Chapter 2

Review of Literature
Literature review provides the background to and justification for the research undertaken (Bruce, 1994). In this chapter, an attempt has been made to give an overview of various aspects and issues of this study through the review of existing literature. It has helped to identify the contradictions, gaps, inconsistencies or discrepancies in the previous studies on the subject. Furthermore, some important conclusions have been drawn on the basis of previous studies, which can serve as a guide mark for this study. Some of the main studies undertaken for review are detailed and discussed below. These have been selected on the following criteria:

2.1. RESEARCH CRITERIA

- In the review of literature, both the descriptive and evaluative elements have been taken into account. Due to scarcity of the literature on the literal topic, all the research done on the efficacy of Mulligan and manual therapy on mechanical neck pain was explored. It included Randomized Controlled Trials (RCTs), non-RCTs, systematic reviews, Cohort case studies, case series and single case studies.
- Only those studies have been undertaken in which the participants were diagnosed with mechanical neck pain showing no radiating symptoms in the upper limbs.
- All those studies which used joint manipulations, mobilization exercises, strengthening exercises or Mulligan’s techniques for mechanical neck pain and other peripheral joints were included.
- The literature available on validity and reliability of the outcome measures used (Inclinometer for range of motion, McGill pain questionnaire, NDI, STAI and VAS) has been included in the study.
Limitations of the Given Criteria

• This review included studies written in English language only. Though this can be a major source of bias in a literature review (Morrison et al., 2009) but languages other than English were excluded because of inability of the reviewer to understand non-English scripts. Moreover, it was beyond the scope of this review to recruit a translator, as this would have been time-consuming. Moreover, there are not many competent translators around.

• Studies published mainly during the period 1990 to 2010 have been included in this review. This was because of two reasons. Firstly, this was done to collect the latest information and knowledge on the subject under study. Secondly, the Mulligan’s concept of mobilization with movements (MWM), which is frequently used as a joint manipulative intervention for LE, emerged only in the early 1990s.

However, some of the research studies have been excluded from the review for the following reasons:

• Studies including neck disorders with definite pathology (Infection or Inflammation or radicular symptoms) were excluded as these could bias the diagnostic accuracy.

• Studies that primarily examined the effectiveness of pharmacological or surgical interventions were also excluded as this research evaluates the value of conservative interventions (MWMs or other physiotherapy interventions) used for neck pain.

• Duplicate studies were excluded as they have the tendency to bias the results (Khan and Kleijnen, 2002).

Databases Searched

The following approaches were followed to locate information in order to answer the research question:

• Electronic databases search
• Manual search
• Secondary searching.
Review of Literature

Electronic Database Search

The electronic databases accessed through the Coventry University (UK), University of South Australia (AUS), University of Birmingham (UK) were used as a potential resource to explore, collect and collate relevant information that was significant for this review. In order to achieve standardisation, only acclaimed search engines were explored. These were AMED Allied and Complementary Medicine, Biomed Central (BioMed), Cumulative Index for Nursing and Allied Health Literature (CINAHL), Cochrane Library, Medline, PEDro Physiotherapy Evidence Database, Pubmed, Science Direct, Scopus and SPORTDiscuss.

Key Words Used

All the databases mentioned above were searched using the following keywords: “Mechanical neck pain”, “neck pain”, “Mulligan’s techniques”, “SNAGs”, “NAGs”, “manipulation”, “mobilisation”, “manual therapy”, “mobilization with movement”, “MWM”, “mobilisation with movement”, “physiotherapy”, “physical therapy”, “McGill Pain Questionnaire” “strengthening”, “exercise”, “Inclinometer”, “range of motion”, “Neck Disability Index”, “VAS”, and “Anxiety”. The Boolean operator terms “AND”, “OR” were used to link related terms that describe either interventions or diagnosis.

Manual or Non-electronic Search

In order to expand the search strategy, information was generated from critical evaluations and interpretative research work. Various scholarly articles, books, journals, newsletters, dissertations were referred to while reviewing all the previous literature concerned to the topic of research. Also, other sources like seminars and conference proceedings were followed.

