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Effectiveness of Passive Joint Mobilisation for Shoulder Dysfunction: A Review of the Literature

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1. Introduction

Shoulder pain and stiffness is common in the general community. It is the third most frequent site of musculoskeletal pain after back and neck. Not only does shoulder pain and stiffness impact on the physical functioning, it also contributes significantly to the emotional and psychological distress of the patient. Furthermore, it imposes considerable financial burden on the affected individual and the society. The first half of this chapter will review in detail the literature on the scope of the problems associated with shoulder dysfunction, in particular the prevalence, clinical course, and specific target groups such as the elderly, occupational and sporting groups. It will also review patients with specific medical problems such as spinal cord injury, stroke and diabetes mellitus. In addition personal suffering and the financial burden of shoulder pain, occupational risk factors and prognostic factors will be discussed, and the diagnostic dilemmas associated with shoulder problems will be highlighted.

Many approaches have been employed in the treatment of shoulder disorders. Physiotherapy intervention is often the first line management of this problem, and a wide array of physical therapies has been used, in particular, passive joint mobilisation and exercise therapy. Whilst there is growing evidence for exercise therapy (Ainsworth & Lewis, 2007; Ginn et al, 1997; Ginn and Cohen, 2005; Grant et al, 2004; Trampas and Kitsios, 2660), there is a paucity of research investigating the effectiveness of this commonly-used technique on shoulder disorder. The second part of this chapter is a descriptive review of the latest evidence in support of the efficacy of passive joint mobilisation in the management of shoulder disorders.

2. Scope of the problem

2.1 Prevalence

Shoulder pain is a common problem in the general community, with prevalence ranging from 7% to 34% (van der Windt et al, 1995; van der Heijden, 1999; Vogt et al, 2003; Luime et

al, 2004; Picavet & Schouten, 2003; Pope, 1997). An estimated 20% of the population will suffer shoulder pain during their lifetime (Pope, et al 1997), with a yearly incidence of 15 new episodes per 1,000 patients seen in the primary care setting (van der Windt et al, 1995). Brox (2003) suggested that half the population has at least one episode of shoulder pain yearly. Furthermore, Pope et al (1997) has found that prevalence of shoulder pain could be influenced by case definition. Hence according to this definition, prevalence could range even higher to 51%. The shoulder is the most frequent site of musculoskeletal pain after the lower back, neck and knee (Parsons et al, 2007; McCormick et al, 1996), and shoulder complaints were found to be the most common contributor to the total incidence figure for non-traumatic arm, neck and shoulder pain (Feleus et al, 2008).

Not everyone consults the general practitioner for their shoulder complaints. It has been estimated that the proportion of the population seeking treatment ranged from between 20% to 50% (Picavet and Schouten, 2003; Chard et al, 1991; Badcock et al, 2003; Walker Bone et al 2004). In particular, Chakravarty & Webley (1990) found only 47% of elderly patients had consulted their general practitioner about shoulder pain. Chard & Hazleman (1987, 1991) found underreporting of disorders of shoulder in elderly patients in the hospital and in the community. Fewer than 40% of subjects sought medical attention for shoulder disorders in the community survey, and from the hospital survey, only 3 out of 21 patients with shoulder symptoms had sought medical treatment. This was probably due to the higher acceptance of illness and disability of the elderly population. Hence the prevalence of shoulder problem is higher than what is quoted in the literature. With the population ageing, the incidence of shoulder dysfunction will continue to rise. This has been reflected in the increasing number of referrals for treatment of shoulder disorders in the current clinical settings.

2.2 Specific target groups

Shoulder disorders are commonly encountered in the community, but more prevalent in specific populations such as the elderly, workers involved with repetitive work, those who undertake sports/recreation involving repetitive arm movements, and those with specific medical problems. The following is a brief survey of what has been reported in the literature.

As mentioned previously, surveys have reported a high prevalence of chronic shoulder problems in the elderly in the general community, with rates ranging from 26% (Chard et al, 1987, 1991) to 34% (Chakravarty & Webley, 1990) to 74% (Vecchio et al, 1995). Shoulder pain, either alone or in conjunction with pain in other joints, has a substantial impact on the function and well-being of older adults (Chakravarty & Webley, 1990). Of those aged 85 years and over who reported shoulder joint problems, most had difficulty or were dependent on others in activities in daily living (Badley & Tennant, 1992). Measures of physical performance involving the upper extremity were also decreased in the elderly, together with increased prevalence of joint pain at other body sites (Vogt et al 2003).

Restricted shoulder movement is also common in the elderly, especially in females (Chard & Hazleman, 1987; Chard et al, 1991). It has been shown that there is a mean of 30 degrees less movement in the elderly as compared with younger subjects, with a 10 degree reduction per

decade. Prevalence of symptomatic shoulder disorders in the elderly population is high. The potential disability and unmet needs caused by shoulder disorders in the elderly is considerable.

Workers involved in repetitive work and manual handling report higher prevalence rates of shoulder pain than the general community (Silverstein et al, 1998), with considerably higher rates of shoulder pain reported in occupations such as dentists (Fish & Morris-Allen, 1998; Lalumandier et al, 2001), sewing machine operators (Kaegaard & Andersen, 2000); forestry workers (Miranda et al, 2001); hotel restaurant workers (Chyuan et al, 2004); computer workers (Brandt et al, 2004); construction workers (Ludewig & Borstad, 2003), and nursing home and elderly care workers (Luime et al, 2004/2005). The six month prevalence of shoulder pain among workers exposed to repetitive work has been reported to be 45% (Leclerc et al, 2004). Performing artists also report musculoskeletal problems related to the shoulder. Musicians working in an elevated arm position (eg. violinists, violists, flautists, trumpet players) had a higher prevalence of neck-shoulder pain than those working in a more neutral position (Nyman et al, 2007).

