

# Effectiveness of McKenzie Intervention in Chronic Low Back Pain: A Comparison Based on the Centralization Phenomenon Utilizing Selected Bio-Behavioral and Physical Measures

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## Abstract

**Objectives:** To compare selected physical and bio-behavioral improvements following McKenzie intervention in individuals with discogenic chronic low back pain (CLBP) demonstrating centralization and partial centralization of pain.

**Design:** Prospective cohort study with three assessments; at base line and two follow-ups.

**Setting:** Two out-patient orthopedic Physical Therapy clinics.

**Participants:** 105 volunteers with CLBP (52 men and 53 women) average ages 41.9 and 37.1 years.

**Methods:** Subjects filled out pain and related fear and disability questionnaires, performed selected physical tests then underwent a McKenzie assessment protocol. McKenzie assessment protocol utilizes directional preference exercises to determine the pain centralization-phenomenon. Subjects were divided into 2-groups; completely centralized group (CCG) and partially centralized group (PCG), and underwent a McKenzie intervention. Outcome measurements were repeated at the end of the 5<sup>th</sup> and 10<sup>th</sup> weeks after completing the treatment

**Outcome Measurements:** Pain related fear and disability beliefs were assessed using the Fear Avoidance Belief Questionnaires (FABQ) and Disability Belief Questionnaire (DBQ). The time of sit-to-stand, forward bending, and customary and fast walking was recorded. Pain (anticipated vs. actual perception), were measured before and after each physical task. Descriptive statistics, Chi-square, paired t-tests, repeated measures ANOVA were used for longitudinal comparisons across assessment intervals at  $p < 0.05$  level.

**Results:** Significant improvements in patient physical performance times and bio-behavioral variables were observed on the 5<sup>th</sup> week following the intervention, but tended to regress thereafter.

**Conclusions:** In this cohort study of CLBP both CCG and PCG patients demonstrated significant measurable improvements in physical performances that remained stable for 10 weeks as a result of improved pain and related fear and disability beliefs.

**Keywords:** Bio-behavioral; Physical therapy; Fear Avoidance Belief Questionnaires (FABQ)

## Introduction

It is typical for an individual with acute low back pain, to avoid physical activities associated with pain and discomfort, however, the persistence of avoidance behaviors beyond the expected healing time when little or no pain exists represent a complex challenge to health care practitioners [1-3].

Numerous bio-behavioral factors including psychosocial, cognitive, environmental and physiological factors influence the pain experience. These factors intermediate between the neurophysiological aspect of pain and the actual sensory perception of pain, which may attenuate or exacerbate the discrepancy among pathology, actual pain, impairment, functional disability and eventually lead to chronic low back pain (CLBP) [2,4-7].

Cognitive factors such as anticipation of pain and pain related fear beliefs, as well as perception of self-disability are among the strongest predictors of poor functional performances that reinforce the persistence of avoidance behaviors [4-9].

Fear of pain triggered by anticipation of pain is fundamental assumption in the Fear-Avoidance Model of Exaggerated Pain Perception (FAMEPP) [4]. The model determines whether a person will become an "avoider" and experience persistence disability or become "a confronter" and resume previously avoided physical activities [4-

6]. Accordingly, confrontation of pain is perceived as "a well adaptive" response associated with a gradual return to normal activities, while avoidance is perceived as "a maladaptive" response associated with exaggerated fear beliefs and physical disability [4-6].

According to the FAMEPP, successful clinical intervention for CLBP should be evaluated in light of its long term influence on modifying the bio-behavioral variables and correct the maladaptive avoidance behaviors to promote and maintain the well behaviors, and to prevent recurrent episodes of back pain [1,2,3,4-8,10-16].

The McKenzie intervention approach is a comprehensive method of care for low back pain used by physical therapist that emphasize self-

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treatment, and enhance self-awareness of pain in relation to posture and spinal movement [17-21]. Numerous studies have reported the value of the phenomenon of centralization of pain (CP), which occurs during the initial McKenzie assessment and is associated with a desirable response and dramatic change in the pain intensity and location [18-24]. Pain and symptom modification by the CP help guide clinicians to select appropriate exercises and other manual techniques [22-31]. In addition, McKenzie directional preference exercises that are performed throughout the day may provide a rehearsal opportunity with mechanical, cognitive and sensory perception of pain that may modify pain expectation and related fear beliefs and ultimately to the correction of functional disabilities. Furthermore, CP has been regarded as a reliable predictor of positive outcomes and fast return to work while absence of CP or partial centralization was associated with poor outcomes and delayed or no recovery [22-31].

