation of clinical pain intensity for both conditions, without massage (blue) and with massage (red), at 3 points: (1) at the beginning of the session, (2) after massage (in dotted line for massage condition only), and (3) after the experimental protocol.* VAS*, visual analog scale. *P < .05.*

Table 6. *Clinical Pain Intensity for Both Conditions*

	Mean ± SD		*P* Value		
VAS (/10 cm)	Control Condition	Massage Condition	Time	Condition	Time × Condition Interaction
At the beginning	1.8 ± 0.4	2.0 ± 0.4	.8	.1	.004
After experimental protocol	2.4 ± 0.4	1.5 ± 0.3			

SD, standard deviation; *VAS*, visual analog scale.
P <.05.

Discussion

The main objective of this study was to determine if the short-term physiological and clinical effects of muscle fatigue can be reduced in individuals with nonspecific cLBP after a single session of massage. The second objective was to study the potential association between physiological and clinical changes induced by massage. The main result of this study showed that a 30-minute massage reduced clinical pain intensity in individuals with nonspecific cLBP in the presence of lumbar muscle fatigue, but that these changes were not associated with significant changes in muscle fatigue functional and physiological parameters.

Muscle Fatigue

The observed decrease in MF slope values indicates that participants in the control and massage conditions experienced muscle fatigue during the modified Sorensen test.[7] The MF value is considered a robust indicator of muscle fatigue[38] because it is less sensitive to noise[39] than other EMG parameters. The decrease in MF values was coupled to a significant decrease in MVC values after the Sorensen test (a decrease of 5% for the control condition and 8% for the massage condition). Even if there was no significant difference between the pre- and post-Sorensen RMS values during MVC, previous studies have shown that RMS values are less relevant to assess muscle fatigue in cLBP patients because they might refrain from performing MVC owing to fear of injury[40] or pain compared with healthy participants.[23,41]

Clinical Outcomes

The present study showed that clinical pain intensity of the back muscles was reduced after a 30-minute massage. Although pain intensity decreased after massage, the intervention did not seem to influence pain score increases occurring during the lumbar muscle fatigue task. In a previous study, a reduction of leg and back muscle soreness was observed when massage was provided as a recovery treatment after a 10-km running race.[42] Similarly, Preyde et al reported a decrease in pain intensity in individuals with LBP after 6 treatments of comprehensive massage therapy over a 1-month period compared with soft tissue manipulation only, remedial exercise with posture education only, or a placebo of sham laser treatment.[43] Pain relief is of interest to the clinician but must carefully be interpreted in the context of manual therapy studies. In the present study, changes in pain scores were modest after massage and did not reach the suggested minimal clinically important difference of 10% in the LBP population.[44] Even if clinical pain intensity increased in both conditions after the fatigue task, the level of pain intensity was still lower than baseline pain intensity in the massage condition.

Physiological Variables

In the present study, no significant difference was observed between the control and massage conditions for all physiological variables (MVC, RMS, MF). These results are in accordance with previous studies.[17,45] One study, assessing lower limb muscle fatigue in healthy participants, reported no change in EMG parameters and MVC after a cycle ergometer task.[45] Tanaka et al assessed back extensor muscle fatigue during a sustained back extension and also found no significant difference in median frequency, mean power frequency, or RMS when comparing massage to a resting condition.[17]

Endurance of Back Muscles

Contrary to our initial hypothesis, the endurance time was comparable in both conditions, suggesting that there were no residual effects of massage during the fatigue task. Our study indicates that individuals with higher disability show less endurance during a back extensor fatiguing task. Similar results were observed in a study comparing LBP individuals to healthy participants.[46,47] Interestingly, although massage therapy significantly reduced pain, decreased pain was not associated with increased endurance, nor any changes in physiological parameters of muscle fatigue. In this study, endurance, strength, and EMG parameters were used as surrogate measures of physiological processes underlying muscle fatigue. One could argue other physiological changes could explain the pain score during our protocol. For instance, Mori et al reported increased skin blood flow, muscle blood volume, and skin temperature after massage. On the other hand, changes in clinical outcomes after massage therapy may not be mediated by physiological changes in muscles because "fatigue-prevention effects" may be due to nonspecific components of the massage therapy, such as contextually aided recovery.[48]

Limitations

First, LBP and disability mean scores at the time of testing show that our participants presented light to moderate levels of disability (according to inclusion and exclusion criteria). The present results may not be generalizable to individuals with more severe LBP because participants were chosen based on their capacity and willingness to complete the modified Sorensen test. However, our participants reported a fairly high maximal peak pain intensity over the past 6 months (mean = 7.3; SD = 2.1), reflecting the typical fluctuating nature of cLBP symptoms.[49,50]

Furthermore, the control session was shorter because no rest time was provided to the participants. Although one would not expect a significant change in clinical outcomes over a 30-minute rest period, such a rest period and an additional assessment of pain should be considered. The observed changes after massage therapy may have been combined with resting effects that were not present in the control condition. Finally, the therapist who performed the massage protocol also conducted the participant's assessment of clinical pain intensity, potentially leading to an experimenter effect. The study was originally designed to assess the physiological changes induced by massage therapy. The absence of significant correlations between changes in self-reported outcomes (pain) and both physiological and functional indices (MVC and sEMG) suggest that clinical changes after massage therapy may partly be mediated by nonspecific components of the treatment, such as patient–therapist interaction per se.

Conclusion

This study shows a reduction in pain intensity in individuals with cLBP and localized muscle fatigue after a single session of 30-minute massage. Also, the results of EMG parameters (MF, RMS) did not show a significant difference between the control and massage conditions. Although massage led to positive effects on pain intensity, no changes in muscle fatigue indices could be observed, indicating that any "fatigue-prevention effects" may mostly be due to pain decrease and other nonspecific components of the massage therapy. More studies are needed to better understand the physiological effects of massage therapy.

Funding Sources and Conflicts of Interest

This work was supported by the In-Cam Research Network and the College of Massage Therapists of Ontario (Canada), which funded the study through a grant from the Massage Therapy Research Fund. This funding source had no involvement in collection, analysis, and interpretation of data. This source had no role in writing the article and no decision in publication. No conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): C.D., V.C., M.D.
Design (planned the methods to generate the results): C.D., V.C., M.D.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.D., V.C., M.D.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.D., V.C., M.D.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.D., V.C., M.D.
Literature search (performed the literature search): C.D., V.C., M.D.
Writing (responsible for writing a substantive part of the manuscript): C.D., V.C., M.D.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): V.C., M.D.

Practical Applications

- In this study, we found that massage reduced pain perception immediately after a fatigue task.
- Massage yielded no significant effect on fatigue-related physiological variables.
- Clinical effects were not associated with changes in physiological outcomes.

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