A high incidence of shoulder problems is common in overhead sports (Gohlke et al, 1993), such a baseball (Ruotolo et al, 2006), tennis (Vad et al, 2003), and volleyball (Wang & Cochrane, 2001). In fact, painful shoulder conditions are the most common musculoskeletal complaint in swimmers, with prevalence rates of as high as 76% being reported (Pink & Tibone, 2000; Weldon & Richardson, 2001). It is also the second most affected joint in golfers (Gosheger et al, 2003), and in world-class badminton players, 52% of players reported shoulder pain and stiffness (Fahlstrom et al, 2006).

Shoulder pain in individuals with traumatic spinal cord injury is common, and frequently results in chronic debilitating pain recalcitrant to treatment. The incidence of people with spinal cord lesions reporting shoulder pain ranges from 30% to 69% (Gironda et al, 2004; Ballinger et al, 2000), with tetraplegics reporting an even higher prevalence of 80% (McCasland et al, 2006; Samuelsson et al, 2004). In addition, shoulder pain is also not self-limiting in patients with acute traumatic quadriplegia. Waring & Maynard (1991) reported 23% of this group of patients still had the same or worse shoulder pain at the 6 months discharge. Regardless of the level of spinal cord injury or the result of functional movement patterns, muscle imbalances around the shoulder joint are thought to contribute to shoulder disorders in wheelchairs users (Sinnott et al, 2000).

Like spinal cord injury, shoulder pain is also a common complication of stroke. Stroke-related shoulder problems have been categorised into frozen shoulder, shoulder-hand syndrome and subluxation (Chard & Hazleman, 1987). The prevalence of shoulder pain post stroke has been reported ranging from 30% to 67% (Sackley et al, 2008; Lindgren et al, 2007). It can impede rehabilitation and has been associated with poorer outcomes and prolonged hospital stay (Turner-Stokes & Jackson, 2002).

Lundbaek (1957) first described the association between shoulder pain and diabetes mellitus. It was noted that the incidence of adhesive capsulitis was two to four times higher in patients with diabetes than in the general population, and it has been described as the most disabling of the common musculoskeletal manifestations of this disease, affecting up to

58% of people within this population (Thomas et al, 2007; Laslett et al, 2008). In addition, older female patients with diabetes were more likely to report shoulder pain or disability (Laslett et al, 2008).

2.3 Personal suffering and financial burden

Studies have reported on the severity and impact of shoulder pain and restriction of movement, and the resultant disability and reduced health of the sufferers. Functional limitations in activities of daily living such as personal care, dressing, washing, cooking, housework, gardening and general activities are commonly reported (Pope et al, 1996; Largacha et al, 2006; Smith et al, 2000). As mentioned before, the impact of personal suffering is more prominent in the elderly (Chard et al, 1991; Chakravarty & Webley, 1993; Vecchio et al, 1995; Vogt et al, 2003; Smith et al, 2000). Sleep disturbance was the most common complaint in patients with shoulder pain (Andersen et al, 2002; Ostor et al, 2005). Croft et al (1994) and Smith et al (2000) reported up to 83% of patients with shoulder pain were unable to sleep on the affected side.

The presence of rotator cuff pathology is predictive of impaired physical health quality of life (MacDermid et al, 2004; Chipchase et al, 2000; Smith et al, 2000; Andersen et al, 2002; Ostor et al, 2005; Winters et al, 1999). Self assessment of general health status in patients with common shoulder conditions rank in severity with major medical conditions such as hypertension, congestive heart failure and acute myocardial infarction, and clinical depression (Gartsman et al, 1998; Kaergaard & Anderson, 2000). Ostor et al (2005) found significant difference in 6 of the 8 domains in SF-36 (self-assessment of general health status questionnaire) between population norms and those with shoulder pain, being especially marked for emotional, physical function and physical role. Badcock et al (2002) also found significant psychological distress and disability scores in subjects reporting unilateral shoulder pain.

Rotator cuff tears can have a profound effect on a person's activity level (Harryman et al, 2003). Lippitt et al, (1993) found patients with a tear could only perform 4.4 of the 12 functions on the Simple Shoulder Test. The greatest functional deficits were the inability to throw overhand and lifting 3.6kg to shoulder level (Lippitt et al, 1993; Largacha et al, 2006; Smith et al, 2000).

Apart from the personal and social costs to sufferers of shoulder dysfunction, direct and indirect health care costs pose significant economic burden on the health care system. Swedish insurance data showed that 18% of disability payments made for musculoskeletal disorders was spent on neck and shoulder problems (Nygren et al, 1995). Up to 30% of workers have reported sick leave due to shoulder pain (Kuipers et al, 2006), with sick days ranging from 25 to over 101 days (Ekberg & Wildhagen, 1996). Silverstein et al (1998) reported the average cost of a claim for an occupational shoulder disorder was nearly \$US16,000, and in 2000, the direct costs for the treatment of shoulder dysfunction in the United States totalled a staggering \$7 billion (Meislin et al, 2005). Many workers with chronic shoulder pain are unable to resume full-time work (Chipchase et al, 2000) and this has important socio-economic implications as the associated disability is likely to result in time lost from work (Croft et al, 1994).