Regardless of the effectiveness of the McKenzie intervention for acute low back pain, systematic reviews of randomized trials do not support a long term effect of the McKenzie intervention for CLBP [20,21]. Although several studies have demonstrated the short term effectiveness of McKenzie intervention in acute back pain [18-31], few studies have focused on McKenzie effectiveness in CLBP [20,21]. Whether McKenzie interventions can influence the bio-behavioral variables and therefore physical activities in individuals who completely centralize or those who partially centralize is worth investigation. The purpose of this study therefore was to compare selected bio-behavioral factors and physical performances at baseline and at subsequent intervals following McKenzie intervention. We hypothesized that following McKenzie interventions, individuals with discogenic CLBP, with complete or partial pain centralization will demonstrate long term improvement towards avoided physical performances as a result of improved bio-behavioral factors.

## Methods

### Subjects

Volunteers were recruited from various hospitals and two physical therapy clinics. Included were subjects with LBP for more than two months, with referred pain and symptoms to the lower extremities, had no previous experience with McKenzie exercises, currently not receiving workers compensation, and willing to comply with the study protocol. Excluded were subjects with spinal tumors, spinal inflammations, spondylolisthesis, spinal fracture or dislocation, lower extremity motor or sensory deficit, concurrent cervical or thoracic pain, cardiopulmonary diseases, diabetes, cigarette smoking, pregnancy, use of steroids and analgesic medications, received epidural injections, had spinal surgery or inability to answer the questionnaires independently.

A total of 297 subjects were interviewed, only 193 were found eligible (64.9%). The remaining 104 subjects were excluded for the following reasons: 33 had to be rescheduled for spinal surgery, 11 had spondylolisthesis, 22 suffered from chronic facet arthropathy, and 38 individuals with co-morbidities. Eighty eight individuals (45.5%) dropped out of the study; 27 were not interested in continuing the treatment program or requested passive pain modalities, 15 admitted taking pain medications, 13 were unable to demonstrate complete or partial pain centralization, and an alternative treatment program was given to them, 27 were non-compliant with their home exercise program, and six were scheduled for epidural injections. Only the records of subjects who demonstrated complete or partial pain centralization were included in the study. A total of 105 individuals of the 193 eligible subjects (54.4%) comprised the final sample. Accordingly, subjects were divided into two groups; complete centralized group (CCG)

which consisted of (28 males and 34 females), and partially centralized group (PCG) consisting of (25 male and 19 females). Written consent was obtained from all subjects prior to any data collection. The study was approved by the Institutional Review Board.

### Outcome measurements

**Measurement of pain perception:** The physiological and cognitive perception of pain was assessed using three separate Visual Analogue Scales (VAS) [32-39]; One VAS for anticipated pain (AP) which measured expected pain intensity prior to executing a given physical task [37-39], a second VAS to measure the actual reported perception of pain (ARP) that measured the actual pain experienced while performing a given physical task [38-40] and finally a VAS to measure the overall pain (OP) that was experienced throughout the day. The VAS measures multiple dimensions of the pain experience such as intensity, distress, and pain anticipation. In addition, the VAS has high test-retest reliability [32-39].

**Measurements of pain related fear beliefs:** The individual self-perceptions of fear of pain beliefs associated with physical activities and work were measured by the Fear Avoidance Beliefs Questionnaire (FABQ) [12]. The FABQ has 16 items and each item has a score range between 0 and 6; the higher the score, the higher the fear beliefs. FABQ has two subscales; a 4-item subscale concerning physical activity (FABQ-PA) with score range between 0-24 and a 7-item subscale concerning work (FABQ-W) with a score range between 0-42. The FABQ has high reliability and validity for both subscales when used with CLBP patients [12]. An Arabic translation-back-translation version of FABQ was used in this study.

**Measurement of disability beliefs:** The perceived activity limitations due to LBP was measured by the Roland-Morris Back Pain Disability Questionnaire (DBQ) [40]. DBQ, consist of 24 items, with scores ranging from 0% for "no disability" to 100% for "severe disability" [40]. The DBQ has high test-retest reliability (ICC= 0.91 in < 2 weeks,  $r = 0.83$  in 3 weeks) and construct validity with the sickness impact profile (SIP;  $r = 0.85$ ), and Oswestry Disability Questionnaire ( $r = 0.59$ ), and the VAS ( $r = 0.59$ ) [41-43]. An Arabic translation-back-translation version of DBQ was used in this study.

