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Regional manual therapy and motor control exercise for chronic low back pain: a randomized clinical trial

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ABSTRACT

Objectives: Clinical practice guidelines recommend a focus on regional interdependence for the management of chronic low back pain (CLBP). This study investigated the additive effect of regional manual therapy (RMT) when combined with standard physical therapy (SPT) in a subgroup with CLBP.

Methods: Forty-six participants with CLBP and movement coordination impairments were randomly assigned to receive SPT consisting of a motor control exercise program and lumbar spine manual therapy, or SPT with the addition of RMT to the hips, pelvis, and thoracic spine. Outcome measures included disability level, pain intensity, pain catastrophizing, fear avoidance beliefs, and perceived effect of treatment. Appropriate parametric and non-parametric testing was used for analysis.

Results: Both groups demonstrated improvements in disability level, pain intensity, pain catastrophizing, and fear avoidance beliefs across time ($P < 0.001$). There was no difference between groups for any variable over 12 weeks, although a significantly greater proportion of participants in the RMT group exceeded the minimal clinically important difference (MCID) for disability. The perceived effect of treatment also was significantly higher in the group receiving RMT at two weeks and four weeks, but not 12 weeks.

Discussion: SPT with or without RMT resulted in significant improvements in disability level, pain intensity, pain catastrophizing, and fear avoidance beliefs over 12 weeks in persons with CLBP and movement coordination impairments. RMT resulted in greater perceived effect of treatment, and a clinically meaningful improvement in disability, across four weeks compared to SPT alone.

Level of Evidence: 1b

Clinical Trial Registration: ClinicalTrials.gov registration No. NCT02170753

KEYWORDS

Clinical trial; chronic; low back pain; manipulation; regional interdependence; exercise; manual therapy; physical therapy

The low back pain (LBP) clinical practice guidelines from the Orthopaedic Section of the American Physical Therapy Association suggest that specific treatments should be applied to homogeneous subgroups with a defined movement or pain impairment [1]. An impairment in movement coordination is thought to be common in patients with chronic low back pain (CLBP), and can be identified by the presence of aberrant movements during functional activities, pain that worsens with sustained end-range positions, hypermobility on segmental motion testing, and diminished trunk or lower quadrant strength and endurance [1]. Clinical practice guidelines recommend both motor control and general exercise programs for the management of CLBP with or without a specific movement coordination impairment [1–5]. This open-ended exercise recommendation is based on multiple systematic reviews reporting no difference in outcomes when comparing motor control exercise to either a general exercise approach, or to manual therapy, for non-specific CLBP [6–9]. Although exercise is a key component in the management of non-specific CLBP, evidence suggests that manual therapy combined with exercise can provide superior benefits to exercise alone [10–12].

Clinical practice guidelines support the general application of manual therapy for managing LBP [1–5], but do not specify an optimal type or location of technique. Multiple studies have reported equivalent benefits when either thrust or non-thrust techniques are applied to the lumbopelvic region in participants with subacute-chronic LBP, and in those fitting the clinical prediction rule for lumbar spine manipulation [13–16]. Although the issue of technique type has been widely investigated, many questions remain regarding the determination of technique location. Recent interest has focused on the concept of regional interdependence, which suggests that

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'seemingly unrelated impairments in a remote anatomical region' may contribute to an area of primary pain [17]. In support of this concept, the LBP clinical practice guidelines from the Orthopaedic Section recommend that manual therapy be applied to the hips, lumbopelvic region, and thoracic spine for patients with CLBP and movement coordination impairments [1]. However, limited evidence is available to support or refute the use of regional hip or thoracic manual therapy for managing CLBP [18–23].

The notion of a hip-spine syndrome as proposed by Offierski and MacNab [24] has received support from two case series and a randomized controlled trial (RCT). The first case series reported a 12-point reduction in Oswestry disability scores in patients with CLBP and hip pain undergoing total hip replacement [25], whereas the second reported a 6-point reduction in Oswestry disability scores in patients with CLBP after a short program of hip mobilization and stretching [22]. A recent RCT comparing isolated lumbar treatment to lumbar treatment with prescriptive hip treatment (i.e. strengthening and mobilization) reported significant short-term benefits for pain, disability, perceived effect of treatment, and patient satisfaction favoring the combined treatments [23]. Although the results of this RCT support the use of multimodal hip treatment (strengthening and mobilization) for CLBP, it is uncertain if isolated strengthening or isolated mobilization would have the same effect.

Several RCTs have focused on the use of thoracic manipulation for CLBP. The highest quality evidence suggested that thoracic manipulation was equivalent to lumbar manipulation for providing immediate reduction in LBP [18]. Longer term improvements in LBP also have been reported in RCTs comparing thoracic manual therapy to a control or exercise group; however, the quality of these studies is considered low [19–21]. In summary, although positive findings of reduced pain and disability have been reported, additional high-quality RCTs are needed to support the use of combined hip and thoracic regional manual therapy (RMT) in treating CLBP.