2.4 Prognostic factors

Little is known about the aetiology of shoulder disorders, hence many studies have aimed to determine the prognostic factors associated with shoulder complaints in order to avoid a protracted clinical course. A multitude of factors such as patient demographics (Kennedy et al, 2006; Zheng et al, 2005), duration of symptoms (Croft et al, 1996; Thomas et al, 2005), pain intensity (van der Windt et al, 1996; Macfarlane et al, 1998), baseline disability (Kuipers et al, 2004; Croft et al, 1996), range of motion (van der Heijden, 1999; Croft et al, 1996), hand dominance (Thomas et al, 2005; Bartolozzi et al, 1994), concomitant neck pain (Thomas et al, 2005; van der Windt et al, 1996), trauma (van der Windt et al, 1996), early presentation (Viikari-Juntura et al, 2000), psychosocial factors (Reilingh et al, 2008; Kuipers et al, 2006), medication (Brox & Brevik, 1996), injection (van der Windt & Bouter, 2003), education (Brox & Brevik, 1996; Reilingh et al, 2008; Feleus et al, 2007), occupation (van der Windt et al, 2000; Cassou et al, 2002; Miranda et al, 2001; Viikari-Juntura et al, 2000; Kaergaard & Andersen, 2000) and even acromial morphology (Morrison et al, 1997) have been repeatedly identified as potential predictors of outcome; however these are not consistent findings in the literature and results of studies often do not agree.

Increasing age, for example, has been found to be a predictor of outcome in patients with shoulder pain in many studies (Kennedy et al, 2006; Ginn and Cohen, 2004; Linsell, 2006; Miranda, 2001; Morrison, 1997; Ostor, 2005; Pope, 1997; Kuipers et al, 2004); yet just as many studies do not support this (Feleus, 2007; Kennedy et al, 2006; Kuipers et al, 2006; Picavet, 2003; Reilingh et al, 2008; Solomon et al, 2001; Winter et al, 1997; van der Windt, 1996). Similarly gender (female) was found by Cassou et al (2002), Kennedy et al (2006), Picavet (2003), Smith et al (2000) and van der Heijden (1999) to be a predictor of poor outcome, but again other studies did not agree (Feleus, 2007; Kuipers et al, 2006; Pope, 1997; Solomon et al, 2001; van der Windt et al, 1996).

The conflicting and inconsistent outcomes of the prognostic studies could be attributed to the heterogeneity of the studies. There was a wide variety among the studies in terms of the study population, length of follow-up, prognostic factors investigated, outcome measures used and method of analysis. For example, some studies investigated shoulder pain only (Kuipers et al, 2006; Croft et al, 1996; Picavet, 2003; Reilingh et al, 2008; Winters et al, 1999), while others included shoulder pain with or without restriction (Ginn and Cohen, 2004; Kennedy et al, 2006; van der Windt et al, 1996). Treatment of shoulder complaint was included in some study models but not in others. Even when treatment was included, comparison of results was not possible due to the variability of treatment administered, such as physiotherapy with or without surgery (Brox et al, 1993, 1999); physiotherapy to strengthen rotator cuff, cortisone injection (Bartolozzi et al, 1994), pendulum exercises and wall-climbing exercises (Chard et al, 1988), exercise aimed at restoring neuromuscular control of the shoulder girdle muscles (Ginn et al, 1997; Ginn and Cohen, 2005), physiotherapy stretching program (Griggs et al, 2000) and general physiotherapy (Kennedy et al, 2006; Linsell et al, 2006).

In general there is no consensus for prognostic indicators that can identify patients at high or low risk of chronicity. Kuipers et al (2004) concluded that there is strong evidence that high pain intensity predicted a poorer outcome and middle age is associated with poor outcome in occupational population. They also found moderate evidence that a long

duration of symptoms and high baseline disability score predicted a poor outcome. However these results are based on small number of studies with large heterogeneity; therefore the results should be interpreted with caution. It is not known whether subjects in these studies had shoulder pain only, or had both shoulder pain and stiffness. Hence little is known about the prognostic factors associated with painful restricted shoulder dysfunction, and only one study (Zheng et al, 2005) has specifically investigated the clinical course of shoulder symptoms in patients treated conservatively for shoulder pain and stiffness.

2.5 Occupational risk factors

Studies of occupational diseases have shown the proportion of workers with neck/shoulder pain is high (Cassou et al, 2002). Occupational factors relating to both physical aspects of the work undertaken as well as psychological factors concerning work and the working environment have been associated with musculoskeletal symptoms in the shoulder. Results from numerous relevant studies evaluating occupational risk factors of shoulder pain are in agreement regarding the occupational physical demands associated with shoulder pain. Biomechanical factors such as heavy workload (Frost et al, 2002), duration of employment (van der Windt, 2000), duration of working above shoulder level (Svendsen et al, 2004; Silverstein et al, 2008; Pope et al, 2001; Harkness, 2003), repetitive movements (Andersen et al, 2002; Frost et al, 2002), awkward postures (Pope et al, 2001) and vibration (van der Windt, 2000) have been attributed as potential causes of shoulder problems in workers.

Psychosocial risk factors have also been reported to be associated with the development of shoulder pain. These include depression (Miranda et al 2005), age (Cassou et al, 2002; Bonde et al, 2003), poor control at work (van der Windt, 2000), job dissatisfaction (van der Windt, 2000), high job demand (Andersen et al, 2002), and poor social support (Kaergaard & Andersen 2000; Grooten et al 2004). Shoulder pain and poor work conditions have been associated with long term sickness absence amongst workers (Ekberg & Wildhagen, 1996; Viikari-Juntura et al, 2000). In order to design cost-effective measures for the prevention of shoulder pain, data on the importance of each of these risk factors and the dose-response is needed (Bongers, 2001).