**Measurement of physical performances time:** Four physical tasks were selected in this study; Customary Walking (CW), Fast Walking (FW), Sit-to-Stand (STS) and Trunk Forward Bending (TFW) [35-37,42,43]. A stopwatch was used to measure the time of each task. These physical performances were found to be reliable clinical measures for commonly performed tasks [42]. All measures had excellent inter-tester reliability (ICC>0.95). Test-retest (within session) reliability was adequate for all measures (ICC>0.83) except repeated trunk flexion (ICC>0.45) in patients with LBP. Self-report of disability was moderately correlated with the performance tasks ( $r = 0.400-0.603$ ) [42].

The VAS, FABQ, DBQ, as well as all physical task performances were measured at baseline prior to the McKenzie assessment, and were repeated at the end of the 5<sup>th</sup> and 10<sup>th</sup> weeks after interventions for both groups.

### McKenzie assessment procedure

A standardize McKenzie assessment protocol was utilized to determine the occurrence of CP [18,19]; Subjective assessment reflects on pain intensity, location, frequency, nature of pain, spinal movement or posture that increases or decreases the symptoms and the number of previous pain episodes. The objective assessment reflects on posture

evaluation, quality of lumbar spine range of motion, pain response to directional preference exercises; specifically lumbar extension and flexion in standing or laying, and lumbar side glides in standing [18,19]. The assessment also included static end range positions aiming to provoke, decrease or abolish the pain. Changes in pain locations were documented to determine the occurrence of the CP. The assessment protocol was repeated within 48 hours to confirm the occurrence of complete or partial centralization phenomenon. The occurrence of the pain centralization was based on the operational definitions given by Werneke et al. [23,24], and on the changes of pain location on the body diagrams [23]. Two separate body diagrams were used to establish changes in pain location at baseline and immediately after the initial McKenzie assessment. Only patients demonstrating the centralization phenomenon (complete or partial) were admitted to this study.

### Treatment intervention

Subjects in both CCG and PCG underwent a McKenzie intervention. McKenzie intervention was individually designed and prescribed after the McKenzie assessment protocol. The intervention included sustained end range positions, specific directional preference exercises to facilitate the CP and pain relief, lumbar spine mobilization and utilization of passive lumbar support. Movement (s) associated with the CP determined the directional preference of the spinal loading strategies, while movements associated with peripheralization of pain were avoided. Treatment progression was based on patient pain responses on subsequent visits and varied according to the needs of each subject. Therapeutic modalities such as ice or heat were provided on limited basis. All patients received standardized instructions and advice about posture correction, lifting, and the use of passive lumbar support. Home specific exercises were prescribed to be performed every two hours and treatment visits were scheduled within 24–48 hour intervals. For consistency, a total of 12 visits were allowed for each patient with a minimum of 3 visits per week. Termination of treatment was based on a reduction in the overall pain at the end of the treatment sessions, no pain peripheralization, ability to recover full spinal movements in standing or lying, and maintenance of good posture. Each patient was instructed to attend two assessment follow-ups at the end of the 5<sup>th</sup> and 10<sup>th</sup> weeks following interventions. Subjects who did not demonstrate CP were eliminated from the study and given alternate treatment.

The therapists conducting the McKenzie assessment and treatment procedures had 21 years of clinical experience at the time of the study, and completed parts A through D of the basic McKenzie certification courses. The therapist had no access to the VAS, DBQ, FABQ or the task performance time as these data were recorded by another trained therapist.

### Data analysis

Data were presented as mean  $\pm$  SD or number (%). Chi-square test was used for qualitative variables (FABQ & DBQ) and Student *t*-test was used for normally distributed quantitative variables (VAS and physical performance time) for the comparison between CCG and PCG. Paired *t*-test was used to compare groups, and repeated measures ANOVA was used for longitudinal comparisons across assessment intervals.

To measure the magnitude of improvement between groups, the differences from the baseline were calculated for each individual by subtracting the sum of the means of the baseline scores for each variable from those of the 5<sup>th</sup> or the 10<sup>th</sup> week assessments, and those between the 5<sup>th</sup> and 10<sup>th</sup> weeks assessment. The mean changes were

then compared between groups using the Mann Whitney U-test due to the skew in these values. Statistical Analysis was performed using statistical Package for Social Sciences, SPSS v. 19.0 (SPSS Inc., Chicago, USA). The level of statistical significance was set at 0.05.