The purpose of this randomized clinical trial was to determine the additive effects of regional thoracic, pelvic, and hip manual therapy when combined with standard PT (SPT), consisting of motor control exercises and lumbar spine manual therapy, to improve disability level, pain intensity, pain catastrophizing, fear avoidance beliefs, and perceived effect of treatment in a CLBP subgroup with movement coordination impairments. We hypothesized that all participants would demonstrate improved outcomes, but that participants receiving RMT would achieve greater improvements in outcomes than participants receiving SPT alone.

Methods

Study design

This was a randomized clinical trial with 2 treatment arms (RMT vs. SPT). The trial was registered with ClinicalTrials.gov (NCT02170753) in June 2014, and conducted between August 2014 and December 2015. An a priori power analysis was performed using G*Power 3.1 [26]. Using a small-medium effect size (*f*) of 0.20 for our primary outcome measure, the Modified Oswestry Low Back Pain Disability Questionnaire (ODQ), we determined that 36 participants were required in order to obtain a power of 0.80 at an alpha level of 0.05. Anticipating a 10% attrition rate, we initially determined that 40 participants with CLBP would need to be recruited for this study. However, because our actual attrition rate (13%) was higher than we anticipated, six additional participants were recruited. Approvals from the UT Southwestern Medical Center and Texas Woman's University Institutional Review Boards were obtained prior to participant screening, enrollment, and data collection. All participants provided written informed consent and the rights of all participants were protected throughout the study.

Participants

Participants were recruited from a consecutive sample of patients coming to physical therapy for treatment of non-specific CLBP at the UT Southwestern Medical Center, and from flyers posted at the Dallas campuses of UT Southwestern and Texas Woman's University. Participants were included in this study if they: (1) were between the ages of 18 and 65, (2) had an active complaint of non-specific LBP for at least three months, (3) demonstrated hypomobility of the thoracic or lumbar regions on at least one spinal level, (4) demonstrated at least two of the following unilateral or bilateral hip ROM deficits: [22,27] supine-lying hip flexion <106°, supine-lying hip extension loss >6°, or prone-lying hip rotation <30° internally or externally, and (5) demonstrated hypermobility with or without pain of the lumbar region on at least one spinal level, or diminished trunk or pelvic muscle strength and endurance (as defined by a manual muscle test grade ≤3/5). Criteria (2)–(5) were chosen to identify participants who presented with a classification of CLBP with movement coordination impairments [1].

Participants were excluded from this study if they exhibited: (1) evidence of red flags, including fracture, infection, spinal tumor, or cauda equina syndrome, (2) pain that could be centralized through repeated movements, (3) signs of hyporeflexia, hypoesthesia, or myotomal weakness indicative of nerve root compression, (4) pregnancy, (5) systemic inflammatory conditions such as rheumatoid arthritis or ankylosing spondylitis, (6) inability to safely tolerate manual therapy to the spine or hips, (7) reports of receiving an injection to the spine within two weeks prior to study enrollment, or (8) an ODQ score below 20%. Participants with nerve root compression signs or a directional preference and centralization were excluded from this study because they may benefit more from treatments such as end-range repeated movements or traction that were not included

