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Application Of The McKenzie System Of Mechanical Diagnosis And Therapy In Patients With Shoulder Disorders

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A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Health and Rehabilitation Sciences

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Abstract

Shoulder pain is one of the leading causes of referrals to physiotherapy clinics. The annual prevalence of shoulder complaints is about 100 to 160 per 1000 patients in general population. Complexity of shoulder joint, and lack of uniformity of diagnostic labeling commonly used in clinical practice, makes it difficult to make a precise diagnosis. In addition, issues with reliability and validity exist for the shoulder Orthopedic Special Tests (OSTs), making accurate diagnoses challenging.

The primary aim of this thesis was to investigate usefulness of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in classifying and treating patients with shoulder disorders. This thesis includes three research studies. The first study (chapter 2) is a reliability study suggesting that the McKenzie system of MDT has very good inter-examiner reliability in classifying patients with shoulder pain. The second study (chapter 3) has a specific focus on clinical application of the MDT system in patients with shoulder pain through conducting a prospective longitudinal study. The primary objective of this study was to determine whether patients' pain and functional response to the McKenzie system of MDT differs by MDT classification category at two and four weeks following the start of MDT treatment. The study results suggest that classifying patients with shoulder pain using the MDT system can impact treatment outcomes and the frequency of discharge. When MDT-trained clinicians match the intervention to a specific MDT classification, the outcome is aligned with the response expectation of the classification. The third study (chapter 4) investigated the relationship between the results of three shoulder OSTs (Hawkins-Kennedy, Speed's test, and Empty Can) and the McKenzie system of MDT classification to explore the possibility that MDT classification of Derangement adversely affect the consistency of OSTs. The study results suggest that, due to the rapidly changing nature of Derangement classification, there is poorer agreement between the OSTs in patients with Derangement compared to patients with Dysfunction classification. Thus, Derangement may be responsible for reducing the overall agreement of commonly used OSTs. The thesis concludes with a discussion

(chapter 5) of next steps towards comprehending usefulness of the MDT system in management of patients with shoulder disorders.

Keywords

McKenzie; Mechanical Diagnosis and Therapy (MDT); Inter-examiner reliability; Orthopedic Special Tests (OSTs); Shoulder.

Co-Authorship Statement

Afshin Heidar Abady carried out the literature search and review, study design and planning, data collection, statistical analysis, and interpretation / synthesis of results. He took the lead role in the preparation of the manuscripts including the initial draft, coordination of revisions, and submission. Richard Rosedale contributed to the literature search and review, study design and planning, coordination of data collection, interpretation of results, and manuscripts review and revision. Tom J Overend and Bert M Chesworth contributed to study design and planning, interpretation of results, and review and revision of the manuscripts. Michael A Rotondi supervised and guided the statistical analysis, sample size calculation, interpretation of results and review and revision of the manuscripts. All authors read and approved the final articles.

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Chapter 1

1 General introduction and thesis outline

1.1 Mechanical Diagnosis and Therapy (MDT)

The McKenzie system of Mechanical Diagnosis and Therapy (MDT) was initially described in 1981, to introduce a new comprehensive approach to the classification and management of low back pain.¹ The system comprises both assessment and intervention components. The MDT system uses a non-pathology specific mechanical syndrome classification that is based on an assessment that includes the use of repeated movements while symptoms are monitored.² The primary objective of this assessment approach is to obtain a pattern of symptomatic response introduced as “centralization”, which is defined as the sequential and lasting abolition of all peripherally referred symptoms and subsequent elimination of any residual spinal pain in response to a single direction of repeated movements or sustained postures.¹ The assessment may also reveal a “directional preference” which is described as a particular direction of lumbosacral movement or sustained posture that leads to centralization, reduction, or even abolition of symptoms, while the patient’s limited range of spinal movement concurrently returns to normal.³ A standardized McKenzie assessment form developed for this purpose is used to record patient’s history, physical examination results and classification. Each classification requires a different and individually tailored management approach.²

The overall objective of the MDT system is to enhance patient self-management consisting of three fundamental phases: 1) patient education and demonstration about the benefits of appropriate positions, and exercise on their symptoms, and the provocative influence of the opposite movements and postures; 2) patient education on how to maintain improvement in their symptoms; and 3) patient education on how to regain full function to their lumbar spine without symptom recurrence.³

It is worth mentioning that many clinicians use the intervention component of the McKenzie system alone (e.g. repeated or sustained flexion/extension exercises) without

going through the appropriate steps of the MDT assessment. It is appropriate in such circumstances to introduce the intervention descriptively (e.g. repeated prone extension) rather than identifying it as McKenzie exercises, that stands for a more comprehensive assessment and matched intervention approach.³ This matter is very prominent taking into consideration the frequency with which the MDT system has erroneously been equated with that of extension exercises.³ This misconception is predominantly due to the fact that the proportion of the patients who benefit from extension is so large.

There has been a growing body of literature on the application of the MDT system in patients with spinal disorders. A series of systematic reviews support the efficacy of the MDT system in the management of acute and chronic low back pain.⁴⁻¹⁰ The MDT system has also demonstrated acceptable reliability^{3, 11-17} as well as diagnostic and prognostic validity¹⁸⁻²⁸ among experienced physiotherapists, when used with patients with spinal disorders.

1.2 MDT in extremities

McKenzie's original description¹ indicates that MDT could also be applied to extremity problems, and in his book on the application of MDT in the human extremities,²⁹ there is a detailed description of the clinical application.

According to McKenzie, extremity problems consist of the following syndromes:²⁹

- Derangement, identified by the presence of a directional preference which will give a rapid and lasting improvement in symptoms, in range of movement and in function;
- Articular Dysfunction, identified by intermittent pain consistently produced only at a restricted end range of motion with no rapid change of symptoms or range;
- Contractile Dysfunction, identified by intermittent pain, consistently produced by loading the musculo-tendinous unit, for instance, with an isometric contraction against resistance;

- Postural Syndrome, identified by intermittent pain only produced by sustained loading, with movements and activities being unaffected;
- OTHER subgroups are considered when none of the above syndrome patterns are present. Each has a definition and specific criteria that together complete the classification for all remaining presentations. Examples include Trauma, Peripheral Nerve Entrapment and Inflammatory (Appendix A).²⁹

When we started developing our study design in 2012, literature in this area was limited to individual case studies, which generally revealed very good treatment responses.³⁰⁻³⁴ One survey of the prevalence, classification and preferred loading strategies for the use of the MDT system in the extremities has also been published; demonstrating that 30 participating therapists were able to use the system to successfully classify all patients with an extremity problem.³⁵ Kelly and coworkers³⁶ studied the inter-examiner reliability of the MDT system in the extremities by conducting a pilot study with 11 patient vignettes and three MDT trained practitioners. May and colleagues³⁷ completed a follow-up study using 25 patient vignettes and 93 MDT diploma therapists.

1.2.1 *The Shoulder*

The clinical application of the MDT classification system for the extremities has not been investigated in any samples comprised exclusively of patients with shoulder pain. The shoulder is one of the leading causes of referrals to physiotherapy clinics. The annual prevalence of shoulder complaints is reported to be between 100 to 160 per 1000 patients in the general population,³⁸ and in some studies as high as 30% of the total referrals of patients with musculoskeletal disorders, making it the third most common musculoskeletal disorder after low back pain and neck pain.³⁹ In addition, the complexity of the shoulder joint, and lack of uniformity of diagnostic labeling⁴⁰ commonly used in clinical practice, makes it difficult to make a precise diagnosis of the underlying cause of pain. In the shoulder joint, stability is sacrificed for mobility. The shoulder can move in more than 16,000 positions, and it is predominantly called ‘the shoulder complex’ consisting of the acromioclavicular joint, the sternoclavicular joint, the scapulothoracic

articulation, and the glenohumeral joint.^{41,42} As the arm moves to elevation, movement takes place in all the four joints, therefore, proper coordination must exist between movements in all these joints in order to have smooth arm movements.⁴¹

The stability of the glenohumeral joint depends on both static and dynamic stabilizers. The static stabilizers are structures such as the labrum, glenohumeral ligaments, the joint capsule, capsular ligaments, and bony glenoid whereas dynamic stabilizers are the local musculature (the rotator cuff and periarticular muscles).⁴³ The greatest degree of the shoulder motion occurs in the glenohumeral joint due to its ball and socket structure.⁴⁰ The head of the humerus is considerably larger with respect to the glenoid fossa; therefore, only 30% of the humeral head can contact the glenoid fossa at a given time.⁴⁴ The bony glenoid is a shallow structure deepened by the glenoid labrum.⁴⁵ The glenoid and the labrum combine to make up a socket with a depth up to 9 millimeters.⁴⁶ From a theoretical viewpoint, all the above mentioned anatomical structures could potentially be a source of shoulder pain. Pain can also arise from the cervical spine and it may originate from the intervertebral disc, facet joints or nerve roots. However, there is a growing recognition in the literature that the focus on identifying the specific pathoanatomic source of pain has not resulted in satisfactory clinical diagnosis and subsequent management; therefore, systems such as MDT use a non-pathoanatomical approach in assessment and management of patients in both spinal and extremity disorders.

Pathoanatomic explanations for the response to MDT assessment and the classification of Derangement Syndrome in the shoulder have not yet been forthcoming. However, the spinal classification of Derangement has been described using the dynamic disc model originally described by Robin McKenzie in the lumbar spine. Multiple cadaveric,⁴⁷⁻⁴⁹ discographic⁵⁰ and MRI⁵¹ studies showed posterior transfer of nuclear content in response to anterior disc loading associated with lumbar flexion, as well as the reversely directed anterior nuclear migration in response to lumbar extension.⁵² Acknowledging that the annulus has nociceptors in its outer third⁵³ and has been recognized as a possible source of low back pain,⁵⁴ it seems that pain that aggravated with flexion may be due to an

increase in mechanical noxious stimuli on the posterior annulus resulting from both annular tension and posterior migration of nuclear contents with lumbar flexion.^{1, 55}

These findings support the McKenzie description whereby an offset load applied to the disc in a symptom- and fissure-specific direction of spinal movement would apply a reductive force or load onto displaced nuclear content, redirecting it back toward its more physiologic central location. Such a reduction would require an intact, competent annulus and a functioning hydrostatic mechanism.⁵² The symptom-generating annulus and/or nerve root are consequently mechanically decompressed, resulting in a lessening of nociceptive stimuli and the centralization of pain. The direction of spinal testing that elicits this beneficial pain response is referred to as the patient's "directional preference".⁵²

If we speculated what possible structures in the shoulder might have a potential to act similarly to what was described in the spine for the Derangement classification, we may think of the labrum, or even the capsule. For example, it may be possible that the symptomatic and mechanical response seen with the MDT Derangement classification could be due to the capsule becoming temporarily entrapped in the joint causing pain and movement loss.

The MDT classification of Contractile Dysfunction is clearly related to the shoulder's contractile structures, tendons or muscles. Hence pain is provoked by active and resisted movements and the shoulder moves relatively pain free passively. So the same principles of rehabilitating tendinopathies would be applicable to Contractile Dysfunctions, appropriate loading being the key in the rehabilitation process.

Articular Dysfunction where pain is only provoked at end range of the joint movement, actively or passively, would implicate passive joint structures. Ligamentous tissue and the capsule would likely be the structures more commonly associated when either a trauma or disuse has left these structures shortened and painful when stretched. The remodeling process needed would be the repeated end-range stimulus in the painful

range. Recovery would be slow, but pain-free range should gradually be restored as the capsule or ligaments are stimulated over a period of weeks and months.

1.3 Limitations of conventional practice

In general, developing a useful and comprehensive classification system for musculoskeletal disorders has been a great challenge for practitioners and researchers. In order to apply an appropriate treatment, the first step is to classify patients based on their clinical presentation. That would decrease practice variation, and enhance the effectiveness of treatment.⁴¹⁻⁴² A useful classification system would direct appropriate treatment and predict outcomes.

Conventionally-used diagnostic tests grounded in anatomy and biomechanics provide essential information, however such measures are not without shortcomings.⁴³ For instance, in one of the earliest studies of its kind, Boden and coworkers,⁴⁴ reported that 16% of asymptomatic volunteers had meniscal abnormalities in their magnetic resonance imaging (MRI) results consistent with a tear. The prevalence of MRI findings of a meniscal tear increased from 13% in individuals younger than 45 years of age to 36% in those older than 45.⁴⁴ There are a significant number of similar MRI, x-ray, and ultrasonographic screening studies conducted on the knee, hip, shoulder, and lumbar spine that report the prevalence of incidental abnormal findings with diagnostic tests in asymptomatic subjects. There are also reports that persons with, for instance, low back pain have normal MRI.⁴⁵⁻⁵² Therefore, despite the enormous amount of valuable information that diagnostic tests provide, the high incidence of abnormal findings in asymptomatic subjects should be taken into account when clinicians interpret their results. It is crucial to correlate these findings with clinical findings before planning therapy.

On the other hand, for clinical findings, commonly used orthopaedic special tests have also demonstrated limited utility in informing diagnosis. In the shoulder joint in particular, studies have revealed conflicting diagnostic performance for the majority of

orthopaedic tests used in the assessment of common shoulder disorders such as rotator cuff disorders, superior labrum anterior-to-posterior (SLAP) lesions, etc.^{46, 53-68}

Diagnostic labels for shoulder disorders such as adhesive capsulitis, frozen shoulder, and impingement syndrome are used often in clinical practice and research. Two systematic reviews have shown that criteria to define those labels were not uniform among the randomized controlled trials (RCTs) included in the studies.^{40,69} Schellingerhout and colleagues also reported that besides the lack of uniformity, the currently used labels have only fair to moderate inter-observer reproducibility and in systematic reviews none of the trials using a diagnostic label show a significant benefit of treatment.⁴⁰ They strongly suggested abolishing the use of these labels and directed future research towards unlabeled population with general shoulder disorder. Furthermore, they proposed that subgroups with a better prognosis and/or treatment outcome could then be identified within this patient population. Preferably, these new subgroups will be based on common characteristics that are valid and reproducible, to avoid the current problems with inter-observer agreement.⁴⁰

Taking into consideration the shortcomings of conventionally used examination procedures, a growing body of opinion favors implementing a different approach than a patho-anatomical model in the assessment and diagnosis of musculoskeletal disorders. We believe that the McKenzie system of Mechanical Diagnosis and Therapy (MDT) is one of the alternative methods that may fill the current care gap in the effective assessment and diagnosis of musculoskeletal disorders (and the shoulder joint in particular), leading practitioners toward better patient care.

1.4 Thesis outline

Lack of extensive supporting evidence on the application of the MDT system in the extremities, in general, and particularly in patients with shoulder disorders inspired us to focus our research project on the application of this method in patients with shoulder pain being one of the leading causes of referrals to physiotherapists. Thus, the overall objective of this thesis was to investigate the usefulness of the MDT system in patients

with shoulder problems. This study was conducted with three sets of experiments, the results of which are presented as separate thesis chapters.

For a classification system to be of clinical use, it must have certain characteristics.⁷⁰ First, different clinicians must be able to reliably classify patients into different subgroups so that one can be certain that these subgroups actually exist. Second, it must be verified that the classification system has clinical application in a significant proportion of the patient population. Finally, the value of the classification system needs to be determined by undertaking efficacy studies with and without classification.⁷⁰ The first feature requires reliability studies; the second feature, cross-sectional prevalence studies; and the third feature, prospective cohort studies and randomized controlled trials.⁷⁰ Reliability is necessary to ensure consistent identification between clinicians. However, if reliability were perfect but the classification system only applied to a small proportion of all potential patients, its clinical use would be limited. For a system to be clinically useful, it must be able to incorporate a substantial proportion of all potential patients.⁷¹

As the first step, in the study reported in chapter 2 we conducted a reliability study examining the inter-rater reliability of MDT trained practitioners in classifying patients with shoulder disorders using clinical vignettes. The aim of this study was to investigate the inter-examiner reliability of MDT-trained diploma therapists when classifying patients with shoulder disorders. We hypothesized that the MDT system has good inter-rater reliability when classifying patients with musculoskeletal shoulder disorders.

In chapter 3 we investigated the clinical application of the MDT system in patients with shoulder pain using a prospective longitudinal cohort study. The primary aim of this study was to investigate whether the response of pain and function to MDT treatment differs by classification category. The secondary objectives were to describe the frequency of discharge over time by MDT classification category, and determine the proportion of shoulder patients appropriately classified using the MDT system.