## Results

### Demographic and clinical characteristics

Demographic characteristics of groups are shown in table 1. There were no significant differences between groups with regards to age, gender, height, employment status and level of physical activity. However, patients in the CCG had more body weight than the PCG (77.0  $\pm$  10.0 vs. 73.2  $\pm$  7.4,  $p < 0.025$ ).

### Physical performances and bio-behavioral variables

Table 2 displays baseline comparison of groups. The two groups differ significantly on the FABQ-W and DBQ, with higher scores reported by the PCG groups ( $p = 0.003$  and  $p < 0.050$  respectively).

Initially, individuals in both groups reported more AP than ARP experienced during the performance of a given task, this was more significant among the PCG; for both walking tasks ( $p < 0.001$ ). There were no group differences for AP prior to TFB and ARP for STS. However, the patients in the PCG took significantly more time to perform all tasks than their counterparts ( $p < 0.004$ – $p < 0.001$ ).

Figure 1 shows the longitudinal changes in performance times across assessment intervals. Using repeated measures ANOVA, our data revealed highly significant ( $p < 0.001$ ) longitudinal changes for all performances time. These changes were significantly different between groups ( $p < 0.001$  for all tasks). Also, the interaction of patient group  $\times$  assessment weeks were significant except for FW ( $p = 0.048$  for CW,  $p < 0.001$  for STS, and  $p = 0.010$  for TFB). Although the graph demonstrates significant improvements among the CCG, it also displays a considerable magnitude of improvement for patients in the PCG.

### Magnitude of improvements from baseline for bio-behavioral and physical performances

Table 3 Displays the magnitude of the mean changes from

	Centralized n=62	Partially centralized n=43	p-value
	Mean $\pm$ SD	Mean $\pm$ SD	
Age (years)	39.3 $\pm$ 4.8	41.5 $\pm$ 6.7	0.065 <sup>a</sup>
Height (cm)	172.4 $\pm$ 5.6	171.9 $\pm$ 5.5	0.650 <sup>a</sup>
Weight (kg)	77.0 $\pm$ 10.0	73.2 $\pm$ 7.4	0.025 <sup>a</sup>
BMI (kg/m <sup>2</sup> )	25.9 $\pm$ 3.0	24.8 $\pm$ 2.5	0.047 <sup>a</sup>
Gender			0.283 <sup>b</sup>
Male	28 (45.2)	24 (55.8)	
Female	34 (54.8)	19 (44.2)	
Employment			0.265 <sup>b</sup>
Full-time	40 (64.5)	26 (60.5)	
Part-time	13 (21.0)	14 (32.6)	
Retired	9 (14.5)	3 (7.0)	
Physical activity			0.730 <sup>b</sup>
Regular	22 (35.5)	13 (30.2)	
Partial	16 (25.8)	14 (32.6)	
Not active	24 (38.7)	16 (37.2)	

p-values are generated using <sup>a</sup>Student *t*-test and <sup>b</sup>Chi-square test for the comparison between centralized and partially centralized patients

**Table 1:** Characteristics of centralized and partially centralized patients (n=105).



	Centralized	Partially centralized	p-value
FABQ-PA	22.2 ± 3.3	21.7 ± 2.5	0.461
FABQ-W	34.7 ± 3.4	38.7 ± 3.4	0.003
DBQ	18.3 ± 4.9	20.2 ± 4.4	0.050
Overall Pain	84.0 ± 7.8	84.5 ± 5.6	0.752
Customary Walking			
Time (seconds)	64.2 ± 12.9	70.5 ± 8.8	0.004
Anticipate Pain	62.0 ± 13.2	84.1 ± 9.0	<0.001
Actual Reported Pain	46.4 ± 12.3	57.1 ± 17.4	0.001
Fast Walking			
Time (seconds)	38.5 ± 5.8	46.1 ± 11.2	<0.001
Anticipated Pain	66.3 ± 12.9	87.4 ± 5.5	<0.001
Actual Reported Pain	47.6 ± 10.1	56.6 ± 5.5	<0.001
Sit To Stand			
Time (seconds)	47.0 ± 6.6	61.9 ± 10.6	<0.001
Anticipated Pain	70.1 ± 22.2	90.3 ± 4.1	<0.001
Actual Reported Pain	57.2 ± 15.5	59.4 ± 8.9	0.359
Trunk Forward Bending			
Time (seconds)	43.3 ± 8.5	53.8 ± 8.5	<0.001
Anticipated Pain	78.7 ± 19.6	77.5 ± 15.4	0.748
Actual Reported Pain	58.9 ± 17.1	65.4 ± 15.5	0.050

Values are expressed as Mean ± Standard Deviation (SD). p-values are generated using Student t-test for the comparison between centralized and partially centralized patients.

p<0.001 for all comparisons between Anticipated pain Vs Actual Reported Pain among complete centralized and partially centralized patients by paired t-test.