2.6 Diagnostic dilemma

The main problem with shoulder studies is that there is no agreement on the diagnosis and classifications of shoulder disorders. This poor agreement between health care providers is due to poor reliability of diagnostic tools and clinical tests. Medical staff and physiotherapists utilise diagnostic classification of shoulder disorders to form the hypothetical framework with which management approach is adopted. Many conditions underlie shoulder pain, yet there is no generally accepted explanation for the aetiology of shoulder problems. Patients with high pain severity, chronic complaints and bilateral involvement represent a diagnostic challenge for clinicians. Furthermore, many patients seen with shoulder disorders have recurrent complaints, and the nature of these complaints varies over the course of time, leading to changes in diagnostic category (Winters et al, 1999). Koester et al (2007) highlighted the difficulty in making a diagnosis in their systematic review of the efficacy of subacromial corticosteroid injection in the treatment of rotator cuff disease. They found that even for a relatively focused topic of rotator cuff disease, there were a variety of pathologic conditions ranging from acute strains to full-thickness cuff tears described in the literature.

2.6.1 Interobserver agreement

Most studies have shown that there is little interobserver agreement among surgeons (Kuhn et al, 2007); physiotherapists (de Winter et al, 1999); rheumatologists (Bamji et al, 1996); and between general practitioners and physiotherapists (Liesdek, 1997) in diagnosing soft-tissue shoulder disorders. In these well-powered studies, all the practitioners were experienced and well-trained. The results showed a disappointingly low observed agreement, in particular, in one study (Liesdek, 1997), where the physiotherapists were not blinded for the diagnosis of the general practitioners, and still, the agreement between the two professions was low. Only one study reported almost perfect inter-observer agreement of the Cyriax method for the assessment of shoulder pain by trained and experienced physiotherapists (Pellecchia et al, 1996).

2.6.2 Reliability of clinical tests

A large number of tests are used by clinicians to help with the diagnose shoulder pain, but none of these have been standardized. The sensitivity, specificity, positive predictive value, negative predictive value, interobserver reliability and overall accuracy of commonly-used physical examination tests of the shoulder have been comprehensively evaluated in numerous studies (Calis et al, 2000; Park et al, 2005; Silva et al, 2008; Ostor et al, 2004; Nomden et al, 2009; Dinnes et al, 2003). The results of these studies demonstrated that there is a wide variation in the reliability of these tests, with poor to moderate concordance between observers. This was further confirmed in two recent high quality systematic reviews of clinical tests for shoulder pathology. Hughes et al (2008) reviewed 13 studies which evaluated 14 clinical tests commonly used to diagnose rotator cuff pathology. The authors found that most of the tests for rotator cuff pathology were inaccurate and cannot be recommended for clinical use. Hegedus et al (2008) systematically reviewed studies concerning the accuracy of clinical tests for the shoulder, and they included studies on all shoulder pathology. Of the 45 studies reviewed, half were considered to be of high quality according to the Quality Assessment of Diagnostic Accuracy Studies tool, but only 2 studies had adequate sample size (Park et al, 2005; Litaker et al, 2000). Nonetheless, the review found that no tests demonstrated significant diagnostic accuracy. Hegedus et al (2008) examined 10 of the 13 papers included in the review by Hugh et al (2008), and concurred with their assessment. Both reviews concluded that most physical examination tests used for shoulder pathology are inaccurate.

Based on the findings of the literature it is questionable whether these commonly-used clinical tests are useful at all in differentially diagnosing pathologies of the shoulder. As a result of the low reliability of clinical tests for shoulder problems, imaging techniques have been recommended to be used to better define shoulder lesions (Silva et al, 2008). The following section briefly describes some of the current literature in this area.

2.6.3 Diagnostic imaging techniques

Due to the diagnostic dilemma and lack of agreement between observers in their diagnosis of shoulder complaints based on clinical examination, diagnostic imaging techniques such as diagnostic ultrasound and magnetic resonance imaging (MRI) are increasingly being used to evaluate patients with painful shoulders.

2.6.3.1 Ultrasound

Ultrasound is commonly used to diagnose soft tissue disorders of the shoulder (Ptasznik, 2001). Numerous studies have found ultrasonography to be highly accurate for detecting full-thickness rotator cuff tears, characterising their extent, and visualising dislocations of the biceps tendon (Teefey et al, 2000; Moosikasuwan et al, 2005; Naredo et al, 2002). In addition, ultrasound has been used in detecting acromioclavicular pathologies in 30 patients with anterior shoulder pain (Blankstein et al, 2005). When compared with 30 asymptomatic controls, degenerative changes which were undetected in plain radiographs were found in the patient group.

Milosavljevic et al (2005) evaluated the accuracy of high-resolution ultrasonography compared to arthroscopy in the detection of rotator cuff tears preoperatively in 190 shoulders. Ultrasound correctly depicted 118 of 124 rotator cuff tears, all 94 full-thickness tears, and 24 of 30 partial-thickness tears. They concluded that ultrasound is a highly accurate diagnostic method for detecting full-thickness rotator cuff tears, but is less sensitive in detecting partial-thickness rotator cuff tears. This is in agreement with the results of Norregaard et al (2002) who found ultrasound to be less sensitive for detecting partial-thickness rotator cuff tears and ruptures of the biceps tendons. Nonetheless ultrasound is quick, non-invasive, and relatively inexpensive; hence it should be used wherever possible to improve diagnosis and treatment of painful shoulder even though the effectiveness of ultrasound is dependent on the type of disorder and the skills and experience levels of the operator (O'Connor et al, 2005).

2.6.3.2 Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is used to detect joint disorders in the shoulder. It is considered an excellent non-invasive method of diagnosing shoulder problems (Toyoda et al, 2005; Mohtadi et al, 2004; Bearcroft et al, 2000). It has also been used to help in the planning of rotator cuff repairs (Ertl et al, 1998). Management plans have been shown in a literature review by Bearcroft (2000) to be subsequently changed due to the impact of MRI on the clinician's diagnosis. The impact on the clinician's diagnosis varied widely between papers: the primary diagnosis was altered in 23% to 68% of cases, and the management plans were subsequently changed in 15% to 61% of cases.