In our final study, we described the consistency of three commonly used Orthopedic Special Tests (OSTs) of the shoulder when used with the MDT classification. A common observation by MDT clinicians indicates that the results of OSTs can change dependent upon the MDT classification. The aim of this study was to examine whether the shoulder MDT classification and subsequent treatment received affects the consistency of the results of commonly used shoulder OSTs, in particular, to answer the question of whether the occurrence of a shoulder Derangement interferes with the results of and hence skews the interpretation of the OSTs. We hypothesized that there would be lower agreement between the consecutive results of the OSTs in patients with shoulder Derangements compared to patients with shoulder Articular or Contractile Dysfunctions over the course of their treatment.

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Chapter 2

2 Inter-examiner reliability of diplomats in the Mechanical Diagnosis and Therapy system in assessing patients with shoulder pain¹

2.1 Introduction

It is accepted that an accurate diagnosis is an important prerequisite for developing an effective treatment strategy.¹ Interventions are ideally targeted to a specific diagnosis; hence, an incorrect diagnosis may well lead to inappropriate management of a pathological condition and an increased likelihood for a poor treatment outcome. If the procedures and tests used in an examination are not reliable and valid, an incorrect diagnosis is the likely sequela.² A key to accurate diagnosis is the reliability of the diagnostic tests being used by the clinician. Inter-rater reliability has been defined as “the extent to which examiners, using the same test on the same patients, agree on the results of the test”.³

The literature has highlighted the fact that establishing an accurate diagnosis in patients with shoulder pain is problematic.⁴⁻⁸ Many commonly used examination procedures and orthopedic special tests for the shoulder lack reliability^{2,8} and validity.^{4,9-10} Additionally, there is a growing body of evidence suggesting that the findings from imaging tests, such as Ultrasound, Computed Tomography or Magnetic Resonance Imaging, should not be relied upon entirely for clinical decision making, as the incidence of pathological findings in clinically asymptomatic shoulders is significant.¹¹⁻¹⁴ This clearly compromises the clinician’s ability to make an accurate patho-anatomical diagnosis. As a result, there have

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been calls for^{6,8} and the development of^{7-8,15-16} non-pathoanatomic shoulder subgroups so that interventions can be more accurately matched to the patients who are classified within a given subgroup.

One widely used non-pathoanatomical classification scheme is the Mechanical Diagnosis and Therapy (MDT) system. It was initially introduced by Robin McKenzie in 1981 as a new approach to the classification and management of patients with low back pain.¹⁷ He later described application of this system to the cervical and thoracic spines.¹⁸ The MDT system classifies patient presentations based on analyzing the symptomatic and mechanical effect of different loading strategies, positions and postures.¹⁹ Each MDT syndrome requires its own particular management approach.

A series of systematic reviews support the efficacy of the MDT system in the management of acute and chronic low back pain.²⁰⁻²⁷ The MDT system for patients with spinal disorders has also demonstrated acceptable reliability,²⁸⁻³⁴ as well as diagnostic and prognostic validity,³⁵⁻⁴⁵ among experienced physiotherapists. McKenzie proposed that this system of diagnosis and treatment could also be applied to extremity disorders.¹⁷ McKenzie's book on the application of MDT to human extremities⁴⁶ contains a detailed explanation of its clinical application to patients with peripheral joint disorders.

According to McKenzie, patients with extremity disorders can be classified into the following four syndromes.⁴⁶

- Derangement syndrome: identified by a rapid response to a direction-specific loading strategy, known as the directional preference. A lasting improvement in symptoms, range of motion and enhanced function will be achieved once the directional preference has been established and utilized.
- Articular dysfunction: distinguished by intermittent and consistent pain only produced at a diminished end range with a slower response to specific tissue loading strategy.

- Contractile dysfunction: distinguished by intermittent pain consistently produced, but this time only when the musculo-tendinous unit is loaded, for instance, with an isometric contraction against resistance.
- Postural syndrome: intermittent pain only produced by prolonged postures that, once avoided, result in a return to a normal pain-free state. The remainder of the physical examination is normal.
- OTHER: patients who cannot be classified under any of the mechanical syndromes. Examples include trauma, articular structurally compromised, recent surgery and chronic pain syndrome (Appendix A).

These categories allow for the full spectrum of musculoskeletal presentations to be classified within the MDT system.

Use of MDT in the extremities has not been investigated to the same extent as it has in the spine. Currently the scientific literature in this area has been limited to individual case studies which generally reveal a very good treatment response.⁴⁷⁻⁵⁴ One survey of the prevalence, classification and preferred loading strategies for the use of the MDT system in the extremities has also been published; demonstrating that 30 participating therapists were able to use the system to successfully classify all patients with an extremity problem.¹⁶ A more recent pilot RCT study conducted on patients with rotator cuff tendinopathy revealed comparable treatment outcomes in these patients using the MDT-based, self-managed, loaded exercise program versus the usual physiotherapy program.⁵⁵

The MDT classification system, when used on patients with spinal disorders, has demonstrated acceptable inter-examiner reliability among trained physiotherapists.²⁸⁻³⁴ In the extremities, Kelly et al.⁵⁶ conducted a pilot study with 11 patient vignettes and three MDT trained practitioners, including two credentialed and one diploma therapists. May et al.¹⁹ continued with a follow-up study using 25 patient vignettes and 93 MDT diploma therapists. However, the inter-examiner reliability of the MDT classification system for the extremities has not been investigated in any samples comprised exclusively of

patients with shoulder disorders. The previous two studies included patients with a variety of extremity joint disorders, with no secondary analysis exploring inter-examiner reliability of the MDT system in any individual joint such as the shoulder. Only 7 out of 25 vignettes of the larger reliability study¹⁹ were shoulder cases (correspondence from study author). The aim of our study was to investigate the inter-examiner reliability of MDT-trained diploma therapists when classifying patients with shoulder disorders.

2.2 Method

2.2.1 *Design and procedure*

This was a two-phase study. In phase 1, a convenience sample of 11 MDT diploma holders were recruited from a publicly available list of MDT practitioners registered with the McKenzie Institute International who practice in Canada or the United States. They were asked to create 54 anonymous written clinical vignettes based upon findings from the initial assessment of previously treated patients with shoulder disorders. They were directed to document the patients' age in years, but 'not transfer' any identifying information regarding their patients including their name, address, telephone, and date of birth in order to maintain anonymity of the patients. The number of vignettes created for each sub-classification was 11 derangements, 11 articular dysfunctions, 11 contractile dysfunctions, 11 'spinal' category, which represents patients with shoulder pain deemed to be originating from the cervical spine, and 10 OTHER categories. Due to a very low incidence of 'postural syndrome' in patients with extremity disorders¹⁶ a 'spinal' category was used as the fifth MDT subgroup for this study and the 'postural' subgroup was assigned to the OTHER category. The 'spinal' category included patients with complaints of shoulder pain who were determined to have pain originating from the neck; this is commonly seen clinically and has been extensively reported in the literature.^{46, 52}

The standard McKenzie extremity assessment form routinely utilized by MDT practitioners was used to structure the clinical findings of the vignettes. In the event that a clinician did not have any recent patients that would fit one specific MDT sub-classification, the vignette was created based on the presentation of patients in that

subgroup from the past. Ethics approval for the study was obtained from the Health Sciences Research Ethics Board of Western University (Appendix B).

In phase two, the 54 vignettes from phase 1 were used to examine inter-rater reliability. These vignettes were sent to six MDT diploma holders who practice in Canada and the United States who had no involvement with the first phase of the study. They were also recruited from the publicly available list of MDT practitioners registered with the McKenzie Institute International. Following informed consent, an explanation of the study was provided and the clinicians were asked to review each vignette and identify the MDT classification for each vignette from the following five subgroups: derangement, articular dysfunction, contractile dysfunction, spinal and OTHER. All six clinicians were blinded to the MDT classification represented by each vignette.

2.2.2 *Sample size*

A confidence interval (CI) approach for sample size estimation of *Kappa* was used.⁵⁷ This method allows researchers to design their inter-examiner agreement study with any number of outcomes and any number of examiners using a pre-specified level of precision in the estimation of *Kappa*.⁵⁷ Assuming a preliminary estimate of *Kappa* = 0.7, with a 95% CI of 0.2, we determined that 54 vignettes were needed for six clinician examiners (MDT diploma holders).

2.2.3 *Analysis*

The *Kappa* coefficient, standard error (SE), and raw percentage of agreement were calculated across the six participating physiotherapists. Data were analyzed using the MAGREE macro in Statistical Analysis System (SAS) version 9.3 for Windows. *Kappa* values were interpreted using the traditional thresholds of: Less than 0.40= Poor; 0.41-0.60= Moderate; 0.61-0.80= Good; and 0.81-1.00= Very Good.⁵⁸

2.3 Results

Five physical therapists and one chiropractor who solely apply the MDT method when treating their patients with extremity disorders were recruited to classify the clinical

vignettes. Demographic information provided by the participating practitioners is shown in Table 2.1. Distribution of the MDT classification ratings of the clinicians, in addition to the true classification of the vignettes is shown in Table 2.2.

There was consensus among all 6 raters on the vignettes' classification in 78% of the vignettes (42 out of 54). The raw overall level of multi-rater agreement among the six clinicians was 96%. The corresponding *Kappa* value was 0.90 (SE=0.018). The highest level of chance-adjusted agreement was for the spinal category with *Kappa*=0.96; the lowest level was for the OTHER category with *Kappa*=0.80. By factoring in the true diagnoses of the vignettes in our analysis, the raw agreement and *Kappa* were 95% and 0.89, respectively. Values of agreement for each one of the MDT classifications are shown in Tables 2.3 and 2.4.

Table 2-1. Demographic information of the participating practitioners

Variables	Distribution
Number of raters	6
Age, mean (SD) (years)	51 (8.6)
Gender	Female : 2 Male:4
Years in practice, mean (SD)	25.7 (8)
Years since MDT diploma, mean (SD)	16 (4)
Proportion of extremity patients in caseload (n)	<25% : 2 25-50% : 4
Practice setting (n)	Private : 4 Hospital Outpatient: 1 Specialty Clinic : 1
MDT: Mechanical Diagnosis and Therapy, SD: standard deviation	

Table 2-2. Frequency (%) of vignette classification by rater

MDT Classification	Actual Classification (%)	Rater					
		1(%)	2(%)	3(%)	4(%)	5(%)	6(%)
Derangement	11(20)	14(26)	12(22)	13(24)	11(20)	13(24)	13(24)
Articular Dysfunction	11(20)	11(20)	9(16)	10(19)	11(20)	10(19)	10(19)
Contractile Dysfunction	11(20)	11(20)	11(20)	11(20)	10(20)	12(22)	11(20)
Spinal	11(20)	12(22)	12(22)	12(22)	11(20)	12(22)	11(20)
OTHER	10(20)	6(12)	10(18)	8(15)	11(20)	7(13)	9(17)
Total	54(100)	54(100)	54(100)	54(100)	54(100)	54(100)	54(100)

MDT: Mechanical Diagnosis and Therapy, SD: standard deviation

Table 2-3. Agreement findings by MDT classification across raters

MDT Classification	Raw Agreement (%)	<i>Kappa</i>	Standard Error
Derangement	95	0.90	0.035
Articular Dysfunction	97	0.90	0.035
Contractile Dysfunction	97	0.92	0.035
Spinal	97	0.96	0.035
OTHER	94	0.80	0.035
Overall Agreement	96	0.90	0.018

MDT: Mechanical Diagnosis and Therapy

Table 2-4. Agreement by MDT classification across raters and the actual MDT vignette classification

MDT Classification	Raw Agreement (%)	<i>Kappa</i>	Standard Error
Derangement	93	0.88	0.030
Articular Dysfunction	96	0.87	0.030
Contractile Dysfunction	97	0.93	0.030
Spinal	96	0.96	0.030
OTHER	93	0.77	0.030
Overall Agreement	95	0.89	0.015

MDT: Mechanical Diagnosis and Therapy

2.4 Discussion

To our knowledge, this study is the first to address inter-examiner reliability of the MDT system exclusively in patients with shoulder pain. The results support the findings of previous reliability studies on the application of MDT in the extremities.^{19, 56} The principal findings of our study suggest that experienced McKenzie practitioners have a “very good” level of inter-examiner agreement when classifying patients with shoulder pain using the MDT system. The highest level of agreement was for the ‘spinal’ category with $Kappa=0.96$, and the lowest level of agreement was for the OTHER category with $Kappa=0.80$. The relatively lower level of agreement for the OTHER category was anticipated because multiple subcategories are included in this MDT classification. This makes diagnosis more challenging particularly when the decision is solely based on information collected in the initial assessment. A relatively higher level of agreement for the ‘spinal’ category may be due to the presence of more identifying symptoms, such as paraesthesia, reported in some of the vignettes, and also the presence of, in some cases, a relatively quick response in the shoulder pain level of these patients by addressing their cervical spine. By including the actual classification of the vignettes in our analysis, as shown in Table 4, there is only a slight decline in both percent agreement and the $Kappa$ value. This slight decline could be due to the presence of insufficient clinical information provided in the vignettes, as these were based only on the clinical information gathered in the initial assessment session.

The results of our study on the shoulder generally reinforce the findings of previous reliability studies in the spine and the extremities, suggesting that the MDT system is a reliable method to classify patients with musculoskeletal shoulder disorders. Multiple studies have been conducted on inter-examiner reliability of the MDT system in patients with spinal disorders demonstrating an acceptable level of reliability among MDT practitioners in classifying their patients.²⁸⁻³⁴ For instance, Razmjou et al.²⁸ and Kilpikoski et al.³⁰ reported good inter-examiner reliability between two MDT trained therapists in classifying patients with low back pain into MDT classifications ($Kappa=0.7$). In another type of study using video and written clinical vignettes,

Werneke et al.³⁴ reported substantial to almost perfect inter-rater agreement in identifying treatment approaches for neck and low back disorders among MDT trained therapists. There are only two studies addressing inter-examiner reliability of the MDT system for patients with extremity disorders.^{19, 56} These two studies included a pilot study with 11 clinical vignettes⁵⁶ and three therapists, and a follow up study with 25 clinical vignettes and 93 MDT diploma holders.¹⁹ The pilot study showed “good” agreement with a *Kappa* value of 0.7, and the follow up study revealed “very good” agreement with a *Kappa* value of 0.83 (95% CI, 0.68-0.98). The clinical vignettes used for these studies were based on patients with both upper and lower extremity disorders. There was little difference between the reliability in upper (*Kappa*=0.85) and lower extremity (*Kappa*=0.80) cases.¹⁹

The major limitation of the current study was that only practitioners with an MDT diploma, the highest level of MDT training, were included. This limits the generalizability of the findings of this study, as the inter-rater agreement among clinicians without this level of training may not be as high. Therefore, this study is a first step when evaluating the reliability of using the MDT system to classify patients with shoulder pain. Future studies should include practitioners with different levels of training and experience so that the agreement findings are generalizable to a broader group of practitioners. Another limitation of this study was using written vignettes instead of having actual patients. The major concern in this regard, as stated by Werneke et al,³⁴ is the purification of the intervention being expressed in the vignettes, which may not represent all aspects of clinical practice, making the diagnosis easier for the raters and inflating the calculated *Kappa* value. One strength of using written vignettes is that this approach eliminates the potential error created by inconsistent patient presentations between raters. As an alternative, future studies could consider the use of real patients instead of written vignettes in order to further establish reliability of the MDT system in the extremities.

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Chapter 3

3 Application of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in patients with shoulder pain; a prospective longitudinal study²

3.1 Introduction

Shoulder pain is a common problem in the general population with reported rates ranging from 100 to 160 per 1000 patients.¹ Once present, shoulder symptoms have proven to be persistent and recurrent, with 50% still unresolved after 18 months.² It is thus not surprising that shoulder pain is one of the leading causes of referrals to physiotherapy.¹ The complexity of the shoulder joint, poor accuracy of shoulder clinical tests³⁻⁶ and the lack of uniformity of diagnostic labeling⁷ make a precise diagnosis difficult to achieve. Without a precise diagnosis, treatment is likely to be more arbitrary than targeted which may contribute to the lack of efficacy for most interventions.⁸ This difficulty for clinicians is compounded by the knowledge that many pathological findings revealed on diagnostic tests such as Magnetic Resonance Imaging, x-rays, or ultrasound are asymptomatic⁹⁻¹³ and so cannot be relied upon to make informed clinical decisions as to the source of the pain.