FABQ-PA: Fear avoidance beliefs questionnaire-physical activity; FABQ-W: Fear avoidance beliefs questionnaire-work; DBQ: Disability beliefs questionnaire

**Table 2:** Comparison of baseline assessments between centralized and partially centralized patients.

baseline for all the variables at the 5<sup>th</sup> and 10<sup>th</sup> week follow-ups, and those between the 5<sup>th</sup> and 10<sup>th</sup> week follow-ups which reflect either improvements “negative values” or worsening “positive values” of a given variable.

### Bio-behavioral variables

The CCG reported significant improvements from baseline on 1<sup>st</sup> follow up, for FABQ-PA and the OP (p<0.00), while the PCG displayed more improvements in the FABQ-W, but not statistically significant (p<0.06). Both groups did not show any improvements in the DBQ scores.

The improvement in the bio-behavioral variables were more stable for the CCG after 10 weeks of the 12 session mark (p<0.02-p<0.00). Individuals in the PCG reported significant elevation in their FABQ-PA and FABQ-W between the 1<sup>st</sup> and 2<sup>nd</sup> follow ups while no differences were reported for the OP and DBQ for both groups.

### Walking performances

Compared to the initial visit, both groups demonstrated marked improvements in the walking performances time following McKenzie interventions, and group differences were not significant for CW time from baseline to the 1<sup>st</sup> follow up and hardly significant on the 2<sup>nd</sup> follow up.

The magnitude of improvement for FW time surprisingly showed no differences between both groups at any follow-up assessments. We observed that the AP and ARP were markedly reduced for both groups on the 1<sup>st</sup> follow up, but the magnitude of improvement in AP and ARP were more prominent among individuals in the CCG than the PCG (p<0.05 – p<0.001).

The AP for CW and FW was significantly regressed for the CCG

between the 1<sup>st</sup> and 2<sup>nd</sup> follow up (p<0.001, p<0.001 for CW and FW respectively), while the ARP for CW was more elevated in the PCG (p<0.001). No group differences were observed at the between the 1<sup>st</sup> and 2<sup>nd</sup> follow ups for the AP and ARP for the FW. Both groups showed long lasting improvements in the walking performances, more for individuals in the CCG than the PCG.

### Sit to stand

Surprisingly, individuals in the PCG demonstrated more improvements in STS time on both follow ups (p<0.000), with no group differences after the 1<sup>st</sup> follow up (p<0.50). This was associated with significant reduction in the AP scores for STS compared to baseline scores on the 1<sup>st</sup> and 2<sup>nd</sup> follow ups (p<0.005), with no group difference between the 1<sup>st</sup> and 2<sup>nd</sup> follow ups (p<0.50).

Individuals in the CCG demonstrated significant reduction in the ARP scores on the 1<sup>st</sup> follow up as compared to the baseline (p<0.001 for both assessments) with no group differences on 2<sup>nd</sup> follow up (p<0.699).

### Trunk forward bending

The time for TFB of both groups showed significant improvements on both follow ups compared to baseline; more pronounced among the PCG (p<0.01). No group differences were observed between the 1<sup>st</sup> and 2<sup>nd</sup> follow ups assessments. The two groups did not differ on AP and the ARP for TFB on any follow up comparisons.