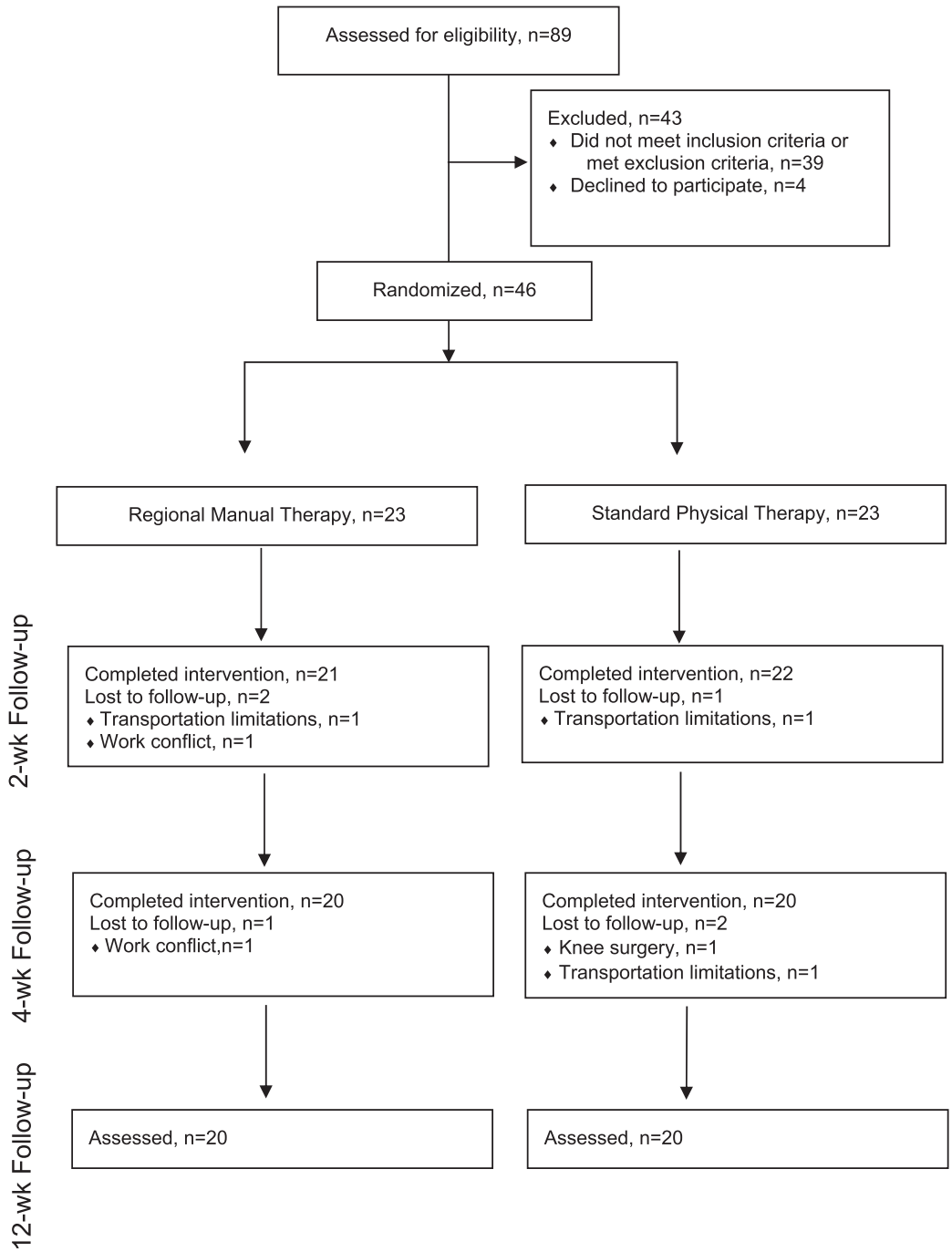

Figure 1. Flow diagram of participant recruitment and retention.

in this study [28]. Figure 1 displays a flow diagram of participant recruitment and retention.

Outcome measures

The primary outcome measure was disability level. The ODQ was used to assess the participant's level of LBP-related functional disability on a 100-point scale. The ODQ has been shown to be highly reliable, valid, and responsive in clinical trials [29]. The minimal clinically important difference (MCID) reported for the ODQ varies widely [30], but we chose to use the most strenuous criteria of ≥50% change [31,32]. Secondary outcome measures included pain intensity, pain catastrophizing, fear avoidance beliefs, and perceived effect of treatment. Pain intensity was assessed using the 11-point Numeric Pain Rating Scale (NPRS). This instrument has been shown to be reliable and responsive in a sample of patients with LBP, and has an MCID of 2 points [33]. The average of the current, best, and worst reported pain levels was used for data analysis at each time period. Fear avoidance beliefs were assessed with the Fear Avoidance Beliefs Questionnaire (FABQ), which contains five questions on how physical activity (FABQ-PA) and 11 questions on how work (FABQ-W) either affect or would affect the participant's pain [34]. Pain catastrophizing was assessed with the Pain Catastrophizing Scale (PCS), which is a 13-item questionnaire designed to

investigate the areas of magnification, rumination, and helplessness [35]. Both the FABQ-PA scale and PCS are highly reliable and valid in a population with CLBP [36]. The Global Rating of Change (GROC) scale was used to determine the participant's overall perceived effect of treatment. Participants selected scores ranging from -7 being a very great deal worse, to 0 being about the same, to +7 being a very great deal better. Jaeschke, Singer, & Guyatt [37] reported that scores of ±1 to ±3 represent small changes, scores of ±4 to ±5 represent moderate changes, and scores of ±6 to ±7 represent large changes. The GROC has adequate test-retest reliability and is sensitive to change [38]. All outcome measures were assessed at two weeks, four weeks, and 12 weeks after initiating treatment. The examiners collecting self-report outcome measures were physical therapists trained in study procedures. Each examiner was only allowed to test a participant for whom they had no treatment role in order to maintain blinding to the participants' group allocation.