The issue of uniformity and accuracy of diagnosis and treatment is an important concern to address. These confounding factors have led to the call for and proposal of alternative methods of assessment and classification.^{7, 14-15} Though some alternative classification systems have been developed, their widespread use and acceptance among practitioners has proven to be challenging. This may be due to their relatively recent introduction and a dearth of research exploring their validity. If such a system was successfully embraced it

² A version of this chapter has been published and is used with permission. Heidar Abady A, Rosedale R, Chesworth BM, Rotondi MA, Overend TJ. Application of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in patients with shoulder pain; a prospective longitudinal study. J Man Manip Ther. DOI 10.1080/10669817.2017.1313929.

would reduce the variation in clinical practice amongst clinicians, and potentially lead to an enhanced effect of treatment.¹⁶⁻¹⁷

The McKenzie system of Mechanical Diagnosis and Therapy (MDT) is one alternative approach to the assessment, classification and treatment of musculoskeletal disorders. The MDT system was initially described in 1981 with the introduction of a new approach to the classification and management of back pain.¹⁸ It uses non-pathology specific classifications that are based on a detailed history and a physical examination exploring the effects of repeated movements, positions and loading strategies on symptoms and motion.¹⁹ Each classification is matched to a different management approach.¹⁹

A series of systematic reviews support application of the MDT system in the management of acute and chronic low back pain.²⁰⁻²⁷ McKenzie's original description¹⁸ indicated that MDT could also be applied to extremity problems, the application of which is outlined in his book on the human extremities.²⁸ According to McKenzie, extremity problems can be classified into the following syndromes and OTHER subgroups:²⁸

- Derangement, identified by the presence of a directional preference which will give a lasting positive change in symptoms, in range of movement and in function;
- Articular Dysfunction, identified by intermittent pain consistently produced at a restricted end range with no rapid change of symptoms or range;
- Contractile Dysfunction, identified by intermittent pain, consistently produced by loading the musculo-tendinous unit, for instance, with an isometric contraction against resistance;
- Postural syndrome is only produced by sustained loading - the rest of the physical examination would be normal;
- 'OTHER' subgroups are considered when none of the above syndrome patterns are present. Each has a definition and criteria that together complete the classification for all

remaining presentations. Examples include Inflammatory, Trauma and Chronic Pain Syndrome (Appendix A).

Despite the number of studies on the utility of the MDT system for spinal pain,²⁰⁻³² there is limited scientific literature about its application with extremity musculoskeletal disorders. For shoulder disorders, only three case studies,³³⁻³⁵ and one case series³⁶ have been published. The prevalence of MDT syndromes in the extremities has been investigated in a number of separate surveys³⁷⁻³⁸ and in a more recently conducted survey by May and Rosedale.¹⁵ The latter showed that more than one third of patients with extremity disorders were classified as Derangements. The authors suggested that if further research shows the rapid treatment response of this subcategory in the extremities, as it is proven to be in the spine, this would have a significant impact on the future treatment of a major group of patients with extremity disorders. Our previous study revealed substantial inter-rater agreement ($Kappa=0.90$) between MDT-trained experts when classifying McKenzie upper extremity syndromes in vignettes of patients with shoulder disorders.³⁹ Therefore, the next logical step would be to investigate the application of the MDT system in patients with shoulder problems.

The primary objective of this study was to determine if the response of pain and function to MDT treatment differs by classification category at two and four weeks following the start of physiotherapy treatment. The secondary objective was to describe the frequency of discharge over time by MDT classification category.

We hypothesized that patients with Derangement classification would be discharged earlier, and there would be a statistically significant treatment response in pain reduction, and improved function compared to patients with shoulder Dysfunction at two weeks and four weeks from their admission.

3.2 Methodology

3.2.1 *Study design and setting*

This study utilized a prospective longitudinal design. An international group of 15 licensed physiotherapists recruited and collected data from consecutive eligible patients attending their clinic for rehabilitation of a shoulder problem. These study collaborators were McKenzie Institute International diploma or credential holders who had greater than one year of experience in using the MDT system with patients who complained of upper extremity problems.

Instructions, consent forms, and data collection sheets were distributed to all the study collaborators. In order to minimize bias, the collaborators had no awareness of the study objectives and hypotheses. Completed data sheets were sent to the primary investigators and stored in a password protected database. Patients' baseline demographic and historical variables were recorded including age, sex, hand dominance, physical demands of job/daily activities, previous episodes and duration of symptoms. Ethics approval for the study was obtained from the Health Sciences Research Ethics Board of Western University (appendix C). Clinical data from a total of 105 patients were collected from March 2013 to November 2014. Sample size was estimated to ensure a reasonable number of cases across subcategories.

3.2.2 *Participants*

To be included in the study, patients were required to be over the age of 18, English speaking, and have shoulder pain for which they were seeking physiotherapy intervention. No specific shoulder diagnosis was required for inclusion. Patients were excluded if they had a surgical procedure on their shoulder within six months prior to the start of physical therapy treatment. No specific shoulder diagnoses were excluded as the intent was to classify all patients presenting with shoulder pain using the MDT system.

3.2.3 *Examination and classification*

Patients were assessed and treated using the MDT method and principles. A “treatment-as-usual” approach was followed. A standard MDT evaluation method was used for all participants, and the patients’ diagnoses were classified according to the MDT system utilized in the extremities. The patients were classified to one of the five following subgroups: Derangement, Articular Dysfunction, Contractile Dysfunction, OTHER and Spinal; the latter was included as patients referred with “shoulder pain” could eventually be diagnosed as a condition originating from the cervical spine. Spinal classification is believed to be a cervical spine Derangement and is anticipated to respond to treatment in a similar manner as shoulder Derangement. OTHER refers to the patients who did not meet the definition for any one of the above-mentioned classifications.

3.2.4 *Intervention*

Treatment ensued based on accepted procedures for each classification, and patients were treated with individually matched exercises and the appropriate progression of forces following the MDT method.²⁸ The detailed intervention and progression of forces were left to the discretion of the treating practitioners. There would have been multiple individually tailored exercise programs based on each patient’s specific classification and response to repeated movements; the patient classified as having a shoulder Derangement with a directional preference for extension for example, would have been given repeated end range extension exercises by the clinician. They would have been advised to perform these exercises regularly, every one to three hours, in sets of 10-15 repetitions. They may also have been advised to temporarily avoid certain exacerbating movements and positions. If the patient improved, the intervention would remain unchanged; however, if progress plateaued then the patient may be guided to apply more force, as long as more force demonstrated a positive effect. Once resolution was well underway the patient would be encouraged to resume all movements with confidence, but integrate the directional preference movements into their daily routine. Those patients classified as having an Articular Dysfunction would have been given repeated end range exercises in the direction of the painful and limited movement, approximately 10 repetitions every

two to three hours. This would be performed until the movement became full and pain-free and the patient felt confident to move freely in all directions. Those with Contractile Dysfunctions would have been treated with a progressive resisted exercise regime in the direction of the painful movement until the movement became pain-free with resistance and full activity restored.

OTHER subgroups would have been managed depending on the particular subgroup. For example, a patient with Chronic Pain Syndrome would be managed with pain education, graded exposure to activity and the addressing of psychosocial barriers to recovery. If the shoulder pain was classified as Spinal i.e. from a Cervical Derangement, the patient would have been advised to perform repeated end range exercises in the directional preference with the same details as outlined above for shoulder Derangements.

The patients were followed up until their discharge from physiotherapy, or after 4 weeks, or 8 treatment sessions, whichever came first. The patients' clinical information was collected at the initial assessment, and the treatment effects were evaluated at primary and secondary target points. The primary target point was the fifth treatment session, or two weeks since the start of treatment, or discharge from physiotherapy treatment, whichever came first. The secondary target point was the eighth treatment session, or four weeks since the start of treatment, or discharge from physiotherapy treatment, whichever came first.

3.2.5 *Outcomes*

Patients were monitored for change in the primary outcome measures used for the study [the Upper Extremity Functional Index (UEFI) ⁴⁰, and the Numeric Pain Rating Scale (NPRS)⁴¹]. The UEFI is a patient-reported outcome measure consisting of 20 items that capture a variety of upper extremity activities. Its purpose is to examine patients' current upper extremity functional status.⁴⁰ Scores can vary from 0-80, with higher scores indicating less functional limitation (i.e. better function).⁴⁰ It has been shown to have excellent test-retest reliability (intraclass correlation coefficient = 0.85-0.95), and internal consistency (coefficient alpha) of 0.94.^{40,42} The minimal level of detectable change

(MDC) is 9 points,⁴⁰ with a minimal clinically important difference (MCID) of 9-10 points.⁴²

The NPRS is an 11-point scale with scores that can vary from 0 (no pain) to 10 (the worst possible pain).⁴¹ It has been shown to have adequate test-retest reliability ($r=0.63-0.92$) and excellent internal consistency (coefficient alpha = 0.84-0.98).⁴³ The MDC for the NPRS has been reported to be 2.5-3 in patients with shoulder and upper extremity disorders,⁴⁴⁻⁴⁵ with a MCID of 2.17 reported in both surgical and non-surgical patients with shoulder problems after 3-4 weeks of rehabilitation.⁴⁶

Data on the primary outcomes were included in the analysis when they were available for at least two out of three data collection points. In case a patient was discharged before their third data collection point, the Last Observation Carried Forward (LOCF) imputation method was utilized to fill in the missing score for the third data collection point. The secondary outcome was the rate of discharge for each one of the MDT classifications at both study target points.

3.2.6 *Data Analysis*

Descriptive statistics were calculated for the MDT classifications, patient characteristics and the two primary outcome variables at baseline. The comparison for the primary outcomes of pain and function was performed among the three major classifications of Spinal, Derangement, and Dysfunction. As there were fewer patients in Articular and Contractile Dysfunction classifications, the two sub-categories were merged to make up a general classification of Dysfunction in order to have a more balanced sample size in comparison to the Derangement and Spinal classifications. Both Articular and Contractile Dysfunction are believed to demonstrate similar responses to treatment over time.

Depending on whether the compared variable was continuous or categorical, one-way analysis of variance (ANOVA) or Chi square analysis was conducted to compare the following baseline characteristics and potential confounding variables among the MDT subcategories: NPRS and UEFI scores at baseline, age, sex, hand dominance of the affected shoulder, and duration of symptoms, history of previous episodes of same

condition, medication use, concurrent physiotherapy treatments received, and physical demand of work/daily activities.

For the primary objective, a two-way mixed model ANOVA was conducted for the primary outcomes of pain (measured by the NPRS) and function (measured by the UEFI) to compare the interaction between MDT classifications (Spinal, Derangement, and Dysfunction) and time (baseline, week 2, and week 4). When the sphericity assumption was not met by our data, a Greenhouse-Geisser correction was used. In the presence of a significant interaction between MDT classifications and time, one-way ANOVA and planned pairwise comparisons were performed for each time point (baseline, week 2, and week 4) to further investigate where the differences between the MDT classifications actually existed. For the secondary objective frequency of discharge by MDT classification and time was reported in percent. The SPSS version 20 (SPSS Inc, Chicago, IL) was used for all data analyses.

3.3 Results

Between March 2013 and November 2014, 105 patients consented to participate in the study and were recruited. The flow of patient recruitment and MDT classifications is shown in Figure 3.1. Of the 105 patients recruited for the study, 12 patients subsequently dropped out after their initial visits, for the following reasons: shoulder manipulation performed by an orthopaedic surgeon (n=1); treatment sought in another clinic closer to home (n=1); change in insurance coverage prompted treatment by another physiotherapy clinic (n=1); treating practitioner took emergency leave of absence (n=2); travel out-of-town for extended period of time (n=3); failure to return for follow up treatment after

initial visit (n=4).

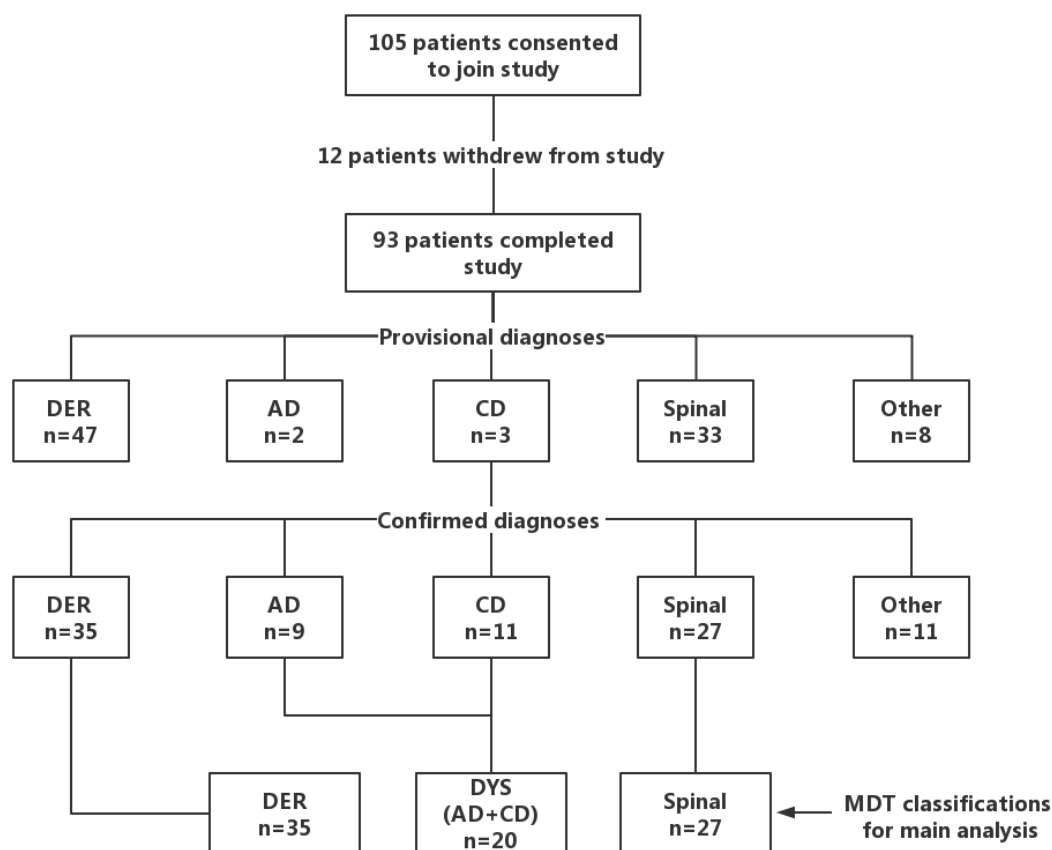


Figure 3-1. Flow of patients and MDT classifications. Abbreviations: AD, Articular Dysfunction; CD, Contractile Dysfunction; DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy.

Of the 93 patients who completed the study, 11 patients had either a concurrent condition of two MDT classifications, or were classified under the OTHER subgroups. These patients were excluded, leaving 82 patients for the main analyses. In 63.4% of the cases, the provisional diagnoses remained unchanged over the course of treatment. The distribution of MDT classifications is shown in Table 3.1. Seventy-two percent of participants (59 out of 82) had their data collected for all the three data collection points. For the remaining 27% who were discharged prior to their third data collection point, LOCF was utilized to fill in the missing data.

Table 3-1. Distribution of the MDT classifications at baseline

MDT Classification	Frequency	Percent	May and Rosedale ³ (%)
DER	35	37.6	42.5
AD	9	9.7	10.8
CD	11	11.8	11.7
Spinal	27	29.0	OTHER 35.0
DER with residual AD	2	2.2	
DER with residual CD	1	1.1	
Spinal with residual AD	2	2.2	
Spinal with DER	1	1.1	
Spinal with residual CD	1	1.1	
OTHER	4	4.3	
Total	93	100.0	

Abbreviations: AD, Articular Dysfunction; CD, Contractile Dysfunction; DER, Derangement; MDT, Mechanical Diagnosis and Therapy

There was no significant difference ($P > 0.05$) among the three MDT classifications at baseline for NPRS and UEFI scores, and other baseline characteristics (Table 3.2). Only two patients in the Derangement group received concurrent treatments (a cold pack) along with their MDT-directed treatments. The remaining patients received solely the MDT-directed treatments, therefore, no comparison was conducted among the MDT classifications for this variable.

³ May S, Rosedale R. A survey of the McKenzie classification system in the extremities: Prevalence of mechanical syndromes and preferred loading strategies. *Phys Ther.* 2012;92(9):1175-86.