The effectiveness of MRI has been compared with ultrasound. In a systematic review of the effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders, Dinnes et al (2003) concluded that MRI and ultrasound could equally be used for detection of full-thickness rotator cuff tears, although ultrasound may be better at picking up partial tears, and MRI are accurate for detection of full-thickness rotator tears. When patients' perceptions and satisfaction with MRI and ultrasound were compared, most patients with shoulder pain preferred sonography to MRI (Middleton et al 2004). Given the large differential in the cost of the two procedures and patient satisfaction, the implication from current evidence is that ultrasound is the more cost-effective and preferred test for identification of full-thickness tears.

2.7 Asymptomatic rotator cuff tears

Clinical decisions of shoulder management should be based on the correlation of physical examination with investigative procedures as many patients could be clinically

asymptomatic. In fact, magnetic resonance imaging and ultrasound studies have identified a high incidence of asymptomatic rotator cuff tears in the community, especially in the ageing population (Schibany et al, 2004; Milgrom et al, 1995; Miniaci et al, 1995; Yamaguchi et al, 2001; Yamaguchi et al, 2006). There is a high correlation between the onset of rotator cuff tears (either partial or full thickness) and increasing age. Surprisingly despite positive findings of rotator cuff tears on MRI, some individuals reported no pain or functional deficits, although strength was significantly lower in those with complete supraspinatus tendon tear (Schibany et al, 2004). Apart from the older population, Connor et al (2003) found 40% dominant shoulders of asymptomatic shoulders of overhead athletes had clinical findings consistent with partial or full thickness rotator cuff as compared with 0% of the non-dominant shoulders. None of these athletes reported any symptoms 5 years later. Indeed Miniaci et al (1995) also found a wide array of abnormal MRI signals in shoulders of young asymptomatic individuals.

3. Evidence of the effectiveness of passive joint mobilisation

Whilst many approaches have been employed in the treatment of shoulder disorders, ranging from surgical to pharmacologic interventions such as oral drug therapy and intra-articular injections, non-pharmacologic interventions such as physiotherapy intervention is often the first line management for shoulder problems, with 53% to 79% of general practitioners referring to physiotherapists (Gentle et al, 1994; Glazier et al, 1998, van der Windt et al, 1995). Peters et al (1994) found shoulder pain accounts for up to 10% of all referrals to physiotherapists in Australia which was similar to findings of Hackett et al (1993).

A wide array of physical therapies is commonly used to treat shoulder disorders, including passive joint mobilisation which is commonly used by physiotherapists in the treatment of musculoskeletal disorders. They are procedures designed to increase the joint range of movement by positioning of the joint and the application of oscillatory movements of that joint in various available ranges. Determination of dosage can be modification of duration, intensity or position of the joint (Maitland 1991). Investigators have examined the physiological effects of passive joint mobilisation (Vicenzino et al, 2007; Teys et al, 2008) and the most effective positions and techniques to perform passive joint mobilisations to optimise the effects (Hsu et al, 2002; Vermuelen et al, 2006; Yang et al, 2007). However, there was a paucity of research specifically investigating the effects of passive joint mobilisation on shoulder disorders as this treatment mode was usually embedded in a package of standardised treatment program. Hence the efficacy of this commonly-used intervention for shoulder disorders has not been established until now.

The following literature review will examine the evidence in support of the efficacy of passive mobilisation directed to shoulder region joints only, in the management of shoulder disorders. To ensure only high quality studies are included, the National Health and Medical Research Council (Australia) evidence hierarchy guidelines and the Physiotherapy Evidence Database (PEDro) rating scale have been used as a guide in this review. Where available, only Level I systematic reviews/meta-analysis And/or Level II evidence of randomised controlled trials of moderate to high quality, rating 5 or more on the PEDro scale are included.

The National Health and Medical Research Council (NHMRC) in Australia has been engaged in the development of evidence-based clinical practice guidelines to rate the strength of evidence in research trials. The strength of evidence includes the level of evidence, quality of evidence and magnitude of treatment effect. The level of evidence reflects on the study design used by the investigators to minimise bias. The quality of evidence assesses the methodological quality of the study. The highest level of evidence (Level I) is represented by a systematic review of high-quality randomised controlled clinical trials measuring relevant outcomes which demonstrates a strong, clinically important, beneficial effect of the intervention. Level II evidence is provided by at least one properly designed randomised controlled trial.

The Physiotherapy Evidence Database (PEDro) contains abstracts of systematic reviews, randomised controlled trials and evidence-based clinical practice guidelines in physiotherapy. The trials have been rated for quality using a rating scale which has sufficient reliability for use in systematic reviews of physical therapy randomised controlled trials (Sherrington et al, 2000; Maher et al, 2003). Studies are rated against a checklist which identifies the internal validity and statistical interpretability of the trials. To assess internal validity the following aspects are included: random allocation, concealment of allocation, comparability of groups at baseline, blinding of patients, therapists and assessors, analysis by intention to treat and adequacy of follow-up. To assess interpretability, between-group statistical comparisons and reports of point estimates and measure of variability are included. The PEDro score is determined by counting the number of checklist criteria that are satisfied in the trial report. The total maximum score is ten. Of note, PEDro does not rate the external validity of the trial.

For this review, a search of the literature was conducted using the Cumulative Index of Nursing Allied Health Literature; MEDLINE; EMBASE from January 1980 to April 2011. Search limits were set to include English language, abstract and human studies. Key search terms included shoulder, shoulder pain, shoulder stiffness, shoulder impingement, physiotherapy, exercise, manual therapy, mobilisation, manipulation and rehabilitation. Inclusion criteria required randomised controlled trials where some form of shoulder “diagnosis” or dysfunction symptoms and some form of manual/manipulative therapy with or without adjunctive or multimodal therapy were used. Articles were excluded when the pain was referred from a spinal source; if there was surgical intervention; sinister pathology such as infection, malignancy, widespread neurological symptoms etc; and contra-indications for manual/manipulative therapy (eg RA, ligamentous instability). The articles were not included if a specific diagnosis of adhesive capsulitis or frozen shoulder was used, unless the article was identified in a systematic review. In addition, conference proceedings, non-peer reviewed literature and case reports were not included.