Procedures

At the initial intake visit, study examiners obtained informed consent, determined participant eligibility, and collected demographic information and baseline outcome measures. Participants were then asked to draw a number from a sealed envelope to determine their group assignment. Three licensed physical therapists administered treatment to the participants. Treatments were provided by a physical therapist with 13 years of clinical experience and manual therapy fellowship training, as well as two therapists each nearing the end of a one-year orthopedic residency program. Prior to initiating the study, the treating therapists completed three hours of training on administration of the standardized motor control exercises and manual therapy techniques used in this study. Treating therapists were blinded to the results of the participants' outcome measures throughout the duration of treatment. Participants kept the same treating therapist for all treatments.

Treatment took place at the UT Southwestern Physical Therapy clinic twice weekly for four weeks, with each session lasting 30 min. Each session began with 10 min of local lumbar spine manual therapy for the SPT group, or local lumbar spine manual therapy plus regional thoracic, pelvic, and hip manual therapy for the RMT group. Local lumbar manual therapy was limited to non-thrust posterior-anterior (PA) or translatoric glides over the lumbar vertebrae, or non-instrumented soft tissue gliding or ischemic pressure between L1 and L5 (Appendix 1). The decision to restrict the use of thrust techniques for the SPT group was due to the likelihood that thrust techniques would include end-range mobilization or manipulation of the thoracic spine or pelvis. RMT included thrust and non-thrust manipulation to the lumbar spine, thoracic spine, ribs, pelvis, and hips, or non-instrumented soft tissue gliding or ischemic pressure over the hip, pelvis, lumbar, or thoracic regions (Appendix 1). The choice of initiating or suspending a specific manual therapy technique and the grade and duration of treatment was left to the discretion of the treating therapist.

Each session concluded with 20 min of instruction in a motor control exercise program (Appendix 2) [39,40]. Generally, exercises for each muscle group began with isolated isometric contractions to ensure adequate motor control, and progressed to open-kinetic-chain leg or trunk raises before moving to closed-kinetic-chain planking or bridging exercises. Instructions to gradually increase time under tension to a maximum of 30 s for four repetitions on each exercise were used in order to provide an element of graded-activity exposure, and to reflect the tonic nature of stabilizing muscles [41,42]. Once participants could perform 30 s of four repetitions without increasing pain and with good technique, they were advanced to an exercise with higher intensity, and were no longer required to perform the original exercise as part of their program. Participants unable to initiate all exercises in the program by the end of the fourth week of treatment were instructed on how to progress to the final exercises with their independent home exercise program.

Participants were asked to complete a home exercise program consisting of motor control exercises and self-mobilization on a daily basis during their four weeks of treatment. Self-mobilization exercises were limited to the use of a foam roller or tennis ball to re-create PA glides or ischemic pressure along the lumbar spine for the SPT group, or along the thoracic spine and adjacent ribs, lumbosacral spine, pelvis, and hips for the RMT group. After participants completed four weeks of treatment, they were asked to complete their home exercise program at least three times per week for an additional eight weeks. The home exercise sessions were expected to take 15–30 min to complete. Participants were asked to fill out an exercise log to track their compliance.

Statistical analysis

Chi square statistics were used to determine between-group differences for non-parametric demographic data such as sex, work status, depression level, and medication usage. Independent *t*-tests were used to determine if there was a difference between groups at baseline for demographic data such as age, pain duration, weight, height, and for scores on the ODQ, NPRS, PCS, and FABQ. Means and standard deviations (SD) were provided for all ratio-level demographic data and outcome measures. Between and within-group differences were assessed for the outcome measures using three forms of statistical analysis. First, linear mixed models with repeated-measures analysis were used to compare groups across time for the ODQ, NPRS, PCS, and FABQ scores ($\alpha = 0.05$).

Post hoc analysis was performed if there was a significant interaction. Second, chi square analysis was used to compare groups across time for the number of participants reaching or exceeding the MCID of 50% on the ODQ ($\alpha = 0.05$). Finally, a Mann–Whitney *U* test was used to compare GROC scores between groups for each of the three follow-up assessments ($\alpha = 0.05$).

Results

Of the 89 patients with LBP screened for eligibility, 46 met study criteria, agreed to participate, and were randomized to receive either RMT ($n = 23$) or SPT ($n = 23$). Data from six participants was not included in the final statistical analysis because these participants did not complete treatment, and the pattern of their missing data was at random [43,44]. Forty participants, 20 in each group, completed treatment and their data was analyzed. Baseline demographic and self-reported variables are described in Table 1. A significant difference was present between groups in height ($P = 0.042$) and BMI ($P = 0.018$), but no other between-group differences existed at baseline. No adverse events were reported in either group upon completion of treatment. Additionally, no significant differences were found between groups in exercise compliance during the four-week treatment ($P = 0.506$), or during the post-treatment phase ($P = 0.519$).