### Discussion

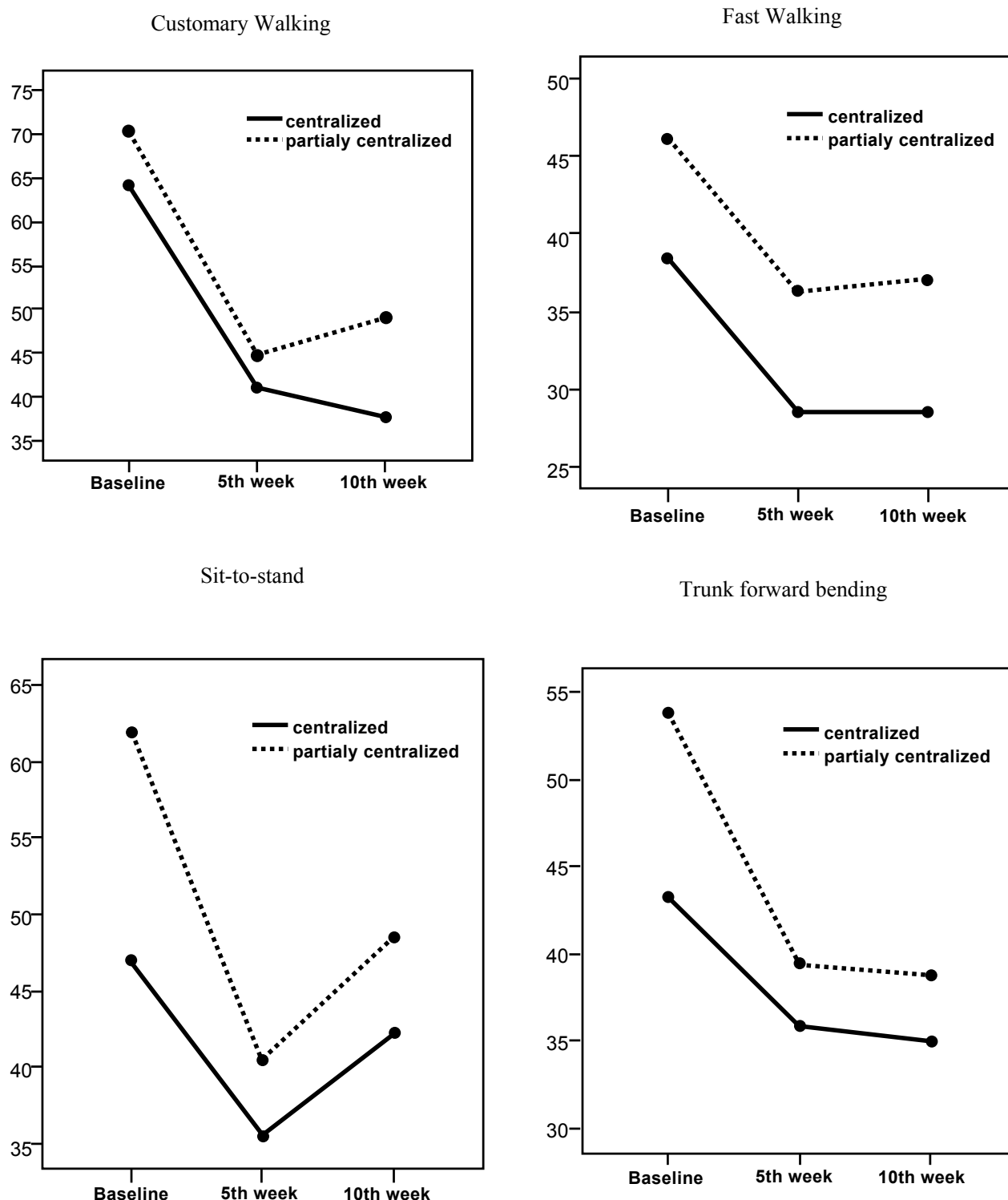
This study demonstrates that the McKenzie intervention was effective in the treatment of individuals with discogenic CLBP who demonstrate complete or partial pain centralization. The improved time of physical performances in both groups emerged as a result of marked modifications in the cognitive and sensory perception of pain.

Several studies have demonstrated positive outcomes associated with the occurrences of the CP [17,18,20-31]. The most reported observation is that centralized patients had significant improvements in pain and disability both in the short and long-term [44-46] and were less likely to undergo surgery [47]. Centralization was found to be a significant predictor of outcome measures than fear-avoidance [48], bothersomeness and depression [49], work satisfaction, pain behavior [23], and referral of symptoms [50].

Our preliminary results showed that the McKenzie intervention provides measureable improvements for selected physical performances even in the absence of specific physical training. Prior to McKenzie intervention, both the CCG and the PCG demonstrated delayed physical performance time as a result of elevated physiological and cognitive perception of pain. This was more pronounced among the PCG.

Although both groups demonstrated significant improvements following the McKenzie intervention, the magnitude of improvement among the PCG was consistent and comparable to the CCG across all bio-behavioral and physical performances, and remained stable for 10 weeks following the McKenzie intervention. Accordingly, partial pain centralization cannot be completely regarded as an indicator of poor outcomes. Our results support those of Werneke et al. [23] who concluded that centralization and the partial-reduction of pain are associated with good treatment outcomes.