Secondary Search Strategy (Pearling)

Pearling is a secondary search strategy in which the reference list of all potentially relevant studies is further searched for additional relevant articles (Dickersin et al. 1994). This technique was particularly useful in identifying relevant articles that were incorrectly indexed or not indexed in the database.
Until recently many researchers have shown interest in the field of Mulligan concept and its efficacy on spinal malalignment. They have carried out numerous controlled trials and case studies to eliminate darkness of this field. Interestingly, Mulligan’s techniques, joint manipulations and passive strengthening exercises are frequently described in literature. Acceptable research was undertaken to prove efficacy of Mulligan techniques but majority is confined to the peripheries. However, after reviewing their findings and suggestions, it was found out that none of these had been investigated for effectiveness in managing the condition in its chronic form. In the case of spine even empirical evidence supporting the clinical use of cervical NAGs is lacking. The review of literature aims at to provide a critical perspective on the available literature on the following topics:

- Studies reporting the conventional physiotherapy options for neck pain.
- Efficacy of Manual Therapy in neck pain
- Effectiveness of other therapies in neck pain
- Effectiveness of Mulligan’s technique
- Outcome Measures and their Application.

2.2. CONVENTIONAL PHYSIOTHERAPY OPTIONS FOR MECHANICAL NECK PAIN

A large number of conservative treatment options are reported in the literature for the mechanical neck pain. There has been a mixed response available regarding their efficacy. However, none of the studies mentions about their long-term effectiveness in the neck pain.

Wolsko et al. (2003) conducted a telephone survey in the US involving 2055 English-speaking adults. This study demonstrated that 54% of participants in the survey who were suffering from neck or back pain sought treatment from complementary health practitioners, including manual therapists. In contrast, only 37% of participants sought treatment from a medical practitioner. Therefore, determining the effectiveness of manual therapy for the treatment of neck pain is important.
Leaver et al. (2010) did a systematic review to know the effectiveness of conservative treatments on neck pain. Some conservative interventions (manipulation multimodal intervention, specific exercise, combination Orphenadrine/Paracetamol, acupuncture, manual therapy) for neck pain are effective in the short-term. Few interventions (LASER therapy) that have been investigated have shown long-term effects that are better than placebo or minimal intervention. Aker et al. (1996) carried out a systematic review of the conservative management of mechanical neck pain and concluded that there was little information available from clinical trials to support many of the treatments for mechanical neck pain.

In a randomized controlled trial, Irnich et al. (2001) compared the efficacy of acupuncture and massage in chronic neck pain. One week after five treatments, they concluded that acupuncture is an effective short-term treatment for patients with chronic neck pain, but there is only limited evidence for long-term effects after five treatments. Furthermore, in another similar study, Vickers (2001) reported that although the efficacy of acupuncture is superior to massage for neck pain, but it is only effective due to its placebo effect.

Gross et al. (2007) in their systematic review stated that there is some support for the use of electromagnetic therapy and against the use of LASER therapy with respect to pain reduction. Low-level LASER therapy (LLLT) is widely used in the treatment of musculoskeletal conditions. However, there is controversy over its true efficacy. Özdemir et al. (2001) compared the analgesic efficacy of low-power LASER with placebo LASER in neck pain patients. They reported an improvement in paravertebral muscle spasm, loss of lordosis and neck ROM in the low-power LASER group. Functional activities were also improved. However, no improvement was seen in the placebo group. In another systematic review by Chow et al. (2009), the researchers provided a very limited evidence (four RCTs) for the use of infrared LASER for the treatment of acute and chronic neck pain. Furthermore in a systematic review, Gross et al. (2007) also stated that the low-level LASER therapy is effective for neck pain. However, Chow et al. (2009) & Gross et al. (2007) suggested that further research is required to confirm the efficacy of LASER in the treatment of neck pain.
In one of the studies, neck collar, neck collar plus transcutaneous electrical nerve stimulation (TENS), and neck collar plus mobilization were compared in patients with neck pain of less than 3 days’ duration (Nordemar et al., 1981). Although the mobilization group exhibited greater mean improvements in pain reduction at 1 week, no differences between groups were detected at 6 weeks and 3 months.

Regarding the efficacy of cervical traction in neck pain, Swezey et al. (1999) reported that traction in both supine and sitting position is effective in treating neck pain. They suggested that sessions ranging from a few minutes to 20 to 30 min., once or twice weekly to several times per day provide symptomatic relief in mild to moderate neck pain. Graham et al. (2006) suggested the use of intermittent traction for mechanical neck disorders. However, further assessment of cervical traction needed in neck pain patients was indicated.

Investigators have also compared the manual therapy with physical modalities and found that in comparison to electrotherapy, exercises are much more effective in treating neck pain. In randomized clinical trials (Kjellman et al., 1999; and Lucas et al., 2001), investigated the efficacy of physiotherapy treatment techniques in neck pain patients. They reported positive outcomes for electromagnetic therapy, manipulation and active physiotherapy. However, traction and acupuncture had either no effect or negative outcome on neck pain.