All relevant articles were read, synthesised and assessed with the PEDro scale. Only those articles which have scored 5 or more on the PEDro rating scale have been included in this review. Essential requirements were randomisation and blinding, with allocation concealment, intention-to-treat and adequate power desirable. A total of 178 citations were retrieved of which 11 met the inclusion/exclusion criteria. Very few peer-reviewed articles restricted passive joint mobilisation to the shoulder region joints alone. Manual therapy/passive joint mobilisation was often part of a multimodal treatment package included with exercise, electrical modalities, massage, stretching etc. The findings of these studies are summarised in Table 1.

Author	Population Details	Intervention	Control	Outcome Measures	Results
Nicholson 1985	Pain, restriction GHJ n = 20 Age = 51-55	Passive joint mobilisation (PJM)- glenohumeral joint (GHJ); active exercises Frequency: 2-3x/ wk 4 weeks	Active exercises within restriction; resistive exercise to increase strength	Pain Range of motion (ROM) Follow-up: 4 weeks	Passive abduction imp mobilisation group; No difference in pain groups
Conroy & Hayes 1998	Primary impingement syndrome; pain, limited functional movement pattern n = 14 Age = 50-55	PJM of GHJ, and multiple physical therapy modalities (hot packs, active ROM, stretching, strengthening, soft tissue mobilisation, patient education) Frequency: 3x/ wk 3 weeks	Multiple physical therapy modalities	Pain Active ROM Function Follow-up: 24 hours, 3 weeks	Mobilisation group: de pain and pain with su compression test Control group: increas function No difference between mobility, functional ga
Van der Windt et al 1998	Shoulder pain and stiffness n = 109 Age = 57-60	Corticosteroid injection plus analgesic 2 x 30 minutes/ wk 7 weeks	PJM ; exercises; ice &/or heat &/or electrotherapy (no ultrasound); analgesics	Self-perceived improvement Pain (VAS) Functional disability ROM Follow-up: 7, 26, 52 weeks	Corticosteroid group: decrease in pain, incre function, and passive e No difference between passive abduction RO
Winters et al 1999	1) Painful stiff shoulders, “synovial “ in origin n= 114 Age = 46-53 2) Painful stiff shoulders, “shoulder girdle” in origin n = 58 Age = 43-46	1) “Synovial” Corticosteroid injection: 1-3 2) “Shoulder girdle” Massage, exercise, electrotherapy	1) “Synovial” Massage, exercises, electrotherapy (2x/wk) Mobilisation and manipulation of shoulder region and vertebral column joints (1/wk- 6 weeks) 2) Mobilisation and manipulation of shoulder region and vertebral column joints	Pain (numerical rating scale) Active and passive ROM Follow-up: 2,6, 11 weeks	1) “Synovial” Improvement in pain i groups More rapid improvem injection group Lower drop out rate d treatment failure in inj 2) “Shoulder girdle” Improvement in both intensity Greater and more rapi improvement in manip Lower dropout due to failure in manipulation

Table 1. Summary of research on randomised controlled trials for passive joint mobilisation for shoulder dysfunction.

Bang & Deyle 2000	Shoulder impingement n = 52 Age = 42-45	Exercise and PJM to shoulder region joints and shoulder girdle, and/or upper vertebral column joints 2 x/wk for 3 weeks	Flexibility and strengthening exercises	Pain (VAS) Function (self-report using Likert scale) Muscle strength Follow-up: 1, 2 months	Improvements in both terms of pain, strength Greater improvement in mobilisation group
Bergman et al 2004	Shoulder pain and dysfunction n = 150 Age = 48	Manipulative therapy to vertebral column joints plus usual medical care 6 sessions over 12 wks	Usual medical care	Self-perceived improvement scale Pain Functional disability General health Follow-up: 12, 26, 52 weeks	Similar improvement in up to 6 weeks At 12 weeks, significant differences between groups in pain and general health in favour of manipulation At 52 weeks similar improvement in both groups
Dickens et al 2005	Subacromial impingement syndrome; failed conservative treatment, awaiting surgery n = 85 Age = 55	PJM to shoulder region and vertebral column joints Exercise therapy, postural advice, strapping, electrotherapy Frequency not reported	No intervention	Constant score Follow-up: 6 months	Intervention group: all means of 20 in Constant score not require surgery Control group: mean in in Constant score of 0.6 surgery
Chen et al 2009	Shoulder pain and stiffness (less than 140 degrees of active flexion and abduction; or greater than 10cm hand- behind-back deficit compared to unaffected side) n = 90 Age = 65	PJM to shoulder region joints; exercise to restore neuromuscular control and advice (avoid painful activities; pain free exercises) Up to 10 sessions over 8 weeks	Same exercise and advice as intervention group	Shoulder Pain and Disability Index (SPADI); global perceived effect; active shoulder ROM Follow-up: 1, 6 months	Similar improvement in measures in both groups differences between groups small and statistically not significant

Table 1. Summary of research on randomised controlled trials for passive joint mobilisation for shoulder dysfunction. (Continuation)