Although 10 weeks of follow up may be short to report the long term effect of the McKenzie intervention, we observed parallel



**Figure 1:** Longitudinal comparison of mean performance time, anticipated and actual pain scores for different tasks at baseline, 5<sup>th</sup> week and 10<sup>th</sup> week.

improvements in bio-behavioral and physical performances that peaked after 5-weeks and persisted for 10 weeks after completion of intervention.

Petersen et al. [29] found that the effectiveness of the McKenzie

method seems to be stable in reducing CLBP disability after 2-months follow up than intensive dynamic strengthening training but equally effective to strength training after 8 months. Similarly, Udermann et al. [51] reported significant improvements in lumbar strength,

	Between 5 <sup>th</sup> week and baseline			Between 10 <sup>th</sup> week and baseline			Between 10 <sup>th</sup> and 5 <sup>th</sup> week		
	Centralized	Partially centralized	p-value	Centralized	Partially centralized	p-value	Centralized	Partially centralized	p-value
FABQ-PA	-11.1 ± 3.7	-4.9 ± 4.6	<0.001	-10.1 ± 4.5	0.7 ± 2.9	<0.001	1.0 ± 2.8	5.6 ± 4.0	<0.001
FABQ-W	-6.4 ± 4.9	-9.7 ± 10.8	0.061	-4.7 ± 5.4	-1.4 ± 4.1	<0.001	1.6 ± 4.5	11.2 ± 10.9	<0.001
DBQ	-6.9 ± 5.2	-5.1 ± 6.3	0.121	-4.0 ± 6.0	-1.4 ± 5.5	0.022	2.8 ± 4.6	3.7 ± 5.6	0.386
Overall Pain	-39.4 ± 15.0	-21.1 ± 14.0	<0.001	-35.7 ± 17.8	-10.8 ± 14.3	<0.001	3.7 ± 22.5	10.3 ± 15.7	0.080
CW									
Time (seconds)	-23.2 ± 13.6	-25.8 ± 12.9	0.337	-26.5 ± 12.3	-21.5 ± 13.3	0.054	-3.3 ± 6.0	4.3 ± 16.8	0.007
AP	-23.4 ± 23.4	-3.3 ± 11.1	<0.001	-6.2 ± 27.2	-0.2 ± 11.4	0.129	17.2 ± 31.9	3.1 ± 2.6	0.001
ARP	-11.2 ± 8.2	-3.5 ± 28.5	0.049	-11.0 ± 13.9	11.7 ± 18.9	<0.001	0.2 ± 12.0	15.1 ± 14.9	<0.001
FW									
Time (seconds)	-9.9 ± 6.4	-9.8 ± 10.8	0.938	-9.9 ± 7.7	-9.1 ± 10.5	0.657	0.001 ± 4.8	0.7 ± 2.4	0.332
AP	-16.2 ± 18.6	-4.7 ± 6.8	<0.001	-6.0 ± 18.4	1.6 ± 7.6	0.005	10.2 ± 12.6	6.3 ± 8.4	0.081
ARP	-20.3 ± 14.7	7.0 ± 6.6	<0.001	-13.2 ± 17.0	13.9 ± 8.7	<0.001	7.1 ± 19.2	6.9 ± 7.1	0.936
STS									
Time (seconds)	-11.50 ± 6.4	-21.4 ± 15.7	<0.001	-4.7 ± 6.3	-13.4 ± 11.9	<0.001	6.7 ± 6.9	8.1 ± 11.6	0.502
AP	-2.5 ± 27.8	-22.3 ± 22.4	<0.001	1.6 ± 29.3	-11.5 ± 17.7	0.005	4.1 ± 21.7	10.8 ± 32.7	0.239
ARP	-12.4 ± 21.9	1.9 ± 17.1	0.001	-9.6 ± 23.9	6.4 ± 11.0	<0.001	2.8 ± 22.7	4.4 ± 19.7	0.699
TFB									
Time (seconds)	-7.4 ± 8.9	-14.4 ± 15.9	0.011	-8.3 ± 11.0	-15.0 ± 15.4	0.016	-0.9 ± 9.9	-0.6 ± 16.0	0.925
AP	-16.8 ± 21.1	-11.5 ± 18.7	0.188	-18.3 ± 23.1	-18.2 ± 19.3	0.981	-1.5 ± 18.1	-6.7 ± 15.6	0.129
ARP	-24.2 ± 19.6	-30.6 ± 17.7	0.090	-6.2 ± 20.3	-7.4 ± 19.4	0.773	18.0 ± 16.0	23.2 ± 17.2	0.113