Table 3-2. Patient characteristics and primary outcome scores at baseline

Variable	MDT Classifications			P-Value
	Derangement (n= 35)	Dysfunction (n= 20)	Spinal (n= 27)	
Age, mean (SD)	47.1 (15.1)	54.1 (15.8)	50.0 (18.1)	0.32
Sex, n (% female)	13 (37.1)	8 (40.0)	16 (59.3)	0.19
NPRS, mean (SD)	5.4 (1.9)	4.7 (2.1)	5.7 (1.6)	0.15
UEFI, mean (SD)	56.0 (15.1)	54.2 (16.0)	52.3 (16.3)	0.66
Hand Dominancy, n (% dominant)	25 (71.4)	13 (65.0)	18 (66.7)	0.86
Previous episodes, n (% yes)	14 (40.0)	8 (40.0)	14 (51.9)	0.60
Medication use, n (% yes)	15 (42.9)	6 (30.0)	10 (37.0)	0.64
Duration of symptoms	<u>≤12 weeks</u>	21 (60.0)	7 (35.0)	0.12
	<u>>12 weeks</u>	14 (40.0)	13 (65.0)	
Physical activities	<u>Sedentary-light</u>	20 (57.1)	11 (55.0)	0.47
	Medium-heavy	15 (42.9)	9 (45.0)	

Abbreviations: MDT, Mechanical Diagnosis and Therapy; NPRS, Numeric Pain Rating Scale; UEFI, Upper Extremity Functional Index; SD, standard deviation.

3.3.1 Main Analysis

For the NPRS outcome measure, a significant interaction effect was present between our between-group variable of MDT classifications, and the within-group variable of time [Greenhouse-Geisser corrected $F(3.2-126.1)=10.57$, $P<0.01$]. This indicates that although the NPRS scores were significantly affected by the factor of time [Greenhouse-Geisser corrected $F(1.6-126.1)=239.63$, $P<0.01$], the effect of time was different among the MDT classifications. There was no statistically significant difference in NPRS scores at baseline among the MDT classifications [$F(2-79)=2.81$, $P=0.15$]; however, a statistically significant difference was present among the MDT classifications in their NPRS values at primary [$F(2-79)=10.81$, $P<0.01$] and secondary [$F(2-79)=5.7$, $P=0.008$] study target points (Table 3.3).

Table 3-3. Baseline and follow-up primary outcome scores and results of analysis comparing MDT classifications (values are means and standard deviations)

Assessment Time/Variable	MDT Classifications			P-Value
	Derangement (n= 35)	Dysfunction (n= 20)	Spinal (n= 27)	
Baseline				
NPRS	5.4 (1.9)	4.7 (2.1)	5.7 (1.6)	0.15
UEFI	56.0 (15.1)	54.2 (16.0)	52.3 (16.3)	0.66
Week 2				
NPRS	1.53 (1.71)	3.35 (1.87)	1.26 (1.32)	<0.01
UEFI	72.89 (7.40)	59.30 (14.85)	72.81 (5.76)	<0.01
Week 4				
NPRS	0.86 (1.16)	1.77 (1.47)	0.68 (1.12)	<0.01
UEFI	75.68 (5.47)	65.45 (16.07)	76.40 (4.18)	<0.01

Abbreviations: MDT, Mechanical Diagnosis and Therapy; NPRS, Numeric Pain Rating Scale; UEFI, Upper Extremity Functional Index.

The Derangement classification had significantly lower NPRS scores than the Dysfunction group indicating pain reduction at week 2 ($P<0.01$) and week 4 ($P=0.02$). The Spinal classification also had significantly lower NPRS scores in comparison to the Dysfunction group at week 2 ($P<0.01$) and week 4 ($P<0.01$). Derangement and Spinal classifications had no statistically significant difference in their NPRS scores at week 2 ($P=0.49$) and week 4 ($P=0.56$) (Table 3.4).

Table 3-4. Contrasts between pairs of MDT classifications for main outcomes at primary and secondary study target points

Contrasts	Value of Contrast* (SE)		P-Value	
	Week 2	Week 4	Week 2	Week 4
NPRS				
DER vs DYS	-1.82 (0.51)	-0.92 (0.38)	<0.01	0.02
DER vs Spinal	0.27 (0.39)	0.17 (0.29)	0.49	0.56
DYS vs Spinal	2.09 (0.49)	1.09 (0.39)	<0.01	<0.01
UEFI				
DER vs DYS	13.58 (3.55)	10.24 (3.71)	<0.01	0.01
DER vs Spinal	0.07 (1.67)	-0.72 (1.22)	0.97	0.56
DYS vs Spinal	- 13.51 (3.50)	-10.96 (3.68)	<0.01	<0.01

Abbreviations: DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy; NPRS, Numeric Pain Rating Scale; NS, not significant; UEFI, Upper Extremity Functional Index; SE, standard error. * Mean difference

The NPRS mean scores with 95% confidence intervals for each of the MDT classifications are shown in Figure 3.2 as a function of time.

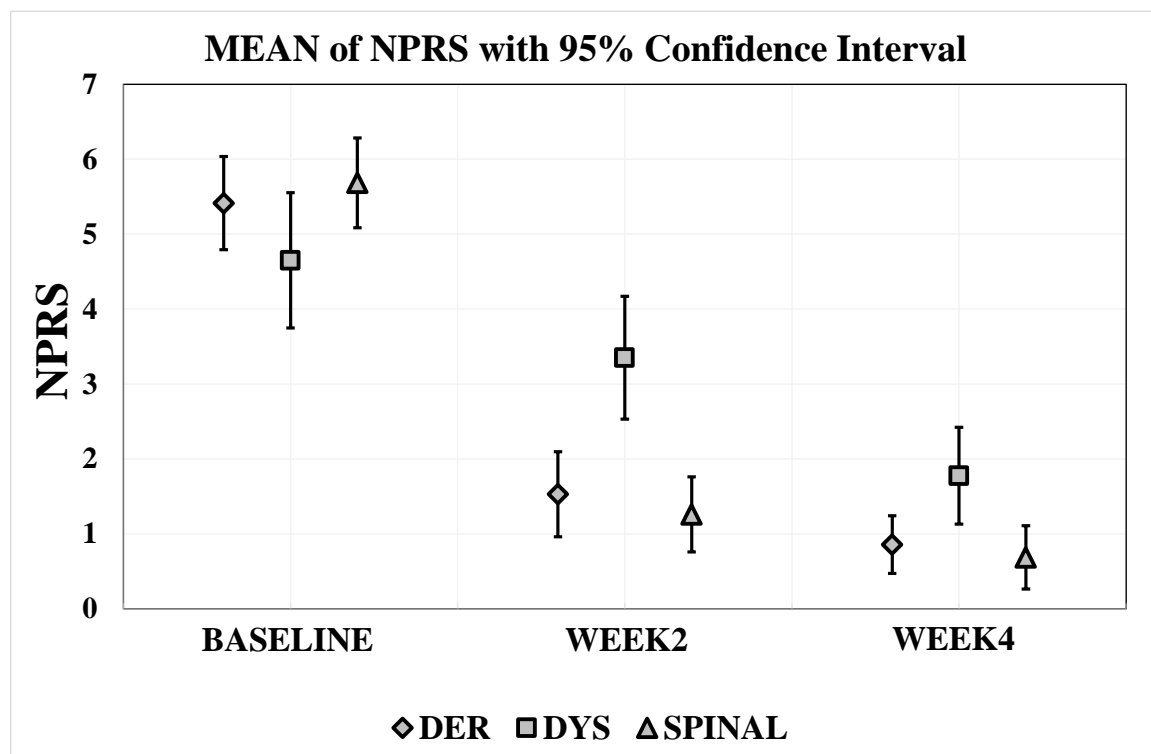


Figure 3-2. Mean NPRS score from baseline to discharge in each MDT classification. Abbreviations: DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy; NPRS, Numeric Pain Rating Scale.

For the UEFI outcome measure, a significant interaction effect was present between our between-group variable of MDT classifications and the within-group variable of time [Greenhouse-Geisser corrected $F(2.31-91.08)=7.08$, $P<0.01$]. This indicates that although the UEFI scores were affected by the factor of time [Greenhouse-Geisser corrected $F(1.15-91.08)=122.99$, $P<0.01$], the effect of time was different among the MDT classifications. There was no statistically significant difference in UEFI scores at baseline among the MDT classifications [$F(2-79)=0.441$, $P=0.66$]; however, a statistically significant difference was present among the MDT classifications in their UEFI values at primary [$F(2-79)=15.87$, $P<0.01$] and secondary [$F(2-79)=10.47$, $P<0.001$] study target points (Table 3.3). The Derangement classification had

significantly higher UEFI scores than the Dysfunction group indicating improvement in their function at week 2 ($P<0.01$) and week 4 ($P=0.01$). The Spinal classification also had significantly higher UEFI scores in comparison to the Dysfunction group at week 2 ($P<0.01$) and week 4 ($P<0.01$). Derangement and Spinal classifications had no statistically significant difference in their UEFI scores at week 2 ($P=0.97$) and week 4 ($P=0.56$) (Table 3.4). The UEFI mean scores with 95% confidence intervals for each of the MDT classifications are shown in Figure 3.3 as a function of time.

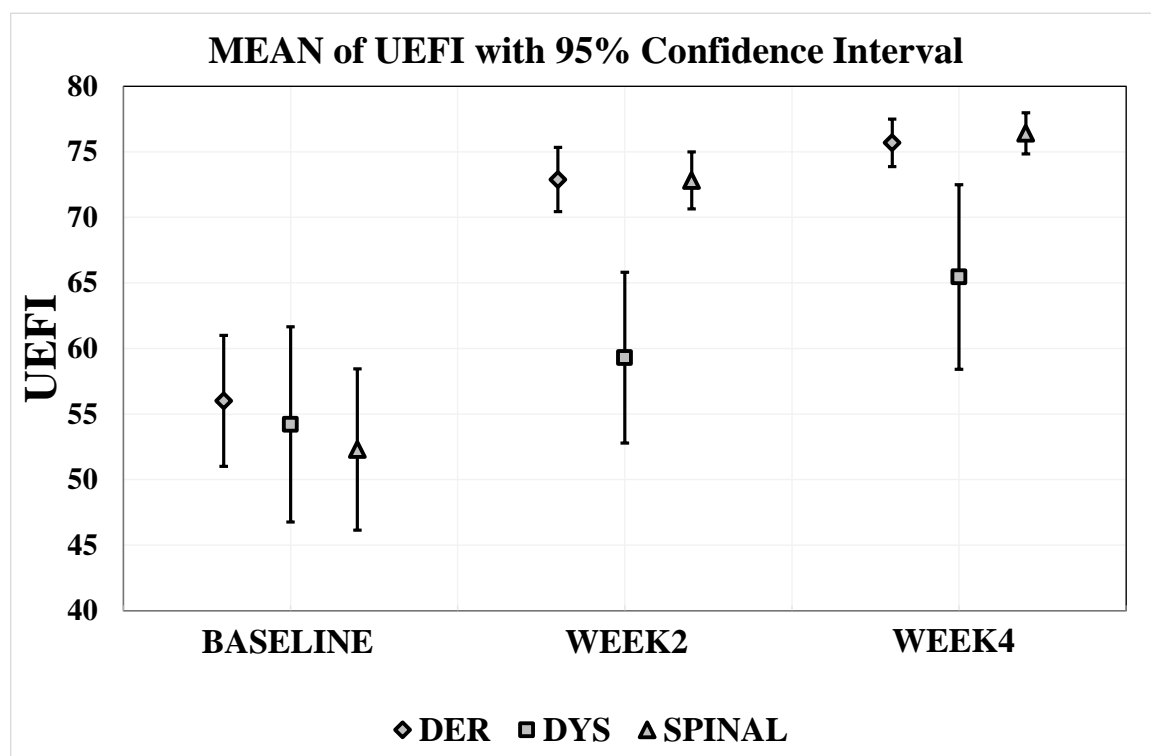


Figure 3-3. Mean UEFI score from baseline to discharge in each MDT classification. Abbreviations: DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy; UEFI, Upper Extremity Functional Index.

The frequency of discharge at the first target point was 37% for both Derangement and Spinal classifications, and there was no discharge for Dysfunction classification at this target point. The frequency of discharge at the second target point was 83% and 82% for Derangement and Spinal classifications respectively, and 15% for the Dysfunction classification (Figure 3.4).

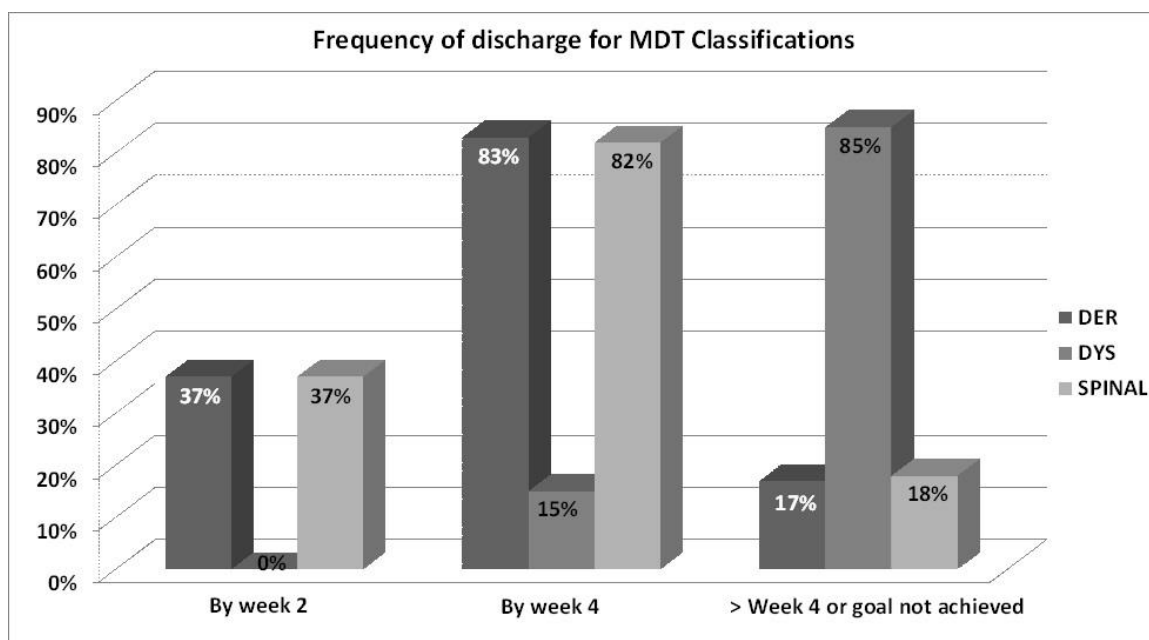


Figure 3-4. Frequency of discharge for MDT classifications at primary and secondary target points. Abbreviations: DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy.

3.4 Discussion

To the best of our knowledge, this is the first study to address the clinical application of the MDT system in patients with shoulder disorders. Over time, patients in the Derangement and Spinal groups demonstrated very similar pain and function responses to treatment and showed significantly greater improvement in comparison to patients with Dysfunction. These treatment responses existed at both the primary and secondary study target time points of week 2 and 4, respectively. Consistent with this, compared to patients in the Dysfunction group, a high percentage of patients with Derangement and Spinal classifications achieved their treatment goals relatively quickly and were discharged from treatment at weeks 2 and 4. This highlights the point that the Spinal extremity classification is in fact a cervical spine derangement and like the shoulder Derangement, classification is anticipated to demonstrate a rapid treatment response.

Therefore, it appears in this non-randomized cohort that when MDT-trained clinicians match the intervention to a specific MDT classification, the outcome is aligned with the response expectation of the classification. Hence, shoulder Derangement or shoulder pain that has a cervical Derangement will respond and resolve rapidly. Dysfunctions will respond, but in a more graduated manner, achieving discharge status at a later point.

As shown in table 1, the distribution of the MDT classifications in our sample was comparable to those reported by May and Rosedale.¹⁵ They did not look at Cervical Derangement as a separate classification for patients with shoulder disorders, however it is interesting to note that only 2% of the total upper and lower extremity patients were classified with spinal problems in their survey. This contrasts dramatically with the 29% of shoulder pain patients diagnosed with Cervical Derangements in this cohort. It is possible that this reflects an increase in the recognition of Cervical Derangements as a source of shoulder pain by MDT clinicians or that the study clinicians studied by May and Rosedale effectively screened out the cervical spine in most of their extremity patients.