Bergman et al 2010	Shoulder pain, restriction of movement; cervicothoracic spine and rib dysfunction n = 150 Age = 48	Manipulative therapy (MT) to spine only; none to shoulder region joints; advice 6 sessions over 12 weeks	Usual care	Patient perceived recovery Shoulder pain Functional disability General health Economic evaluation Follow-up: 6, 12, 26 weeks	At 6 weeks: no difference between groups At 12 weeks: significant improvement with MT shoulder and neck pain At 26 weeks: MT favored shoulder pain and mobility
Bennell et al 2010	Chronic rotator cuff disease Shoulder pain and restriction n = 112 Age = 60	Soft tissue massage; PJM of glenohumeral joint; scapular retraining exercise; taping; home exercise program 10 sessions over 8 weeks	Sham ultrasound; nontherapeutic gel	SPADI Self-perceived global improvement SF-36 AQoL Isometric shoulder muscle strength; compliance to protocol Follow-up: 11, 22 weeks	At 11 weeks: no significant difference between groups SPADI; intervention group significantly better in all measures and strength At 22 weeks: MT significantly better in SPADI, muscle strength interference with activities
Yiasemides et al 2011	Shoulder pain with minimal movement restriction n = 98 Age = 60	Passive mobilisation to shoulder region joints; exercise and advice 1 or 2 sessions/week for first month; where necessary, additional treatment over following 4 weeks to maximum of 12 sessions	Exercise and advice	SPADI; self-rated change; active ROM (flexion and abduction) Follow-up: 1, 3, 6 months	No statistically significant differences in any outcome measurements at each time

Table 1. Summary of research on randomised controlled trials for passive joint mobilisation for shoulder dysfunction. (Continuation)

As can be seen, prior to 2009, only one study had specifically studied the efficacy of the commonly-used physiotherapeutic technique of passive joint mobilisation in the treatment of painful stiff shoulders. Nicholson (1985) investigated the effects of passive joint mobilisation to the shoulder joints and active exercises in patients with painful restricted shoulders. Twenty patients with shoulder pain and limited passive motion at the glenohumeral joint were randomised into an experimental group receiving mobilisation and active exercises or the control group receiving only active exercises. Outcome measures included pain questionnaire and range of glenohumeral motion at baseline and weekly intervals for four weeks. The results demonstrated a mean reduction in pain for the experimental group of -5.1 out of 10 (SD 4.6) compared with -2.9 out of 10 for the control group (SD 4.4). This represented a non-significance difference of - 2.2 (95% CI -6.4 to 2.0). Only passive abduction increased significantly in the experimental group than in the control group. However, due to the small sample size, the study lacked the statistical power to detect small but clinical-meaningful effects of passive joint mobilisation to shoulder region joints.

In 2009, Chen et al conducted a single-blinded randomised clinical trial to assess whether the addition of passive mobilisation of shoulder region joints to advice and exercise for patients with shoulder pain and stiffness was more effective in reducing pain and disability than advice and exercise alone. The experimental group received passive mobilisation directed to the shoulder region joints only. Both experimental and control groups received exercises with proven efficacy which aimed at improving neuromuscular control of the shoulder muscles in order to restore the dynamic stability and muscle force couple co-ordination of the shoulder region. They also received advice on how to use pain-free methods to perform activities of daily living. No other electrotherapeutic modalities were used. Primary outcome measures included pain and disability measured with the 13-point Shoulder Pain and Disability Index. Secondary outcome measures were self-perceived global improvement measured on a 6-point Likert scale and active ranges of motion. All subjects received a maximum of 10 sessions of therapy, and outcome measurements were performed at baseline, one month and six month post randomisation. Results showed that one month after randomisation, participants in both groups had improved in all outcome measure. Further improvements were seen at six months. However between group differences in all outcome measures were small and statistically non-significant. Hence this study demonstrated that the addition of passive mobilisation of shoulder region joints is not more effective than advice and exercise alone for shoulder pain and stiffness.

Results of the previous study were further supported by Yiasemides et al (2011) who investigated the efficacy of passive mobilisation of shoulder region joints for people with shoulder pain and minimal movement restriction. Participant were randomly allocated to the experimental group where they received passive mobilisation of shoulder region joints, exercise and advice, or to the control group where they received exercise and advice alone. Outcome measures similar to those of Chen et al (2009) were taken at baseline and repeated at 3 and 6 months.

Similarly the results demonstrated that the addition of passive mobilisation of shoulder region joints to exercise and advice is not more effective than exercise and advice alone in decreasing pain and painful range of motion and improving function and self-rated change in symptoms in their cohort, with no significant differences in any of the outcome measurements between the 2 groups at short-, medium-, or longer-term follow-up.

Other studies have included passive joint mobilisation as a treatment package together with exercises, modalities, corticosteroid injections, massage, taping etc (Conroy and Hayes, 1998; Winter et al, 1999; van der Windt et al, 1998; Dickens et al, 2005; Bennell et al, 2010). Hence it is not possible to tease out the benefits of passive mobilisation directed to the shoulder region joints alone in these studies. Other studies have directed passive joint mobilisation to the cervicothoracic spine and ribs only (Bergman et al, 2004, 2010) or to a combination of spinal and glenohumeral joints (Bang and Deyle, 2000; Winters et al, 1999; Dickens et al, 2005). In these studies, the cervicothoracic spine and adjacent ribs were deemed to be symptomatic. In contrast, McClatchie et al (2009) investigated mobilising asymptomatic cervical spine (C5, 6, 7) for shoulder pain with painful arc. They found significant decrease of shoulder pain but no difference in muscle strength following spinal mobilisation.