Values are expressed as Mean ± Standard Deviation (SD). p-values are generated using Mann Whitney U-test for the comparison between centralized and partially centralized patients. FABQ-PA: fear avoidance beliefs questionnaire-physical activity; FABQ-W: fear avoidance beliefs questionnaire-work; DBQ: disability beliefs questionnaire. CW: customary walking; AP: anticipated pain; ARP: actual reported pain; STS: sit to stand; TFB: trunk forward bending

**Table 3:** Comparison of change in different task performance times and pain perception scores at 5<sup>th</sup> and 10<sup>th</sup> week assessments between centralized and partially centralized patients.

endurance, and range of motion, as well as in a variety of health-related quality-of-life measures in CLBP patients following 4 weeks of McKenzie intervention. Al-Obaidi et al. [43] following McKenzie intervention for a cohort of CCG of CLBP was able to demonstrate significant improvements in all physical performances that remained stable 2-months following intervention.

A major clinical observation in this study is that anticipated pain prior to any physical task was always higher than the actual reported pain while performing the task at intake and all follow ups. After the McKenzie intervention and on the 1<sup>st</sup> follow-up, there was a marked decrease in both anticipated and actual reported pain scores with marked differences between the two scores indicating great discrepancies between what people anticipate as painful activity, what they actually felt of pain intensity, and more importantly how they actually function. This however, was associated with improved performance time regardless of slight elevation in fear avoidance and disability beliefs scores observed on the 1<sup>st</sup> and 2<sup>nd</sup> follow ups. This observation supports previous hypotheses that the decline in physical performances observed in CLBP may not exclusively be explained by the sensory perception of pain [1,2,4-8,15,16,35-37,51]. In fact, participants of this study were surprisingly not aware of their ability to perform a given task while at the same time reporting high levels of anticipated pain or even related fear and disability beliefs. We assume that improved performance time may be related to the disassociation between anticipated pain and the true perception of pain as a result of the McKenzie interventions. We believe that, as a result of eliminating the underline sources of pain by the McKenzie directional preference exercises, both measures of anticipated and the actual reported pain improve over time and approach one another on the lower side of the intensity scale, so that anticipated pain will be reasonably modified to the actual true perception of pain. This may improve self-confidence and in turn, may reduce anxiety created by anticipation of pain and related fear beliefs towards a given physical performance.

It was clear that certain activities that were considered difficult to perform at intake such as repeated trunk forward bending, sit-to-stand, and fast walking, improved significantly on the 1<sup>st</sup> and 2<sup>nd</sup> follow ups and remained somewhat stable in both groups regardless of the slight increase in the bio-behavioral variables after 10-weeks of intervention.

We postulate that the elevated anticipated and actual reported pain scores on the 2<sup>nd</sup> follow up approximate the high side of the pain intensity scale so that the elevated anticipation of pain exaggerates the actual reported pain. However, these seem not to affect the stability of physical performances in both groups.

Further, our results support previous observations that significant improvements in a rehabilitation program for CLBP is expected for individuals with elevated level of fear and disability beliefs [3,53]. Although we did not dichotomize any of the bio-behavioral scores of the initial visit, the two groups have reported high scores for all bio-behavioral variables at intake, specifically high levels of fear avoidance behaviors, disability beliefs and pain intensity. It was reassuring to observe that in this cohort group of CLBP, the magnitudes of improvements were significant for both groups regardless of elevated pain and related fear and disability beliefs. These finding may suggest that factors other than those explored in this study may have contributed to the recovery process and improved functional performances. We suggest that to maintain the gains following the McKenzie intervention, it is important to address the relationship between functional disability, and pain and related fear beliefs as a complementary educational program with the McKenzie intervention, specifically for partially centralized patients.

It clear from our results that the McKenzie interventions not only reduce the physiological perception of pain, but may also modify the cognitive and bio-behavioral factors influencing physical performances so that patients may be able to quantify realistically their true perception of pain associated with a given physical performances,

as well as inhibiting their related fear and disability beliefs about a given physical activity previously avoided due to pain. We believe that exposure to painful movements through repeated McKenzie exercises may be considered as a form of pain confrontation that complement the FAMEPP.

## Conclusions

In a cohort group of CLBP, both centralized and partially centralized patients demonstrated significant improvements in physical performances that remained stable for 10 weeks after the complete McKenzie intervention. These improvements emerged as a result of improved pain and related fear and disability beliefs.

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