There were several limitations to this study. First, due to the use of a “treatment-as-usual” approach, it was not possible to have a pre-specified number of treatment sessions for each one of our study participants. As a result, it is possible that the patients in each category received a different number of treatment sessions, ultimately affecting treatment outcome. However, our treating clinicians had no awareness of the study objectives, suggesting they had little motivation to affect the outcome of each classification category other than to treat the patient as best as they could, given the clinical findings and MDT classification category. Secondly, exercise compliance was not investigated; therefore, it is uncertain whether the inferior results of the Dysfunction patients resulted from poor exercise compliance or the actual nature of the MDT classification. Third, there was no treatment group assigned to a control condition or conventional physiotherapy intervention removing the ability to compare MDT classification with other treatment approaches. Fourth, a greater proportion of patients included in this study had a pain duration of less than 12 weeks (Table 2). Therefore, it may be that most of these patients

would have recovered without any intervention. Fifth, there was also no randomization because the MDT method was selected as the only method of intervention and the patients were required to be treated within their respective MDT classification groups. Finally, the treating physiotherapists were MDT-trained practitioners and the treatment results may not be generalizable to other physiotherapists with less MDT training. As a next step, randomized controlled trials are needed to compare the MDT system with conventional treatment for patients with shoulder disorders.

Considering the well-described limitations of conventional patho-anatomic models for diagnosis and treatment of patients with shoulder complaints,^{3-6, 10} the MDT system, may be worthy of further investigation to fill the current gap in diagnosis and management of patients with extremity problems. The encouraging aspect of the study results is that two-thirds of our study participants (66.6%) were classified as either a shoulder Derangement or a cervical Spinal Derangement. If further studies confirm that patients classified as Derangements conform to their expected rapid response to tailored MDT treatments, there is potential to significantly impact quality of life and health care utilization for a majority of patients with shoulder problems.

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Chapter 4

4 Consistency of commonly used orthopedic special tests of the shoulder when used with the McKenzie system of Mechanical Diagnosis and Therapy⁴

4.1 Introduction

Shoulder pain is one of the primary reasons for referral to physiotherapy with an annual prevalence of 100 to 160 per 1000 patients in the general population.¹ It has been shown to be relentless and recurring, with half of all cases remaining unresolved after 18 months.² Complexity of the shoulder, and absence of uniformity in diagnostic labeling³ hinder accurate diagnosis. This can have significant implications for conservative management where ideally the diagnosis should directly guide clinical reasoning and decision making.⁴⁻⁵ These diagnostic challenges may inadvertently lead to inappropriate and perhaps more costly interventions.⁶

For physical examination of the shoulder, Orthopedic Special Tests (OSTs) are commonly used⁷ and despite a heavy reliance on their use, demonstrate only limited utility for informing diagnosis.^{3-4, 6, 8} Studies have revealed conflicting diagnostic performance for the majority of OSTs used in the assessment of common shoulder disorders such as rotator cuff pathology, sub-acromial impingement and superior labrum anterior-to-posterior (SLAP) lesions.⁸⁻²³ Considering the shortcomings of commonly used OSTs, a growing body of opinion favours the implementation of an approach that is different than a patho-anatomical based assessment and diagnosis of musculoskeletal disorders.^{3,15,24} In principle, the use of a reliable form of classification should decrease practice variation, and enhance the effectiveness of treatment by matching that intervention to a specific subgroup.²⁵⁻²⁶ The McKenzie system of Mechanical Diagnosis

⁴ A version of this chapter has been published and is used with permission. Heidar Abady A, Rosedale R, Chesworth BM, Rotondi MA, Overend TJ. Consistency of commonly used orthopedic special tests of the shoulder when used with the McKenzie system of mechanical diagnosis and therapy. *Musculoskelet Sci Pract*. DOI 10.1016/j.msksp.2017.10.001.

and Therapy (MDT) is one alternative method that has been proposed to assist the clinician in formulating a classification that enables an appropriate management strategy.²⁷ The MDT system was initially described in 1981 as a new method for classification and treatment of patients with back pain.²⁸ The system uses a non-pathology specific classification approach that consists of a thorough history and physical examination monitoring the effects of repeated movements, sustained positions and loading strategies on patients' clinical presentations.²⁹

Several systematic reviews show varying degrees of support for the utilization of the MDT system when treating patients with acute and chronic low back pain.³⁰⁻³⁷ The MDT system has also demonstrated acceptable reliability³⁸⁻⁴² and varying degrees of validity⁴³⁻⁵³ when used in patients with spinal disorders. A growing body of evidence supports the application of the MDT system when treating patients with musculoskeletal disorders of the extremity.^{27, 54-63} Although reliability varies considerably between different study designs,^{64, 65} very good inter-examiner reliability has been reported specifically for the shoulder.⁶¹

In the McKenzie system, extremity disorders include the following syndromes and subgroups:⁶⁶

- Derangement, identified by the presence of a directional preference which will give a rapid and lasting improvement in symptoms, in range of movement and in function;
- Articular Dysfunction, identified by intermittent pain consistently produced only at a restricted end range of motion with no rapid change of symptoms or range;
- Contractile Dysfunction, identified by intermittent pain, consistently produced by loading the musculo-tendinous unit, for instance, with an isometric contraction against resistance;
- Postural syndrome, identified by intermittent pain only produced by sustained loading, with movements and activities being unaffected;

- OTHER subgroups are considered when none of the above syndrome patterns are present. Each has a definition and specific criteria that together complete the classification for all remaining presentations. Examples include Trauma, Peripheral Nerve Entrapment and Inflammatory (Appendix A).

Although there are clear issues with the validity and clinical interpretation of OSTs, their use is still widespread, with many clinicians continuing to utilize these tests as a basis for diagnosis in shoulder disorders.⁷ One common observation by MDT clinicians and reported in various case studies⁶⁷⁻⁶⁹ is that the results of OSTs can change depending upon the MDT classification. For example, in one case study,⁶⁸ the initial treatment of a patient with a shoulder Derangement was reported to have an immediate effect on the 'Empty can' test, the 'Lift off' test and the 'Hawkins-Kennedy' test, with test results shifting from positive to negative within the first session and remaining negative until discharge. It is possible that the insights from this case may give one possible explanation as to why these OSTs appear inherently unreliable and of questionable validity.

Derangement has a variable nature in terms of movement loss, direction of preference and pain behavior. Hence, at times a patient may be experiencing severe symptoms, considerable loss of motion and limited function; at other times the symptoms may be milder, with greater range and better function. This may happen either naturally in response to the patient's daily movements and loading of the joint or in response to the therapeutic intervention e.g. repeated end range movements in the directional preference. The implication for OSTs when tested in the presence of Derangement is that at times, when the Derangement is more severe they may test positive and at other times when the Derangement is milder they may test negative. The OSTs are intended to gauge the presence or absence of a particular pathology or diagnosis, however, in the presence of Derangement, the OST results may be dependent upon the current behavior of the Derangement rather than reflecting the specific pathology they are proposed to identify. This can be particularly apparent when the Derangement is treated with directional preference exercises, where it can be taken from a more painful and limited state to a much less severe state in a short period of time. The classification of Derangement is reported to be a prevalent cause of shoulder pain^{24, 27} as it is with other musculoskeletal

problems.²⁴ Hence its presence could be a factor underlying the historic lack of accuracy of the OSTs.

The aim of our study was to investigate, in patients with shoulder complaints, whether MDT classifications and their subsequent treatment regime affects the agreement of commonly used OSTs over time. To determine if shoulder Derangement interferes with the results of OSTs, we hypothesized that over the course of treatment, there would be lower agreement between consecutive OST results in patients with shoulder Derangement compared to patients with shoulder Articular or Contractile Dysfunction. This would be the first study to explore the consistency of OST results within the MDT classification system of the shoulder.

4.2 Methodology

4.2.1 *Study design and setting*

This was a multi-centre prospective longitudinal study that ran concurrently with a study that explored the clinical application of the MDT system in patients with shoulder disorders.²⁷ An international group of 15 McKenzie Institute International diploma and credential holders recruited and collected data from consecutive patients visiting their clinics for treatment of a shoulder problem. These study collaborators were licensed physiotherapists with over one year of experience in applying the MDT system to patients who presented with an upper extremity problem.

Instructions, consent forms and data collection sheets were distributed to the study collaborators. To minimize bias, participating physiotherapists had no awareness of the study objectives and hypotheses. In addition, different orthopedic clinicians who were unaware of the patients' MDT classifications performed and recorded the OST results. The patients were followed up until their discharge from their treatment program, and the completed data collection forms were sent to the primary investigator for analysis. Ethics approval for the study was obtained from the Health Sciences Research Ethics Board of Western University (Appendix C).

A confidence interval (CI) approach for sample size estimation of *Kappa* was used.⁷⁰ Assuming a preliminary estimate of *Kappa* = 0.7, with a 95% CI of 0.2, we decided that 89 participants were needed for five MDT classifications to ensure a reasonable number of cases across subcategories. Considering a 10% dropout rate, a total of 100 participants was calculated to be a sufficient number for our primary outcome; however, by the time the primary investigators received sufficient data from the study collaborators and declared the end of the study, five additional patients were already recruited and their data were collected. Therefore, clinical data for a total of 105 patients were collected from March 2013 to November 2014.

4.2.2 *Participants*

To be included in the study, participants were required to be over the age of 18, English speaking and with a shoulder disorder for which they were pursuing physiotherapy intervention. No specific shoulder diagnosis was required for inclusion. Patients were excluded if they had a surgical intervention on their shoulder within six months before the beginning of their physiotherapy program. No specific shoulder diagnoses were excluded, as one of the intentions of our concurrent study²⁷ was to classify all patients presenting with shoulder pain using the MDT system.

4.2.3 *Examination and classification*

A “treatment-as-usual” approach was utilized, and patients were assessed and treated following MDT methods and principles. Patients were allocated to one of the following five subgroups: Derangement, Articular Dysfunction, Contractile Dysfunction, OTHER and Spinal; the latter was recognized as patients referred with “shoulder pain” but the cervical spine was confirmed as the source of symptoms. Spinal classification was accepted to be a cervical spine Derangement and was expected to demonstrate a similar treatment response as shoulder Derangement when the cervical spine was treated. OTHER subgroups included all patients who failed to meet the criteria for any one of the previously described classifications.

4.2.4 *Intervention and outcomes*

Treatment followed recognized procedures for each MDT classification; patients were treated with distinctively matched exercises and the relevant progression of forces were pursued as per the MDT method.⁶⁶ As there would have been numerous individualized MDT exercise programs depending on each patient's diagnosis and response to treatment, the specific intervention and progression of forces were left to the discretion of the treating practitioners.

Three commonly used OSTs documented in systematic reviews of shoulder tests^{10-12, 14, 15, 17, 18, 20} were utilized: Empty Can, Hawkins-Kennedy, and Speed's. In the Empty Can test, resistance is given to abduction in two different positions -- 90 degrees of arm abduction with neutral (no) rotation, and 90 degrees of abduction with the shoulder medially rotated and angled forward 30 degrees (empty can position), so that the patient's thumb points toward the floor in the plane of the scapula.⁷¹ Examiners look for weakness or pain, which reflects a positive test.⁷¹ In the Hawkins-Kennedy test, with the elbow in 90 degrees of flexion, the examiner forward flexes the arm to 90 degrees then quickly medially rotates the shoulder.⁷² As the indicator of a positive test, examiners look for a sharp pain in the superior aspect of the shoulder.⁷² The Speed's test consists of resisted forward flexion of the arm while the elbow is fully extended and the patient's forearm is first supinated, and then pronated.⁷² A positive test induces increased tenderness in the bicipital groove, particularly with the arm supinated.⁷²

The treating practitioner classified the patients into one of the five MDT classifications. To avoid any potential bias from the treating clinician, a second practitioner with education and training in applying the above named OSTs, was blinded to the patients' MDT classifications and administered the OSTs. The patients were followed up until their discharge from physiotherapy, or after 4 weeks or 8 treatment sessions, whichever came first. The patients' clinical information was collected at the initial assessment, and data on the OST results were collected at sessions 1, 3, 5 and 8, or at their discharge from physiotherapy treatment, whichever came first.

4.2.5 *Data analysis*

Descriptive statistics were calculated for the MDT classifications, and patient characteristics. Based on whether the compared variable was continuous or nominal, one-way analysis of variance (ANOVA) or Chi square analysis was performed to compare the following baseline characteristics and potential confounding factors among the MDT classifications: Upper Extremity Functional Index (UEFI),⁷³ and Numeric Pain Rating Scale (NPRS)⁷⁴ scores at baseline, age, sex, hand dominance of the affected shoulder, duration of symptoms, the history of previous episodes with the same condition, medication use and the physical demands of work/daily activities. There were fewer participants in the Articular and Contractile Dysfunction categories and since both types of Dysfunctions have significant similarities, such as their consistent response to examination procedures and slower recovery time, the two groups were merged into a single broad classification of Dysfunction. This allowed for a more equivalent sample size in comparison to the Derangement and Spinal classifications. However, an additional analysis was also conducted whereby the two Dysfunction classifications were analyzed as separate groups.

The *Kappa* coefficient and standard error (SE) were calculated to determine the level of agreement of OST results on repeated testing during treatment within each MDT classification. Repeated OST test results were included in the analysis when they were available for at least three out of four data collection points. The participants with less than three sets of data were excluded from the main analysis. The MAGREE macro in Statistical Analysis System (SAS) version 9.3 for Windows was used for data analysis. Traditional thresholds of *Kappa* values were utilized for interpretation as follows: Less than 0.40 = Poor; 0.41-0.60 = Moderate; 0.61-0.80 = Good; and 0.81-1.00 = Very Good.⁷⁵

4.3 Results

The flow of patient enrolment and MDT diagnoses is presented in Figure 4.1.

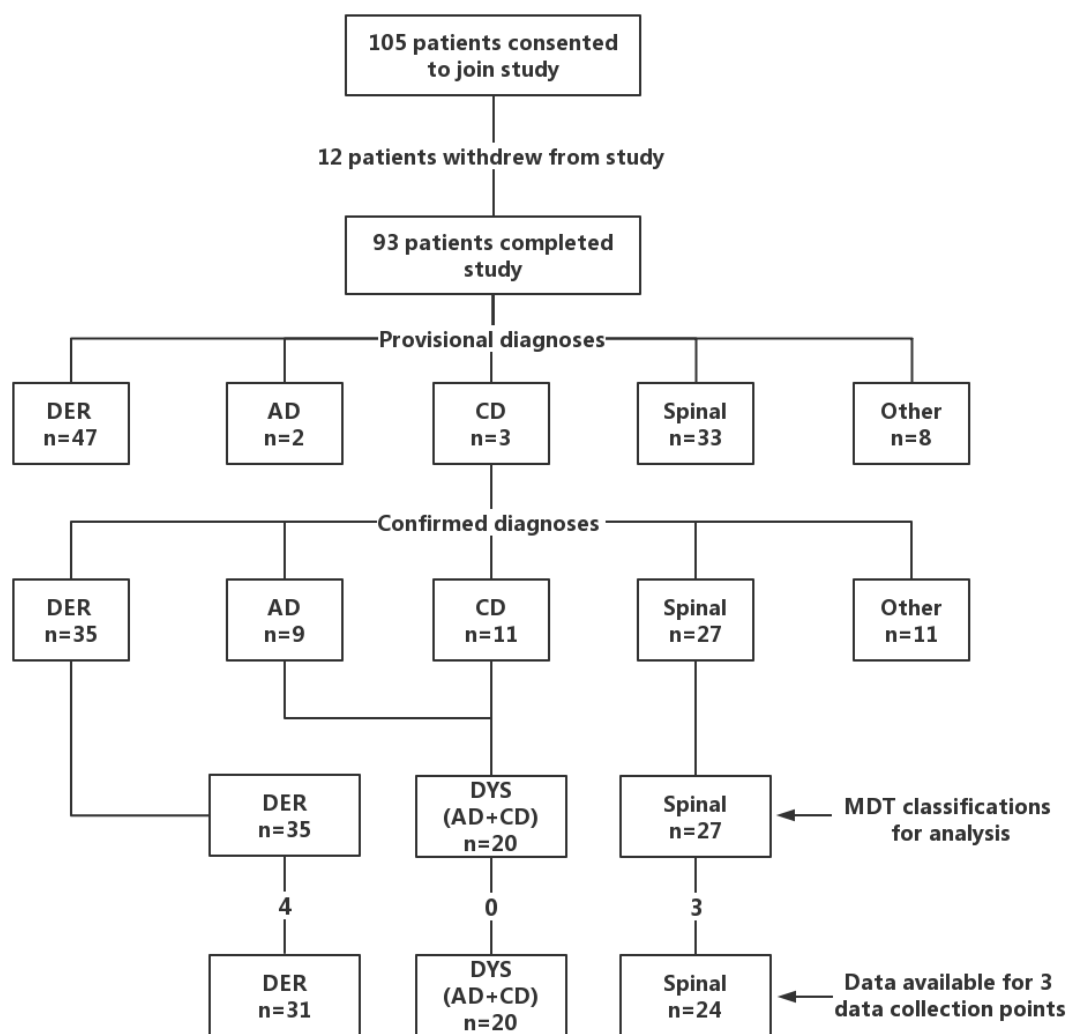


Figure 4-1. Flow of patients and MDT classifications. Abbreviations: AD, Articular Dysfunction; CD, Contractile Dysfunction; DER, Derangement; DYS, Dysfunction; MDT, Mechanical Diagnosis and Therapy.