Table 2 lists the mean, SD, interaction significance, and observed power for each outcome measurement across time points. Analyses revealed that there was no significant 2-way interaction or main effect for group for the primary outcome of the ODQ score ($P = 0.092$), or the secondary outcomes of the NPRS ($P = 0.127$), PCS ($P = 0.827$), FABQ-PA ($P = 0.140$), or FABQ-W ($P = 0.700$) score. A significant difference was found in the main effect of time for the primary outcome of ODQ score and the secondary outcomes of NPRS, PCS, and FABQ scores ($P < 0.001$), indicating that both groups demonstrated improvement in disability, pain intensity, pain catastrophizing, and fear avoidance beliefs across time (Figures 2–4).

Contingency tables for the chi square analyses of participants reaching ≥50% MCID on the ODQ can be found in Table 3. Participants in the RMT group were significantly more likely to report ≥50% reduction in ODQ score than those in the SPT group at two ($P = 0.018$) and four

Table 1. Participant Characteristics.

	Regional Manual Therapy ($n = 20$)	Standard Physical Therapy ($n = 20$)	*P*-Value
Age (years)	46.7 ± 14.1	38.2 ± 13.1	0.055
Sex			0.103
Women	15	10	
Men	5	10	
Height (cm)	165.3 ± 10.9	173.2 ± 12.2	0.042*
Weight (kg)	81.8 ± 19.1	78.4 ± 15.4	0.545
BMI (kg/m^2)	29.8 ± 5.9	26.0 ± 3.5	0.018*
Duration of low back pain (months)	128.2 ± 161.0	69.0 ± 74.5	0.148
Work status			0.753
Employed full time	16	16	
Student full time	2	3	
Not working/ retired	1	1	
Disability	1	0	
Pain medication usage			0.386
Prescription	8	6	
Over the counter	8	6	
None	4	8	
Depression Questions			0.346
Yes to both	2	0	
Yes to one	3	3	
No to both	15	17	
Disability level	29.4 ± 9.1	27.2 ± 7.8	0.416
Pain intensity	4.3 ± 1.4	4.3 ± 1.4	0.952
Pain Catastrophizing	15.4 ± 12.0	17.8 ± 11.8	0.536
Fear Avoidance Beliefs			
Physical activity	14.3 ± 6.5	15.3 ± 5.4	0.618
Work	9.6 ± 8.3	13.4 ± 6.2	0.104

Note: All values are mean ± SD except those reported for sex, work status, pain medication usage, and depression questions. P-value for characteristics with a reported mean ± SD was determined with an independent t-test; all other P-values were determined with chi-square. * denotes a statistically significant difference between groups, $P < 0.05$.

Table 2 Outcome Measurements at Baseline, 2 Weeks, 4 Weeks, and 12 Weeks Post-Treatment and Results of Mixed Model Between-Group Analysis.

	Regional Manual Therapy	Standard Physical Therapy	*P*-Value	Observed Power
Disability level (ODQ)			0.092	0.220
Baseline	29.4 ± 9.1	27.2 ± 7.8		
2 weeks	19.1 ± 9.1	23.1 ± 8.3		
4 weeks	15.1 ± 11.7	17.1 ± 6.2		
12 weeks	11.2 ± 13.2	14.9 ± 7.2		
Pain intensity (NPRS)			0.127	0.490
Baseline	4.3 ± 1.4	4.3 ± 1.4		
2 weeks	2.8 ± 1.9	3.6 ± 1.3		
4 weeks	2.7 ± 1.6	2.6 ± 1.7		
12 weeks	2.6 ± 2.0	2.4 ± 1.4		
Pain catastrophizing			0.827	0.088
Baseline	15.4 ± 12.0	17.8 ± 11.8		
2 weeks	9.6 ± 11.5	11.9 ± 9.1		
4 weeks	6.1 ± 9.0	8.7 ± 8.6		
12 weeks	5.4 ± 10.3	6.3 ± 7.9		
FABQ-PA			0.140	0.472
Baseline	14.3 ± 6.5	15.3 ± 5.4		
2 weeks	11.7 ± 7.0	11.0 ± 5.9		
4 weeks	7.6 ± 6.5	10.4 ± 6.1		
12 weeks	7.8 ± 7.6	10.2 ± 6.3		
FABQ-W			0.700	0.129
Baseline	9.6 ± 8.3	13.4 ± 6.2		
2 weeks	9.1 ± 8.6	11.9 ± 8.6		
4 weeks	5.0 ± 7.8	7.9 ± 6.2		
12 weeks	3.4 ± 7.0	7.8 ± 6.1		
Perceived change (GROC)				
2 weeks	4.1 ± 1.6	2.3 ± 2.2	0.038	
4 weeks	4.8 ± 1.7	3.6 ± 1.7	0.038	
12 weeks	4.8 ± 2.0	4.3 ± 1.7	0.221	

Notes: Pain intensity was assessed with the Numeric Pain Rating Scale (NPRS), disability level with the Modified Oswestry Low Back Pain Disability Questionnaire (ODQ), and perceived change with the Global Rating of Change (GROC) scale. All values are mean ± SD.