Systematic reviews have found some evidence in support of manual techniques (van der Heijden et al, 1997; Green et al, 1998; Desmeules et al, 2003; Michener et al, 2004; Grant et al, 2004; Green et al, 2005; Faber et al, 2006; Trampas and Kitsios, 2006; Kuhn, 2009; Kromer et al, 2009; Dorrestijn et al, 2009), but these studies have included the above-mentioned trials (except Bennell et al, 2011), which directed passive joint mobilisation at both shoulder regions joints and the vertebral column joints. Ho et al (2009) conducted a systematic review of randomised controlled trials to determine specifically the effectiveness of manual therapy (MT) for the management of musculoskeletal disorders of the shoulder. The review included studies where at least one application of manual therapy, defined as manipulation, passive joint or soft tissue mobilisation techniques or massage, was applied to either the shoulder girdle, cervical or thoracic spine. Fourteen RCTs were included in this well-designed and comprehensive review. Interventions included joint mobilisations (Bulgen et al, 1984; Conroy and Hayes, 1998; Maricar and Chok, 1999; Vermuelen et al, 2006), mobilisation of the upper quarter (Winters et al, 1997; Bang and Deyle, 2000; Bergman et al, 2004), manipulation (Winters et al, 1997; Bergman et al, 2004), Cyriax' manipulation and deep transverse frictions (Guler-Ulysal and Kozanoglu, 2004), "mobilisation-with-movement" (MWM) (Teyss et al, 2008) and soft tissue massage (Van den Dolder and Roberts, 2003). Manual therapy was used in isolation (Winter et al, 1997; Winters et al, 1999; Van den Dolder and Roberts, 2003; Vermuelen et al, 2006; Teyss et al, 2008) or in combination with exercises (Nicholson, 1985; Conroy and Hayes, 1998; Maricar and Chok, 1999; Bang and Deyle, 2000; Guler-Ulysal and Kozanoglu, 2004; Citaker et al, 2005), hot packs (Conroy and Hayes, 1998; Citaker et al, 2005) or medical care (Bergman et al, 2004).

The authors concluded that:

- For patients with adhesive capsulitis, MT was not more effective than other interventions in the short term for decreasing pain, improving range of motion (ROM) and function
- For patients with subacromial impingement syndrome, there was conflicting evidence for the use of MT for decreasing pain and improving function in the short term, and moderate evidence that MT was no more effective for improving ROM in comparison to other interventions in the short term
- Combination of soft tissue and joint mobilisation techniques, and therapeutic exercise may be more effective than an exercise program alone
- Conflicting evidence for MT in the management of nonspecific shoulder pain in the short term compared to other interventions

- Massage and MWM are useful in patients with musculoskeletal disorders of the shoulder in the short term compared with no treatment

However these conclusions do not specify the site at which the manual therapy was directed.

Even though systematic reviews provide the highest level of evidence for clinical trials, due to the heterogeneity of the studies, these reviews are not without their difficulties. Due to the low number of articles meeting inclusion criteria of the reviews, conclusions are often product of critical assessments of trials only, or based on single studies which might be of low methodological quality. The ability to generalise the findings of such studies to inform clinical practice is questionable. This present review specifically investigated the evidence for passive joint mobilisation to the shoulder region joints only and can now provide conclusive evidence that the addition of passive mobilisation to shoulder region joints alone do not confer additional benefit in the short or medium term to exercise and advice alone in the treatment of painful shoulders, with or without restriction (Chen et al, 2009; Yiasemides et al, 2011). It provides evidence that there is immediate benefit in manual therapy and home exercise program in people with chronic rotator cuff disease. There is also evidence to suggest that passive mobilisation to glenohumeral joints, cervicothoracic joints and adjacent ribs, together with exercise and advice may be of value in improving shoulder disorders and that these benefits may accrue over time, especially in terms of improving shoulder function rather than pain.

4. Conclusion

Shoulder pain and stiffness is a common and widespread problem affecting many individuals in the community, with even higher prevalence in particular target groups. Not only does shoulder pain and stiffness impact on the physical functioning, it also contributes significantly to the emotional and psychological distress of the patient. Furthermore it also imposes considerable financial burden on the individual and society. The search for a cost-effective, evidence-based management for this complex problem is of utmost importance. Prognostic information can help to distinguish between patients with a favourable outcome and those with a high risk of persistent pain and disability, thus facilitating decisions regarding treatment and referral of patients. Little is known about the cause of shoulder disorders and despite the numerous studies identifying the various factors associated with treatment outcome, there is no agreement in the literature on these putative factors, thus rendering the present clinical prediction guidelines inadequate. The main problem is the lack of consensus on the diagnosis of shoulder disorders amongst health care providers. The myriad of clinical tests commonly used by clinicians to help with diagnosis of shoulder problems are of questionable reliability. As a result imaging techniques have been recommended to better define shoulder lesions, yet these are not without their problems and constraints. In addition the validity and reproducibility of the diagnosis and classification system and commonly-used clinical tests for shoulder complaints is inadequate. This lack of agreement regarding the diagnosis of shoulder disorder raises serious doubts about its usefulness. This also underpins the reason that despite the large number of studies conducted, there is little evidence for the treatment of shoulder problems.

The present review has been able to fill the gap in the current literature on the evidence-based management of shoulder dysfunction. Effective treatment should be administered

according to signs and symptoms rather than diagnosis. Given the competition for the forever decreasing health dollar, it is important that evidence-based and cost-effective treatments are used for shoulder disorders. Further research is needed for a better understanding of the scope of the problem and effectiveness of the different physiotherapy treatment regimes which will help inform and guide clinical practice in the prevention and management of patients with shoulder dysfunction.

5. References

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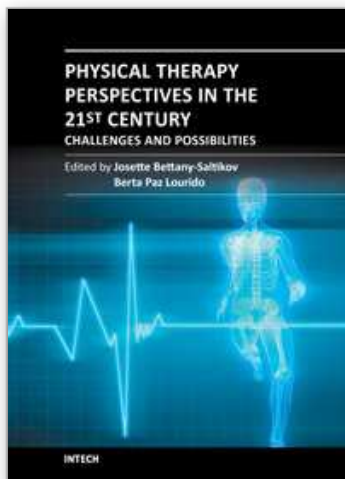
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