Of the 105 patients enrolled in the study, 12 patients dropped out for the following reasons: shoulder manipulation done by specialist (n=1); treatment continued in another centre closer to patient (n=1); change in insurance coverage urged switching to another

physiotherapy clinic (n=1); failure to complete data collection due to emergency leave of absence by treating physiotherapist (n=2); sudden travel out-of-town for lengthy period of time (n=3); decline to return for follow up visit following initial session (n=4).

Of the 93 participants who completed the study, 11 patients were excluded as they had either two concurrent MDT classifications, or were diagnosed as one of the OTHER MDT subgroups. Of the remaining 82 patients, we decided to run the analysis by including patients who had OST results for at least three of the four data collection points. This allowed us to include 75 eligible participants.

Table 4-1. Patient characteristics and outcome scores at baseline

Variable		MDT Classification (n, %)			P-Value
		Derangement (31, 41.3%)	Dysfunction (20, 26.7%)	Spinal (24, 32%)	
Age, mean (SD)		47.7 (15.6)	54.1 (15.8)	50.8 (18.7)	0.42
Sex, n (% female)		11 (35.5)	8 (40.0)	14 (58.3)	0.22
NPRS, mean (SD)		5.6 (1.9)	4.7 (2.1)	5.6 (1.6)	0.15
UEFI, mean (SD)		54.7 (15.5)	54.2 (16.0)	51.9 (16.8)	0.80
Hand Dominancy, n (% dominant)		21 (67.7)	13 (65.0)	15 (62.5)	0.92
Previous episodes, n (% yes)		11 (35.5)	8 (40.0)	13 (54.2)	0.37
Medication use, n (% yes)		12 (38.7)	6 (30.0)	8 (33.3)	0.80
Duration of symptoms	≤12 weeks	18 (58.1)	7 (35.0)	14 (58.3)	0.21
	>12 weeks	13 (41.9)	13 (65.0)	10 (41.7)	
Physical activities	Sedentary-light	18 (58.1)	11 (55.0)	17 (70.8)	0.50
	Medium-heavy	13 (41.9)	9 (45.0)	7 (29.2)	

Abbreviations: MDT, Mechanical Diagnosis and Therapy; NPRS, Numeric Pain Rating Scale; UEFI, Upper Extremity Functional Index; SD, standard deviation.

Distribution of the MDT classifications and patient characteristics are presented in Table 4.1. There was no statistically significant difference among the three main MDT subgroups of Derangement, Dysfunction, and Spinal for the patient characteristics and outcome scores at baseline (Table 4.1).

Values of agreement within each one of the MDT classifications for the Empty Can test are shown in Table 4.2. The overall *Kappa* value (i.e. regardless of MDT classification) was 0.28 (SE=0.07). The highest level of agreement was in the Dysfunction category with *Kappa*=0.67 (SE=0.13); with 0.84 (SE=0.19) for Articular, and 0.49 (SE=0.17) for Contractile Dysfunction. There was no agreement within Spinal and Derangement categories (equivalent to zero) as *P* values were greater than 0.05 (*P*=0.13, and *P*=0.44 respectively).

Table 4-2. Agreement findings for Empty Can test by MDT classification

MDT Classification	<i>Kappa</i>	Standard Error	<i>P</i> -Value
Articular Dysfunction	0.84	0.19	<0.01
Contractile Dysfunction	0.49	0.17	<0.01
Overall agreement	0.28	0.07	<0.01
Spinal	0.13	0.12	0.13
Derangement	0.02	0.10	0.44
Dysfunction (AD+CD)	0.67	0.13	<0.01
Abbreviations: MDT, Mechanical Diagnosis and Therapy; AD, Articular Dysfunction; CD, Contractile Dysfunction.			

Values of agreement within each one of the MDT classifications for the Hawkins-Kennedy test are shown in Table 4.3. The overall *Kappa* value (i.e. regardless of MDT classification) was 0.28 (SE=0.07). The highest level of agreement was again in the Dysfunction category with *Kappa*=0.60 (SE=0.13); with 0.42 (SE=0.19) for Articular, and 0.59 (SE=0.17) for Contractile Dysfunction. The agreement level within the Spinal classification was *Kappa*=0.26 (SE=0.12), and there was no agreement within the Derangement category (equivalent to zero) as the *P* value was greater than 0.05 (*P*=0.50).

Values of agreement within each one of the MDT classifications for the Speed's test are shown in Table 4.4. The overall *Kappa* value (i.e. regardless of MDT classification) was 0.29 (SE=0.07). The highest level of agreement was again in the Dysfunction category with *Kappa*=0.46 (SE=0.13); with 0.47 (SE=0.19) for Articular, and 0.45 (SE=0.17) for Contractile Dysfunction. The agreement level within the Spinal classification was *Kappa*=0.37 (SE=0.12), and there was no agreement within the Derangement category (equivalent to zero) as the *P* value was greater than 0.05 (*P*=0.19).

Table 4-3. Agreement findings for Hawkins-Kennedy test by MDT classification

MDT Classification	<i>Kappa</i>	Standard Error	<i>P</i> -Value
Articular Dysfunction	0.42	0.19	0.01
Contractile Dysfunction	0.59	0.17	<0.01
Overall agreement	0.28	0.07	<0.01
Spinal	0.26	0.12	0.01
Derangement	-0.0005	0.10	0.50
Dysfunction (AD+CD)	0.60	0.13	<0.01
Abbreviations: MDT, Mechanical Diagnosis and Therapy; AD, Articular Dysfunction; CD, Contractile Dysfunction.			

Table 4-4. Agreement findings for Speed test by MDT classification

MDT Classification	<i>Kappa</i>	Standard Error	<i>P</i> -Value
Articular Dysfunction	0.47	0.19	<0.01
Contractile Dysfunction	0.45	0.17	<0.01
Spinal	0.37	0.12	<0.01
Overall agreement	0.29	0.07	<0.01
Derangement	0.09	0.10	0.19
Dysfunction (AD+CD)	0.46	0.13	<0.01
Abbreviations: MDT, Mechanical Diagnosis and Therapy; AD, Articular Dysfunction; CD, Contractile Dysfunction.			

4.4 Discussion

To our knowledge, this was the first study to explore the agreement across repeat testing of three OSTs within MDT classifications of the shoulder. This is perhaps not surprising, as in principle the OSTs are oriented towards gaining a patho-anatomical diagnosis whereas the MDT classification is symptom-based. Hence, OSTs would not normally be an integral part of the MDT assessment. However, many MDT trained clinicians still choose to use OSTs as baseline measures.

The main finding of our study was poorer agreement with repeated testing of the OSTs in patients with Derangement compared to patients with either Contractile or Articular Dysfunction. This is consistent with a case study of a patient with shoulder

Derangement⁶⁸ that reported test results for the Empty Can, Lift off, and Hawkins-Kennedy tests during a standard MDT assessment and treatment protocol. These tests changed from positive to negative during the initial treatment session and remained negative until discharge. This inconsistency of the OSTs has been a frequent observation by MDT practitioners among patients with Derangement. Specifically, what is noted is that positive OSTs will often become negative as soon as the treatment process is initiated, hence the assumption in these cases is that the tests were initially false positives and not truly indicative of the patho-anatomical condition they were being used to diagnose. In our study, inconsistent test results for OSTs performed in patients assigned to the Derangement classification were revealed by poor agreement statistics across repeat testing from the initial assessment through three to four treatment sessions. This may be due to the variable and quickly changing nature of the Derangement classification especially as it rapidly responds to intervention. Reproduction of these findings in another cohort would provide confirmatory evidence that some OST results are impacted by the nature of the MDT classification.

The overall agreement for Empty Can, Hawkins-Kennedy, and Speed's tests were almost identical with a $Kappa=0.28$ ($SE=0.07$) for Empty Can and Hawkins-Kennedy tests, and a $Kappa=0.29$ ($SE=0.07$) for Speed's test. However, as shown in tables 4.2 to 4.4 when values for Derangement and Spinal (a cervical spine Derangement) were removed from the analyses, the agreement level increased dramatically with $Kappa$ values of 0.67 ($SE=0.13$), 0.60 ($SE=0.13$), and 0.46 ($SE=0.13$) for Empty Can, Hawkins-Kennedy, and Speed's tests respectively. Furthermore, P -values for the Derangement classification were greater than 0.05 for all the three OSTs studied. The P -value was similarly greater than 0.05 for the Spinal classification for the Empty Can test. This indicates that the agreement was no greater than zero for the above listed analyses, while agreement varied between moderate-to-good for either Dysfunction classification when the Derangement and Spinal categories were eliminated from the analyses. In the case of Articular Dysfunction for the Empty Can test, the agreement was the highest with $Kappa=0.84$ ($SE=0.19$) which indicates a very good agreement.

The low agreement or no agreement with repeated testing of the OSTs in patients with Derangement classification, including spinal Derangements, may be due to the variable and quickly changing nature of the classification especially as it rapidly responds to intervention. Therefore, the presence of Derangement may explain the poor consistency recorded for the majority of the OSTs and was certainly responsible for reducing the overall agreement in the OSTs used in this study. These results would give additional support for the position taken that clinicians should not rely on these OSTs as diagnostic and prognostic tools.^{3-4, 6, 15} However, there is a clear difference in their consistency in the presence of a Derangement as compared to when Derangements were absent. A rationale could be made for an initial MDT screening of shoulder patients to ensure that shoulder and cervical Derangements have been ruled out before any other testing is performed. This may then enhance the value of the OSTs and perhaps lead to their improved diagnostic capability, if indeed a patho-anatomical diagnosis is still sought.

Alternatively, these OSTs could be used as baseline tests in the differentiation between the MDT classifications of Derangement and Articular and Contractile Dysfunctions. If the OSTs change from positive before, to negative after a repeated movement exam or the initiation of treatment then this would be consistent with a Derangement being present.

The major limitations of this study were as follows: As a “treatment-as-usual” approach was followed, a pre-determined number of treatment sessions was not feasible for each one of our patients. Thus, it is possible that the study participants received a variable number of treatment sessions, potentially influencing treatment results. However, the treating physiotherapists were unaware of the study objectives, minimizing any inclination to influence the outcome of each classification category. In addition, a second practitioner, blinded to the patients’ MDT classifications administered the OSTs to avoid any potential bias from the treating clinician. A second limitation due to following a “treatment as usual” approach was that some patients did not have their data available for all four data collection points; therefore, analysis was done on data from three data collection points to avoid weakening power of our analysis. A third limitation of the

study was that only three OSTs were evaluated in the study as it was not feasible to include all the numerous OSTs used for shoulder assessment. Therefore, no extrapolations is made to other OSTs not investigated in the current study. Finally, the MDT method was followed; therefore, the study results may not be generalizable to other methods of practice.

As a next step, future studies could investigate other OSTs utilized for shoulder assessment, and use a pre-set and equal number of treatment sessions for all patients so that data would be available for all data collection points. Due to the presence of a clear pattern in our findings indicating that the Derangement classification could be the reason for inconsistent OST results, further investigations are warranted on the OSTs utilized in the assessment of other musculoskeletal disorders in both spinal and peripheral conditions.

In conclusion, due to the ability of the Derangement classification to change rapidly, it clearly has the capacity to compromise the reliability of OSTs potentially reducing their clinical utility. Thus, being aware of this characteristic of Derangement prior to the use of these shoulder OSTs could assist clinicians in their interpretation of the test results.

4.5 References

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Chapter 5

5 General Discussion and Future Direction

5.1 Overview of thesis

The overall objective of this thesis was to examine the usefulness of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in patients with extremity musculoskeletal disorders, with a focus on the shoulder. Due to a high prevalence of shoulder pain in the general population,^{1,2} and to fill the current gap in assessment and treatment of patients with shoulder problems, the population of interest in this thesis was individuals with shoulder musculoskeletal disorders. The complexity of the shoulder, and absence of uniformity of diagnostic labeling³ ordinarily used in clinical practice, makes it a great challenge for practitioners to make a correct diagnosis of the underlying source of pain. Without an accurate diagnosis, treatment is anticipated to be more arbitrary and this may contribute to the lack of efficacy for most conventional interventions.⁴ To our knowledge, studies included in this thesis were the first to investigate the application of the MDT system exclusively in patients with shoulder disorders. The thesis assessed the inter-examiner reliability of the MDT system when evaluating patients with shoulder pain using clinical vignettes. We also examined the clinical application of the MDT system when treating patients with shoulder disorders and provided insight into whether the system is applicable for a significant proportion of these patients. Finally, this thesis also evaluated the consistency of three commonly used Orthopedic Special Tests (OSTs) of the shoulder when used with the MDT classification.

This thesis demonstrated a “very good” level of inter-examiner agreement between McKenzie practitioners when classifying patients with shoulder pain using the MDT system ($kappa=0.90$). The results support the findings of previous reliability studies on the application of the MDT system in the extremities,^{5,6} suggesting that the MDT system is a reliable method for classifying patients with extremity musculoskeletal disorders.

In the next phase of this thesis the focus was on verifying whether the response of pain and function to MDT treatment varies by MDT classification category over the

course of treatment. We also looked at the distribution of discharge frequency over time for each MDT classification category in response to treatment. The results suggested that the MDT classification in patients with shoulder pain can impact treatment outcomes and the frequency of discharge. As hypothesized, Derangement and Spinal categories had quicker responses to their treatments with a higher rate of early discharge from treatment in comparison to patients in the articular or contractile classifications. Thus, the treatment outcomes are aligned with the response expectation of the MDT classification. The study also demonstrated that the distribution of patients with Derangement and Spinal categories together make up over two-third of patients with shoulder pain, reinforcing the importance of quick response times for Derangement and Spinal categories.

As a final step, we explored whether the shoulder MDT classification and its subsequent treatment affects the consistency of test results for three commonly used shoulder OSTs. Our main interest was to determine whether the interpretation of the OSTs changes in the Derangement category. The study revealed poor overall agreement for the Empty Can, Hawkins-Kennedy and Speed's tests; however, the agreement was moderate to very good in patients with articular and contractile Dysfunctions with *kappa* ranging between 0.42 for the Hawkins-Kennedy test to 0.84 for the Empty Can test while there was no agreement for any of the OSTs in patients from the shoulder Derangement category, and for the Empty Can test in patients from the spinal Derangement category (P values > 0.05). The agreement was poor for the Hawkins-Kennedy and Speed's tests in patients with spinal classification with *kappa* values of 0.26 and 0.37 respectively. This poor agreement may be due to the rapidly changing nature of patients in the Derangement classifications. Thus, patients in the Derangement category were responsible for reducing the overall agreement of the OSTs explaining the poor consistency for the OSTs.

5.2 Implications of thesis findings on practice, and future research

In chapter 2, we found a “very good” level of agreement among the MDT practitioners in classifying patients with shoulder disorders using clinical vignettes. The results reinforce

the findings of previous reliability studies conducted on clinical cases with spinal⁷⁻¹³ and extremity^{5, 6} musculoskeletal disorders. There have been three additional reliability studies on the extremities¹⁴⁻¹⁶ and one systematic review¹⁷ since the current thesis work. All but one of the reliability studies on the extremities were vignette-based studies suggesting a strong evidence for reliability of the MDT classification system in patients with extremity disorders. Takasaki¹⁴ conducted an inter-examiner reliability study including 33 patients. He reported that the inter-examiner agreement for provisional MDT classification was “good” when the examiners were seeing the same patients concurrently but “poor” when the patients were seen successively. The poor agreement could be due to the fact that during the first examiner’s assessment, the response of the clinical problem to the examination procedure may be altered and hence present somewhat differently during the subsequent assessment. This can occur especially with Derangement syndrome which is known to have rapid changes to end range movements performed during an assessment. Thus there might be inconsistent patient presentations between raters when they are rated successively, leading to “poor” agreement.