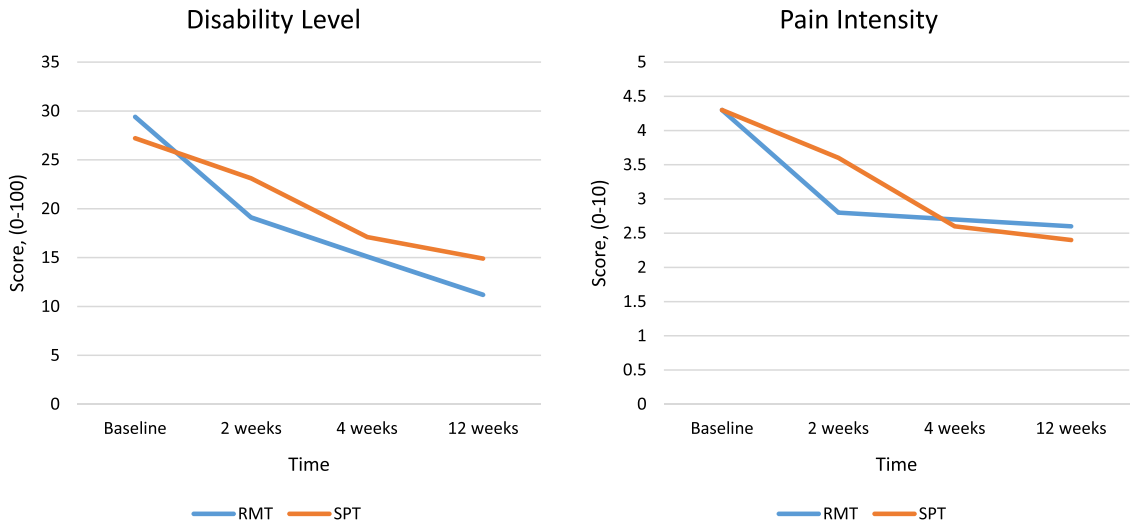

Figure 2. Disability level and pain intensity scores for both groups across time.
Notes: RMT = Regional Manual Therapy. SPT = Standard Physical Therapy.

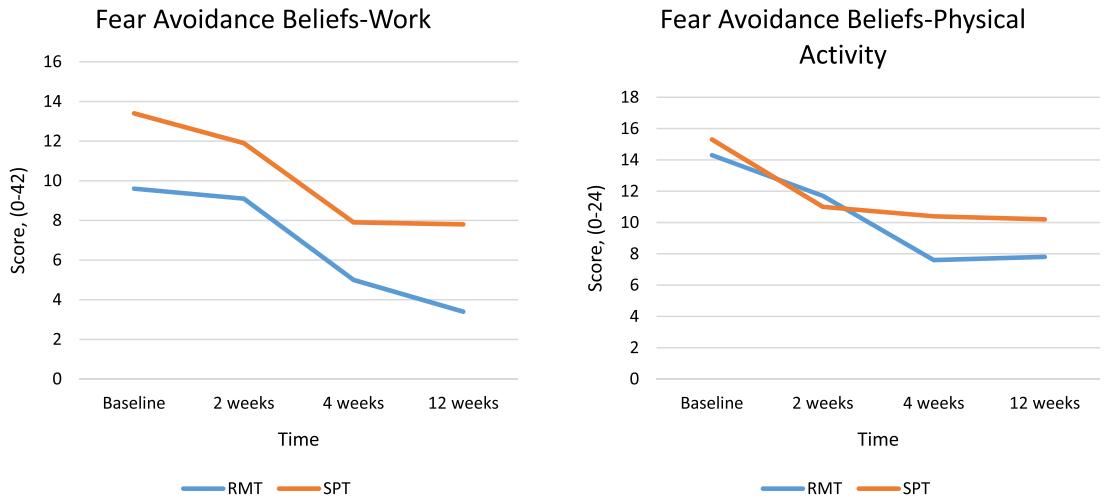

Figure 3. Fear avoidance beliefs scores for both groups across time.
Notes: RMT = Regional Manual Therapy. SPT = Standard Physical Therapy.

($P = 0.025$) weeks, but not 12 weeks ($P = 0.053$). Using non-parametric analysis, a significant difference was also found between groups for perceived effect, with the RMT group demonstrating higher perceived effect of treatment scores at two weeks and four weeks ($P = 0.038$), but not 12 weeks ($P = 0.221$) (Table 2 and Figure 4).