Having considered the available literature, there is strong evidence supporting inter-examiner reliability of the MDT system when used with patients with extremity problems suggesting that this system could be reliably used in classifying the extremity patient population. Additional studies may be needed considering the use of real patients instead of written vignettes to further establish reliability of the MDT system in patients with musculoskeletal disorders of the extremities.

In chapter 3, we demonstrated when MDT-trained clinicians match the intervention to a specific MDT classification, the outcome is aligned with the response expectation of the classification. Patients in the Derangement and Spinal categories make up a great majority of the patient population with shoulder disorders, and they showed very similar pain and functional responses to treatment. We demonstrated significantly greater improvement in comparison to patients with Dysfunction; therefore, compared to patients with Dysfunction, a high percentage of patients with Derangement and Spinal classifications achieved their treatment goals relatively quickly and were discharged from

treatment. This reinforces the point that the Spinal extremity classification is in fact a cervical spine Derangement and like the shoulder Derangement, this classification is anticipated to demonstrate a rapid treatment response. In comparison, Dysfunction respond in a more graduated manner, achieving discharge status at a later point. The results suggest that knowing the MDT classifications for patients with a shoulder problem can provide clinicians with valuable information on prognosis, which is one of the key questions patients have for their clinicians. To further investigate clinical application of the MDT system in patients with shoulder disorders, randomized controlled trials are needed to compare the MDT system with conventional treatment for this patient population.

In chapter 4, we demonstrated that there is poorer agreement between the OSTs in patients with Derangement, (including Spinal Derangement) compared to patients with either Contractile or Articular Dysfunction. These Dysfunctions demonstrated acceptable agreement. The lack of agreement for the OSTs in the Derangement classification may be due to the variable and quickly changing nature of this category especially because it rapidly responds to intervention. Therefore, the presence of Derangement may explain the poor consistency documented for most OSTs. These results reinforce why clinicians should be cautious when using these OSTs as diagnostic and prognostic tools.^{3, 18-20} There was a clear difference in their consistency in the presence of a Derangement as compared to when Derangements were not included in the agreement calculations. Therefore it may be that an initial MDT screening of shoulder patients should be used to ensure that shoulder and cervical Derangements have been ruled out before other testing is performed. This may then enhance the value of the OSTs and perhaps lead to their improved diagnostic capability, if indeed a patho-anatomical diagnosis is still sought. Alternatively, these OSTs could be used as baseline tests to be used in the differentiation between the MDT classifications of Derangement and Articular and Contractile Dysfunctions. If the OSTs change from positive before, to negative after a repeated movement exam or the initiation of treatment, then this would be consistent with a Derangement being present. As a next step, future studies could further examine our study objectives by including other OSTs utilized for shoulder evaluation.

5.3 Limitations

Although we addressed some current gaps in the literature, there are several limitations to this thesis. The major limitation of the reliability study was that only MDT diplomats were included. This reduces the generalizability of the findings of this study, suggesting that the agreement among clinicians without this level of training may not be as high. Future studies should include practitioners with different levels of education and expertise so that the results could be more generalizable. Another limitation of this study was using written vignettes as opposed to having actual patients. Although using written vignettes can minimize the potential error generated by inconsistent patient presentations between raters,¹³ the concern is the simplification of the intervention being demonstrated in the vignettes.¹³ These vignettes may not represent all the complexities and subtleties of clinical practice, making the diagnosis easier for the raters and inflating the calculated *kappa* value.¹³ Future reliability studies could include real patients instead of written vignettes to minimize these shortcomings.

The clinical application of the MDT system in the shoulder had the following limitations: First, due to the use of a “treatment-as-usual” approach, it was not feasible to have a pre-determined number of treatment sessions for each one of our study participants. Thus, it is possible that the patients in each classification received a different number of treatment sessions; this may have influenced the outcomes. However, the treating practitioners had no awareness of the study objectives, and therefore would have been less likely to influence the outcome associated with each MDT category. Rather, they treated each patient as best as they could, considering the clinical presentation. Secondly, exercise compliance was not closely monitored, thus it is uncertain whether the poorer results in the Dysfunction group was because of poor exercise compliance or the typical nature of this MDT classification. Third, and due to the nature of the study design, there was no control group to receive conventional physiotherapy intervention eliminating the ability to compare MDT system with other treatment approaches. Fourth, there was no randomization because the MDT method was selected as the only method of intervention and the patients were required to be treated within their respective MDT classification

groups. As a next step, well-designed randomized controlled trials are warranted to compare the MDT system with other treatment approaches for patients with shoulder pain.

The “treatment-as-usual” approach was also a limitation for our third study, however, as indicated before, the treating physiotherapists were unaware of the study objectives and therefore less likely to influence the results. A second limitation of this study also resulted from following a “treatment as usual” approach. As some patients were discharged from their treatment earlier than the final study target point, they did not have their data available for all the four data collection points. Therefore, analysis was conducted on data from three data collection points instead of four. The third limitation of the study was that only three OSTs were included in the study as it would not be feasible in a study to include all the numerous OSTs used for shoulder assessment. As a next step, future studies could further explore other OSTs utilized for shoulder assessment, and have a pre-set and equal number of treatment sessions for all patients so that data would be available for all data collection points. Due to the presence of a clear pattern in our findings indicating that the Derangement classification could be the reason that the OSTs fail to meet the purpose they are used for, further investigations are warranted on the OSTs utilized in the assessment of other musculoskeletal disorders in both spinal and peripheral conditions.

5.4 Potential Bias

Bias is defined as any tendency which prevents unprejudiced consideration of a question.²⁴ In research, bias can take place at any stage of a project including study design, data collection, as well as in the process of data analysis and publication.²⁵ Pre-trial biases may arise from a flawed study design, selection or channeling bias. In our project, definition of outcome measures and study objectives were clearly defined and measures were taken to blind study collaborators who collected data from their patients. As all the participating practitioners were MDT trained, there could be a potential bias among the practitioners towards inflating the effectiveness of the MDT system, however as a measure to minimize such bias, a second practitioner different from the treating

practitioner, and blinded to the patients' MDT classifications administered the OSTs to avoid any potential bias from the treating clinician in registering the test results.

Selection bias was avoided by including all patients with shoulder pain who referred to physical therapy intervention except for listed exclusion criteria such as recent trauma or surgery, etc. Although there may seem to be channeling bias by including patients with rapid response to treatment in Derangement compared to patients with Dysfunction, however, all group allocation was conducted after a standard MDT assessment by the treating clinicians having no knowledge of our study objectives.

As a source of bias during a trial, chronology bias occurs when historic controls are used as a comparison group for patients undergoing an intervention.²⁵ We chose a prospective study design to avoid such bias. Transfer bias may occur when there is unequal patients lost to follow-up among study groups. In our study, 12 patients were lost to follow-up after their initial assessment; therefore, it was not possible to identify what proportion of them were from different MDT classifications. As a result, these patients were excluded from our analysis. Performance bias may occur when more experienced practitioners treat a specific patient population whereas other classifications were treated by less experienced therapist; however, in our studies consecutive sampling was conducted and the study collaborators treated mixed number of all MDT classifications.

Bias after a trial's conclusion may take place during data analysis or publication.²⁵ Confounding factors should be considered during analysis if there is a chance of influencing the results. We looked at multiple confounding factors listed in table 3-2 that might have had potential influence on the results, but there was no statistically significant difference among the groups for the considered factors. Citation bias refers to the fact that researchers and study sponsors are less likely to publish unfavorable results. We published all our findings and also cited studies with conflicting findings on reliability of the MDT system published by Takasaki.^{14,15}

5.5 Conclusion

Considering the well-described limitations of conventional patho-anatomical models for diagnosis and management of patients with shoulder complaints,²¹⁻²³ the MDT system, may be worthy of further investigation to fill the current gap in the diagnosis and treatment of the musculoskeletal patient population. One of the promising aspects of our study results is that two-thirds of our study participants were classified as either a shoulder Derangement or a cervical Spinal Derangement clinically observed to have a rapid response to MDT treatment. If future studies confirm that patients diagnosed as Derangements conform to their expected rapid response to tailored MDT treatments, there is potential to significantly impact MDT treatment outcomes for a majority of patients with shoulder problems. In addition, with the effect of both shoulder and spinal Derangement classification on the agreement of sequentially performed OSTs, it would seem reasonable to account for this phenomenon in the orthopedic assessment process. Due to the variable nature of patients in the Derangement category and their ability to change rapidly, this category clearly has the potential to compromise the reliability of OSTs and thus reduce their clinical utility. Therefore, screening for patients with Derangement prior to the use of these three shoulder OSTs may contribute to their diagnostic capability.

5.6 References

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Appendices

Appendix A. MDT Extremity 'OTHER' Category

Serious pathology (list is not exhaustive)			
Category	Clinical findings (Red Flags)		Clinical Examples
Cancer	Age >55, history of cancer , unexplained weight loss, progressive, not relieved by rest		May be primary site or metastases
Fracture	History of significant trauma (If osteoporosis present; minor trauma) Loss of function. All movements make worse.		
Infection	Fever, malaise, constant pain, all movements worsen		
Subgroup	Definition	Criteria	Clinical Examples
Chronic Pain Syndrome	Pain-generating mechanism influenced by psychosocial factors or neurophysiological changes	Persistent widespread pain, aggravation with all activity, disproportionate pain response to mechanical stimuli, inappropriate beliefs and attitudes about pain.	Regional pain syndromes
Inflammatory	Inflammatory arthropathy	Constant pain, morning stiffness, excessive movements exacerbate symptoms	RA, sero-negative arthritis, some stages of OA
Mechanically Inconclusive	Unknown musculoskeletal pathology	Derangement, Dysfunction, Postural and subgroups of OTHER excluded Symptoms affected by positions or movements BUT no recognisable pattern identified OR inconsistent symptomatic and mechanical responses on loading	
Peripheral Nerve Entrapment	Peripheral nerve entrapment	No spinal symptoms. Local paraesthesia / anaesthesia. May have local muscle weakness.	Carpal tunnel syndrome, meralgia paraesthetica,
Post-surgery	Presentation relates to recent surgery	Recent surgery and still in post-operative protocol period	
Soft Tissue Disease Process	A fibroblastic or degenerative disease process affecting inert soft tissue with unknown or disputed aetiology	Each disease process has a unique clinical presentation, natural history and response to a variety of interventions.	Frozen shoulder, Dupuytren's, plantar fascia syndrome
Structurally Compromised	Soft tissue and/or bony changes compromising joint integrity	Mechanical symptoms (ROM restricted, clunking, locking, catching). May have sensation of instability. Long history of symptoms or history of trauma. Irreversible with conservative care.	Late stage OA, dislocation, labral tear, cruciate ligament rupture, irreducible meniscal tear
Trauma / Recovering Trauma	Recent trauma associated with onset of symptoms	Recent trauma associated with onset of constant symptoms / recent trauma associated with onset of symptoms, now improving and pain intermittent	
Vascular	Symptoms induced by poor blood supply due to pressure increase in a closed anatomical space	Below knee symptoms, predominantly in younger athletes. Consistently induced by exercise or activity. May have pain and /or paraesthesia in field of local cutaneous nerve and local swelling.	Compartment syndrome

Appendix B. Research Ethics Approval-Study 1



Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Tom Overend
 File Number:103541
 Review Level:Delegated
 Approved Local Adult Participants:100
 Approved Local Minor Participants:0
 Protocol Title:Application of the McKenzie system of Mechanical Diagnosis and Therapy (MDT) in patients with shoulder pain
 Department & Institution:Health Sciences\Physical Therapy,Western University
 Sponsor:
 Ethics Approval Date:March 08, 2013 Expiry Date:June 30, 2014
 Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Instruments	Data collection form - 1	2013/02/12
Instruments	Data collection form - 2	2013/02/12
Instruments	NPRS	2013/02/12
Instruments	UEFI	2013/02/12
Other	Master list of ID# and McKenzie practitioner	2013/02/12
Other	Master list of study collaborators	2013/02/12
Western University Protocol		2013/02/12
Revised Letter of Information & Consent	Letter of Info and Consent Form.pdf	2013/03/06

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Signature

Ethics Officer to Contact for Further Information

Janice Sutherland (jsutherl@uwo.ca)	Grace Kelly (grace.kelly@uwo.ca)	Shantel Walcott (swalcot@uwo.ca)
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 London, ON, Canada N6A 3K7 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/services/ethics

Appendix C. Research Ethics Approval-Study 2 & 3



Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Bert Chesworth
File Number: 102509
Review Level: Delegated
Approved Local Adult Participants: 17
Approved Local Minor Participants: 0
Protocol Title: Inter-examiner reliability of The McKenzie system of Mechanical Diagnosis and Therapy (MDT) in assessing patients with shoulder pain - 19004E
Department & Institution: Schulich School of Medicine and Dentistry/Epidemiology & Biostatistics, Western University
Sponsor:
Ethics Approval Date: May 31, 2012 **Expiry Date:** May 31, 2013
Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Western University Protocol		
Letter of Information & Consent Phase 1	Creation of Clinical Vignettes	2012/05/18
Letter of Information & Consent Phase 2	Rating of Clinical Vignettes	2012/05/18

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

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The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Signature _____

Ethics Officer to Contact for Further Information

Janice Sutherland (jsutherl@uwo.ca)	Grace Kelly (grace.kelly@uwo.ca)	Shantel Walcott (swalcot@uwo.ca)
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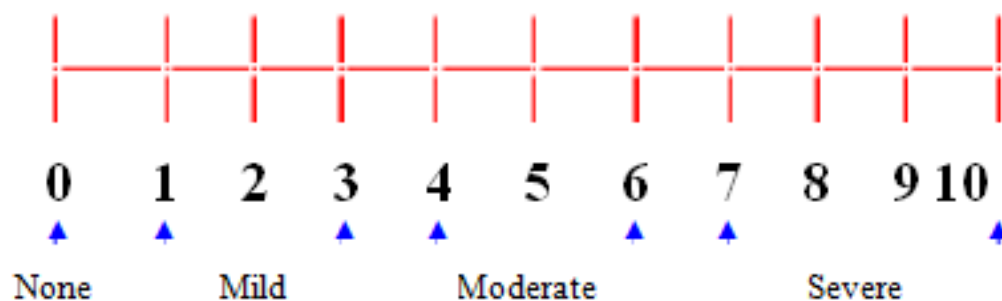
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The University of Western Ontario

Office of Research Ethics

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Appendix D. Numeric Pain Rating Scale (NPRS)



What number on a scale of 0 to 10 would you give to your pain over the past 24 hours?

0 = No Pain

1-3 = Mild Pain (nagging, annoying, interfering little with ADLs)

4-6 = Moderate Pain (interferes significantly with ADLs)

7-10 = Severe Pain (disabling; unable to perform ADLs)

Reference

McCaffery, M., & Beebe, A. (1993). *Pain: Clinical Manual for Nursing Practice*. Baltimore: V.V. Mosby Company.

Appendix E. Upper Extremity Functional Index (UEFI)

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your upper limb problem for which you are currently seeking attention. Please provide an answer for **each** activity.

Today, **do you** or **would you** have any difficulty at all with:

(Circle One number on each line)

	Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
1	Any of your usual work, housework, or school activities	0	1	2	3	4
2	Your usual hobbies, recreational or sporting activities	0	1	2	3	4
3	Lifting a bag of groceries to waist level	0	1	2	3	4
4	Lifting a bag of groceries above your head	0	1	2	3	4
5	Grooming your hair	0	1	2	3	4
6	Pushing up on your hands (eg from bathtub or chair)	0	1	2	3	4
7	Preparing food (eg peeling, cutting)	0	1	2	3	4
8	Driving	0	1	2	3	4
9	Vacuuming, sweeping or raking	0	1	2	3	4
10	Dressing	0	1	2	3	4
11	Doing up buttons	0	1	2	3	4
12	Using tools or appliances	0	1	2	3	4
13	Opening doors	0	1	2	3	4
14	Cleaning	0	1	2	3	4
15	Tying or lacing shoes	0	1	2	3	4
16	Sleeping	0	1	2	3	4
17	Laundrying clothes (eg washing, ironing, folding)	0	1	2	3	4
18	Opening a jar	0	1	2	3	4
19	Throwing a ball	0	1	2	3	4
20	Carrying a small suitcase with your affected limb	0	1	2	3	4
	Column Totals:					

Minimum Level of Detectable Change (90% Confidence): 9 points

SCORE: _____/80

Source: Stratford PW, Binkley, JM, Stratford DM (2001): Development and initial validation of the upper extremity functional index. Physiotherapy Canada. 53(4):259-267.

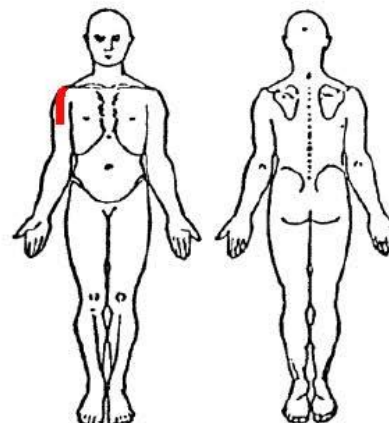
Appendix F. Sample Vignettes



THE MCKENZIE INSTITUTE PERIPHERAL ASSESSMENT

Date _____
 Name 1 _____ Sex ☒ M / ☐ F
 Address _____
 Telephone _____
 Date of Birth _____ Age 35-39
 Referral GP / Orth / Self / Other _____
 Patient accepts anonymous use of data for research ☒ Yes / ☐ No
 Work: Mechanical Stresses Desk work _____

 Leisure: Mechanical Stresses Lifts weights, rock climbing _____
 Functional Disability from present episode _____
 Functional Disability score _____
 VAS Score (0-10) 5/10



HISTORY

Present Symptoms As Above
 Present since 4 months Improving / ☒ Unchanging / Worsening
 Commenced as a result of Fell on shoulder while rock climbing Or no apparent reason
 Symptoms at onset Right anterior shoulder
 Constant symptoms _____ Intermitt. symp. R shoulder _____
 What produces or worsens Raising overhead, lifting objects, reaching, lifting weights, rock climbing

 What stops or reduces Resting the arm, avoiding aggravating activities

 Continued use makes the pain Better / Worse / ☒ No effect
 Pain at rest Yes / ☒ No
 Disturbed night Yes / ☒ No
 Other Questions _____

 Treatment this episode Physical Therapy (ultrasound, massage, stretching) initially helped
 Previous Episodes Nil
 Previous treatments _____
 Spinal history _____
 _____ Paraesthesia Yes / ☒ No
 Medications tried _____
 Present medication _____
 General Health ☒ Good / Fair / Poor _____
 Imaging Yes / ☒ No
 Summary _____ Acute / Sub-acute / ☒ Chronic _____ Trauma / Insidious onset
 Sites for physical examination _____
 _____ R shoulder

EXAMINATION

Observation _____

Baseline measurements (pain or functional activity): _____

Active Movements (note symptoms and range):	PDM	ERP
Flexion: min loss	X	
Abduction: min loss	X	
Passive Movement (+/- over pressure)(note symptoms and range)		
Flexion: min loss, no effect		
Abduction: min loss, no effect		
Resisted tests response (pain)		
Flexion: 4/5, painful		
Abduction: 4/5 painful		

Repeated Tests (choose the most symptomatic from above)

Active movement passive movement resisted test	During Movement	After Movement	Mechanical Response		
			^ ROM	v ROM	no effect
Extension	No effect	No effect			
Internal rotation	No effect	No effect			
Flexion	Produces/ shoulder R	No worse			X
Resisted flexion	Produces/ shoulder R	No worse			X
Effect of static positioning					
Other tests: eg loaded, compression, unloaded etc					

SPINE

Movement Loss Nil _____

Effect of repeated movements Nil _____

Effect of static positioning Nil _____

Spine testing Not relevant / relevant / secondary problem _____

PROVISIONAL CLASSIFICATION

Dysfunction - Articular _____ Contractile _____

Derangement _____ Postural _____

Other _____ Uncertain _____

PRINCIPLE OF MANAGEMENT

Education _____

Exercise _____ Frequency _____

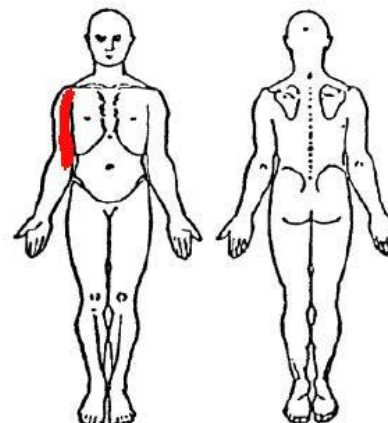
Treatment Goals _____



THE MCKENZIE INSTITUTE PERIPHERAL ASSESSMENT

Date _____
 Name 2 Sex M / ☒ F
 Address _____
 Telephone _____
 Date of Birth _____ Age 45-49
 Referral GP / ☒ Orth / Self / Other _____
 Patient accepts anonymous use of data for research ☒ Yes / No
 Work: Mechanical Stresses Sales

 Leisure: Mechanical Stresses Gardening, active
 Functional Disability from present episode Any UE use
 Functional Disability score _____
 VAS Score (0-10) 10/10



HISTORY

Present Symptoms Sharp pain Right Upper Arm
 Present since 10 days Improving / Unchanging / ☒ Worsening
 Commenced as a result of _____ ☒ Or no apparent reason
 Symptoms at onset Less intense
 Constant symptoms Arm Intermitt. symp. _____
 What produces or worsens Any UE use

 What stops or reduces Holding UE across body

 Continued use makes the pain Better / ☒ Worse / No effect
 Pain at rest ☒ Yes / No
 Disturbed night ☒ Yes / No
 Other Questions _____

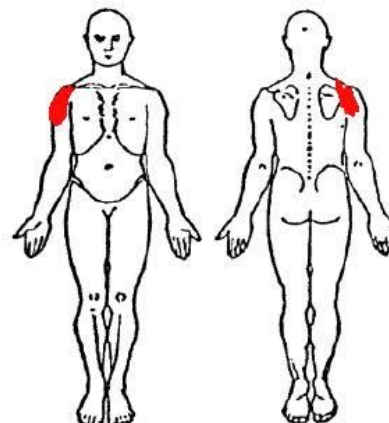
 Treatment this episode Cortisone Shot: NE
 Previous Episodes None
 Previous treatments None
 Spinal history LBP but no cervical spine history
 _____ Paraesthesia Yes / ☒ No
 Medications tried _____
 Present medication _____
 General Health ☒ Good / Fair / Poor
 Imaging ☒ Yes / No MRI: bicepital tendonitis
 Summary ☒ Acute / Sub-acute / Chronic Trauma / ☒ Insidious onset
 Sites for physical examination Shoulder, Neck



THE MCKENZIE INSTITUTE PERIPHERAL ASSESSMENT

Date _____
 Name 3 Sex M/F
 Address _____
 Telephone _____
 Date of Birth _____ Age 65-69
 Referral GP / Orth / Self / Other _____
 Patient accepts anonymous use of data for research Yes/No
 Work: Mechanical Stresses Office work

 Leisure: Mechanical Stresses _____
 Functional Disability from present episode _____
 Functional Disability score _____
 VAS Score (0-10) 7/10



HISTORY

Present Symptoms As Above
 Present since 3 months Improving / Unchanging / Worsening
 Commenced as a result of _____ Or no apparent reason
 Symptoms at onset _____
 Constant symptoms Right shoulder Intermitt. symp. _____
 What produces or worsens All movement of the shoulder

 What stops or reduces Resting the arm at the side

 Continued use makes the pain Better / Worse / No effect
 Pain at rest Yes/No
 Disturbed night Yes/No _____
 Other Questions _____

 Treatment this episode Nil
 Previous Episodes Nil
 Previous treatments _____
 Spinal history Nil
 _____ Paraesthesia Yes / No
 Medications tried _____
 Present medication _____
 General Health Good / Fair / Poor Heart disease, Diabetes, Hx breast cancer over
 Imaging Yes / No 10 yrs
 Summary _____ Acute / Sub-acute / Chronic Trauma / Insidious onset
 Sites for physical examination _____

EXAMINATION

Observation _____

Baseline measurements (pain or functional activity): increased pain with raising

Active Movements (note symptoms and range):	PDM	ERP
Flexion: mod loss, pain throughout motion		
Abduction: mod loss, pain throughout motion		
Internal rotation: major loss, pain throughout motion		
Passive Movement (+/- over pressure)(note symptoms and range)		
Flexion: mod loss, pain throughout motion		
Abduction: mod loss, pain throughout motion		
Internal rotation: major loss, pain throughout motion		
Resisted tests response (pain)		
All motion 4-/5 and painful		

Repeated Tests (choose the most symptomatic from above)

Active movement passive movement resisted test	During Movement	After Movement	Mechanical Response		
			^ ROM	v ROM	no effect
Extension	No effect	No better			
Flexion	Increases/ shoulder R	Worse			X
Internal rotation	Increases/ shoulder R	Worse			X
Effect of static positioning					
Other tests: eg loaded, compression, unloaded etc					

SPINE

Movement Loss Nil

Effect of repeated movements Nil

Effect of static positioning

Spine testing Not relevant / relevant / secondary problem

PROVISIONAL CLASSIFICATION

Dysfunction - Articular	Contractile
Derangement	Postural
Other	Uncertain

PRINCIPLE OF MANAGEMENT

Education

Exercise Frequency

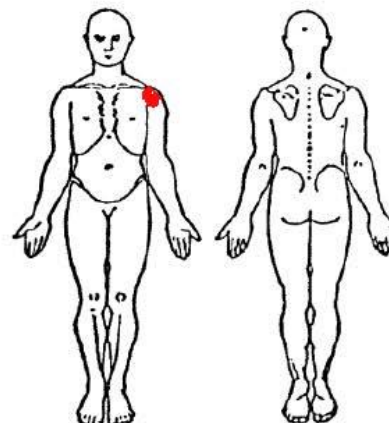
Treatment Goals



THE MCKENZIE INSTITUTE PERIPHERAL ASSESSMENT

Date _____
 Name 4 Sex ☒ M / ☐ F
 Address _____
 Telephone _____
 Date of Birth _____ Age 41-44
 Referral GP / Orth / Self / Other _____
 Patient accepts anonymous use of data for research ☒ Yes / ☐ No
 Work: Mechanical Stresses Labor work

 Leisure: Mechanical Stresses _____
 Functional Disability from present episode _____
 Functional Disability score _____
 VAS Score (0-10) 5/10



HISTORY

Present Symptoms As above
 Present since 3 months Improving / ☒ Unchanging / ☐ Worsening
 Commenced as a result of Lifting box overhead Or no apparent reason
 Symptoms at onset Left anterior shoulder
 Constant symptoms _____ Intermitt. symp. Left shoulder
 What produces or worsens Raising overhead

 What stops or reduces Resting arm at his side

 Continued use makes the pain Better / Worse / ☒ No effect
 Pain at rest Yes ☒ No
 Disturbed night ☒ Yes / ☐ No If lying on the shoulder
 Other Questions _____

 Treatment this episode Nil
 Previous Episodes Right frozen shoulder 3 years ago
 Previous treatments _____
 Spinal history _____
 _____ Paraesthesia Yes ☒ No
 Medications tried _____
 Present medication _____
 General Health ☒ Good / Fair / Poor _____
 Imaging Yes ☒ No
 Summary _____ Acute / Sub-acute / ☒ Chronic _____ Trauma / Insidious onset
 Sites for physical examination _____
L shoulder & neck

EXAMINATION

Observation _____

Baseline measurements (pain or functional activity): _____

Active Movements (note symptoms and range):	PDM	ERP
Flexion: mod loss		X
Abduction: mod loss		X
Extension: min loss		
Passive Movement (+/- over pressure)(note symptoms and range)		
Flexion: mod loss		X
Abduction: mod loss		X
Resisted tests response (pain)		
Flexion: 5/5 no effect		
Abduction: 5/5 no effect		

Repeated Tests (choose the most symptomatic from above)

Active movement passive movement resisted test	During Movement	After Movement	Mechanical Response		
			^ ROM	v ROM	no effect
Flexion	Produces/ shoulder L	No worse			X
Extension	No effect	No effect			X
Internal rotation	No effect	No effect			X
Effect of static positioning					
Other tests: eg loaded, compression, unloaded etc					

SPINE

Movement Loss Min loss all direction _____

Effect of repeated movements Nil _____

Effect of static positioning Nil _____

Spine testing Not relevant / relevant / secondary problem _____

PROVISIONAL CLASSIFICATION

Dysfunction - Articular _____ Contractile _____

Derangement _____ Postural _____

Other _____ Uncertain _____

PRINCIPLE OF MANAGEMENT

Education _____

Exercise _____ Frequency _____

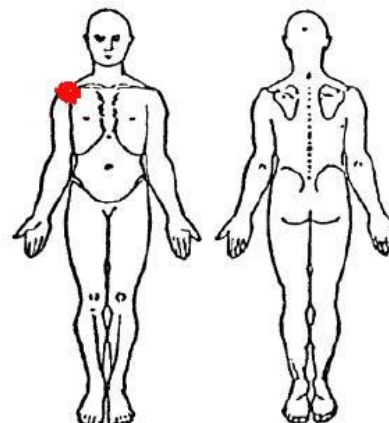
Treatment Goals _____



THE MCKENZIE INSTITUTE PERIPHERAL ASSESSMENT

Date _____
 Name 5 Sex ☒ M / ☐ F
 Address _____
 Telephone _____
 Date of Birth _____ Age 40-44
 Referral GP / Orth / ☒ Self / Other _____
 Patient accepts anonymous use of data for research ☒ Yes / ☐ No
 Work: Mechanical Stresses Desk Work

 Leisure: Mechanical Stresses Hockey, running, weights
 Functional Disability from present episode Slap shot, bench press
 Functional Disability score _____
 VAS Score (0-10) 0 at rest, 3-4 with activities



HISTORY

Present Symptoms Rt shoulder
 Present since 6 months Improving / ☒ Unchanging / ☐ Worsening
 Commenced as a result of Fell on shoulder playing "pick up" Football Or no apparent reason
 Symptoms at onset Pain reduced function x 3 weeks
 Constant symptoms _____ Intermitt. symp. Pain
 What produces or worsens Slap shot, reaching for seat belt, Sleep

 What stops or reduces Rest

 Continued use makes the pain Better / Worse / ☒ No effect
 Pain at rest Yes / ☒ No
 Disturbed night ☒ Yes / ☐ No if he sleeps on this side
 Other Questions _____

 Treatment this episode Nil
 Previous Episodes Nil
 Previous treatments Advice / meds
 Spinal history Previous LBP episodic
 _____ Paraesthesia Yes / ☒ No
 Medications tried NSAIDS
 Present medication NIK
 General Health ☒ Good / ☐ Fair / ☐ Poor
 Imaging Yes / ☒ No
 Summary _____ Acute / Sub-acute / ☒ Chronic _____ Trauma / ☒ Insidious onset
 Sites for physical examination R Shoulder

EXAMINATIONObservation Slight step deformity Rt AC jointBaseline measurements (pain or functional activity): No Pain

Active Movements (note symptoms and range): _____

Slight Loss of Horizontal Adduction

Slight Loss of IR

Passive Movement (+/- over pressure)(note symptoms and range) _____

Extension (+ overpressure)

ER (+ overpressure)

Resisted tests response (pain) _____

Extension 4+

ER 4+

PDM	ERP
	X
	X
	X
	X
	X
	X

Repeated Tests (choose the most symptomatic from above)

Active movement passive movement resisted test	During Movement	After Movement	Mechanical Response		
			^ ROM	v ROM	no effect
ER	8 rep/ Produces/ VAS 4	No worse			X
Extension	6 rep/ Produces/ VAS 4	No worse			X
IR	6 rep/ Produces/ VAS 4	No worse	X		
Effect of static positioning					
Other tests: eg loaded, compression, unloaded etc					

SPINEMovement Loss No Loss of Cervical movement

Effect of repeated movements _____

Effect of static positioning _____

Spine testing Not relevant / relevant / secondary problem _____**PROVISIONAL CLASSIFICATION**

Dysfunction - Articular _____ Contractile _____

Derangement _____ Postural _____

Other _____ Uncertain _____

PRINCIPLE OF MANAGEMENT

Education _____

Exercise _____ Frequency _____

Treatment Goals _____

Answer Key

	Derangement	Articular dysfunction	Contractile dysfunction	Cervical spine	Other
Vignette #1			X		
Vignette #2				X	
Vignette #3					X
Vignette #4		X			
Vignette #5	X				

Curriculum Vitae

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Post-secondary Education and Degrees: Iran University of Medical Sciences
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Publications:

Heidar Abady A, Rosedale R, Chesworth BM, Rotondi MA, Overend TJ. Consistency of commonly used orthopedic special tests of the shoulder when used with the McKenzie system of mechanical diagnosis and therapy. *Musculoskelet Sci Pract*. DOI 10.1016/j.msksp.2017.10.001.

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