Discussion

Participants receiving SPT or RMT each improved in disability level, pain intensity, pain catastrophizing, and fear avoidance beliefs across time, supporting our hypothesis of finding an improvement in both groups who received manual therapy and exercise. Recent evidence suggests that a multimodal program of manual therapy and exercise yields significant benefits for CLBP [12]. Aure, Nilsen, & Vasseljen [10] were the first to show that an 8-week/16-visit program of mobilization and manipulation from T10 to the pelvis, combined with specific stabilizing and general exercise, was more beneficial than exercise alone at improving pain and disability level up to one year after completion of treatment. These findings were further supported by the work of Balthazard et al., [11] who found that a 4- to 8-week/8-visit program of spinal mobilization and manipulation combined with mobility and motor control exercises was superior to detuned ultrasound and exercise at improving pain and disability up to six months after completion of treatment. The present study sought to build upon the work of these authors by determining how the location of manual therapy performed would influence outcomes for a subgroup with CLBP and movement coordination impairments, and the results were in agreement with those of the above-mentioned studies.

Although the group means for disability level were not statistically different, a closer analysis revealed that a significantly greater proportion of participants in the RMT group achieved the 50% MCID for the ODQ at two

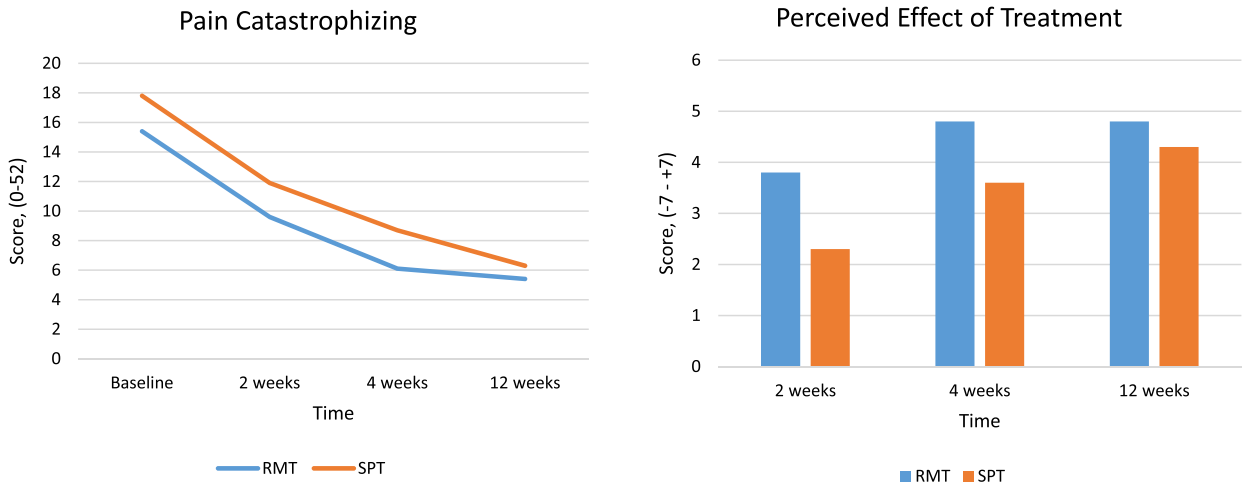

Figure 4. Pain catastrophizing and GROC scores for both groups across time.
Notes: RMT = Regional Manual Therapy. SPT = Standard Physical Therapy.

Table 3. Contingency Tables for Achieving or Exceeding the 50% Minimal Clinical Important Difference for Disability Level at 2, 4, and 12 Weeks Post-Treatment.

		2-Week MCID 50%	
		Not Met	Met
Group	RMT	13	7
	SPT	19	1
		4-Week MCID 50%	
		Not Met	Met
Group	RMT	8	12
	SPT	15	5
		12-Week MCID 50%	
		Not Met	Met
Group	RMT	5	15
	SPT	11	9

Notes: MCID = Minimal Clinical Important Difference. RMT = Regional Manual Therapy. SPT = Standard Physical Therapy.

and four weeks, with a trend toward significance at 12 weeks (P = 0.053). Both groups had a similar disability level at baseline (ODQ = 29.4 for RMT vs. 27.2 for SPT). However, at the two-week assessment, the RMT group could be classified as having minimal disability according to the criteria given by Fairbank and Pynsent [45], whereas the SPT group did not reach this distinction until week four. Additionally, the RMT group was able to exceed the 10.5-point minimal detectable change (MDC) [46] and 12-point minimal important difference (MID) [47] for the ODQ by week four, whereas the SPT group was just able to exceed these thresholds at the 12-week assessment. This difference may partially explain our significant findings for the 50% MCID, and for the perceived effect of treatment at the same time points.

At two weeks, the RMT group reported a mean GROC score of 3.8, which is approaching a moderate, positive change in the participant's perception of their condition [37]. In contrast, at two weeks, the SPT group reported a mean GROC score of 2.3, which represents a small, positive change in the participant's perception of their condition [37]. Although perceived effect of treatment scores for the RMT group improved over time, the magnitude of the change was relatively small, meaning that participants maintained their initial degree of change in perception despite steadily improving disability scores. The inability to discriminate a change on the GROC with further change in disability level may be explained by inconsistency in the relationship between these two variables over time, as small-large changes on the GROC have all been associated with achieving the MCID of 12-points on the ODQ [47,48]. Because the GROC allows the individual to determine what construct is most important for determining health status, it is also possible that other variables, such as demographic characteristics, may have impacted our outcomes.

Significant differences were found between groups in the demographic characteristics of height and BMI. Participants in the RMT group were an average of three inches shorter and four points higher in BMI than participants in the SPT group. No significant difference was found between groups for age or duration of symptoms, yet the RMT group was on average 8.5 years older and reported having pain for nearly twice as long (10+ years compared to 5+ years) as the SPT group. Although height and BMI have not been suggested as predictors of outcome in CLBP management [49], younger age and shorter duration of symptoms have each been associated with lower disability rates immediately post-treatment, and at 5 months and 1 year post-treatment [50–52]. Because the RMT group had a trend toward being older with a longer duration of symptoms, this group may have been expected to demonstrate smaller improvements in disability compared to the younger and less chronic SPT group. Conversely, the RMT group demonstrated a trend toward a greater improvement in disability. It is possible that the between-group difference in disability may have been even greater if both groups were of a similar age and reported duration of symptoms as the SPT group.

Six participants dropped out of the study before completing treatment. The reasons provided for dropping out varied, but were not related to any reported adverse events experienced by the participants. A comparison

of participant characteristics at baseline for those completing the study and those dropping out of the study revealed significant differences in a couple of areas. First, participants completing the study had lower pain levels ($t(38) = -3.3$, $P = 0.002$) on the NPRS at baseline (4.3 ± 1.4) as compared to participants who dropped out of the study (6.3 ± 1.7). Second, participants completing the study were less likely to be on disability or not working due to pain than participants who dropped out of the study ($\chi^2 = 8.4$, $P = 0.038$). Fifty percent of those who dropped out of the study, compared to 5.8% of those who completed the study, were on disability or not working due to pain. Higher pain intensity scores and reduced work participation at baseline have been associated with an unfavorable course of disability for persons with CLBP at one year [51]. In our study, it appeared that those with higher pain and reduced work participation had a less favorable prognosis for completing treatment.

Limitations

The results of this study should be interpreted in light of several limitations. A small sample size likely contributed to large variability between groups in some baseline demographic characteristics. Although these differences were not believed to contribute to a Type I error, they may have contributed to a greater likelihood of making a Type II error for some outcome measures. Additionally, this study was unable to control for all potentially confounding variables. The use of thrust manipulation was encouraged, but not required, for participants in the RMT group, whereas it was not allowed for participants in the SPT group. Different forms of manipulation were not believed to bias study results, as evidence suggests no difference in outcomes for the use of thrust vs. non-thrust spinal manipulation in patients with CLBP, or in those with LBP over the age of 55 [15,53]. Given that the participants were allowed to continue using pain-relieving medications throughout the duration of the study, it is also possible that the use of pain medications could have influenced the results of some outcome measures. However, participants were asked to refrain from starting any new medications or treatments while participating in the study. The presence of fear avoidance beliefs, pain catastrophizing, or depression could have also negatively influenced the recovery of some participants. The process of randomization was used to address the potential for these variables to bias study results. Given that both treatment groups were similar in medication usage, fear avoidance beliefs, pain catastrophizing, and depression at baseline, these variables are not likely to have unduly influenced study results. Finally, the results of this study should only be generalized to patients with CLBP tested and classified into a movement coordination impairment subgroup and displaying signs of hip stiffness with spinal hyper- and hypomobility. Future studies may report that the prescriptive, regional application of manual therapy and motor control exercise could be beneficial for all patients with non-specific CLBP, regardless of subgroup.

Conclusion

Manual therapy, including thrust manipulation, applied to the thoracic spine, pelvis, and hips may provide some additional short-term benefits over localized lumbar treatment alone for patients with CLBP and movement coordination impairments. The addition of RMT resulted in a significantly greater magnitude of change in disability level, and a significantly higher perceived change due to treatment, at two weeks and four weeks from the start of care.

Contributors

JZ, SWP, TR, KB conceived and designed the study, revised the article. JZ, SWP obtained funding and ethics approval, analyzed the data, wrote the article in whole/part, JZ enrolled subjects, administered interventions, collected the data.

Disclosure statement

The authors report no declarations of interest.

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