**Studies Reporting the Efficacy of Therapeutic Ultrasound in Mechanical Neck Pain**

Moodley and Brantingham (2002) conducted a randomized controlled trial to assess the efficacy of spinal manipulation and ultrasound in mechanical neck pain patients. Patients (n = 30) were randomized into two treatment groups: (1) spinal manipulation group (SMG), and (2) ultrasound group (USG). The study demonstrated a significant improvement in the cervical range of motion (p<0.05), decreased disability and decreased pain intensity (p<0.05) in the SMG in the first treatment and at one month follow-up as compared to USG. This evidence supported the superiority of the spinal manipulation in decreasing disability, reducing pain and restoring mobility. Earlier, Moodley and Brantingham (1999) undertook a similar study. It was a comparative
study, which concluded that mobilizations were more effective as compared to Ultrasonic therapy in restoring overall mobility and decreasing cervical disability. In a fairly recent study, Walker et al. (2008) assessed the effectiveness of manual therapy, physical exercise for mechanical neck pain and minimal intervention approach (sub therapeutic ultrasonic therapy). They reported clinically significant short and long-term improvements in pain, disability and patient perceived recovery with manual therapy.

Taimela et al. (2000) in a randomized study divided the subjects with nonspecific chronic neck pain in three groups and concluded that the multimodal treatment in the active group was more efficacious than activated home exercises that were further more efficacious than just advising in the control group. They suggested that multimodal treatment including postural exercises; relaxation and psychosocial/behavioural support result in earlier return to work and better emotional response.

In general, conservative interventions have not been studied in enough detail to assess efficacy in mechanical neck pain adequately.

2.3. EFFICACY OF MANUAL THERAPY IN MECHANICAL NECK PAIN

Extensive research has been done to explore the efficacy of manual therapy in managing neck pain. Most of the studies were randomized controlled trials (RCTs) and thus showed high levels of hierarchy. Due to a variety of treatment options available for the mechanical neck pain, this part of the review has been divided into four sections:

(a) Studies comparing the effects of manipulation and mobilization in neck pain.
(b) Studies comparing the effects of manipulation vs. mobilization in neck pain.
(c) Studies reporting the efficacy of manipulation with and without exercise therapy.
(d) Studies reporting the effects of thoracic manipulation on neck pain.
(a) Studies Comparing the Effects of Manipulation and Mobilization in Neck Pain

Gemmell and Miller (2006) reviewed the comparative efficacy of mobilizations, manipulations and activator system. Five studies came under inclusion criteria out of 217 non-specific citations on efficacy of mobilizations, manipulations and activator system. Study concluded that no one therapy is more effective than other.

Hoving *et al.* (2002 & 2006) and Ingeborg *et al.* (2003) did RCTs to compare the effectiveness of manual therapy (MT; mainly spinal mobilization), physical therapy (PT; mainly exercise therapy), and continued care by the general practitioner (GP; analgesics, counseling and education). Short-term results (at 7 weeks) have shown that MT speeded recovery compared with GP care and, to a lesser extent, also compared with PT. In the long-term, GP treatment and PT caught up with MT, and differences between the three treatment groups decreased and lost any statistical significance at the 13-week and 52-week follow-up. Ingeborg *et al.* reported that manual therapy was more effective as well as less costly compared to physiotherapy and care by a general practitioner.

Häkkinen *et al.* (2007) compared manual therapy (mobilizations, manipulations and massage) and stretching and concluded that both have short-term effects on chronic neck pain. Ylinen *et al.* (2007) did a RCT to compare the efficacy of the two. They concluded that both stretching exercise and manual therapy considerably decreased neck pain and disability in women with non-specific neck pain. The difference in effectiveness between the two treatments was minor. Low-cost stretching exercises can be recommended in the first instance as an appropriate therapy intervention to relieve pain, at least in the short-term.

Skillgate *et al.* (2010) investigated the efficacy of napropathic manual therapy (Napropathy combines manual techniques like spinal manipulation/ mobilization, massage, and stretching to correct the cause being practiced in Sweden, United States, Finland, Norway, and some other countries) and concluded that Combined manual therapy, like napropathy, is effective both in the short and long-term, and might be considered for patients with non-specific back and/or neck pain.
Mobilization can produce a hypoalgesic effect to mechanical nociception. In conjunction with that, it demonstrates significant decrease in EMG activity of the superficial neck flexor muscles (Sterling et al., 2001). Another study showed that following mobilization 69% of patients reported pain improvement and increased range of motion immediately after the treatment (Cassidy et al., 1992). Also, there are some lasting changes associated with the immediate change (Tuttle, 2005).

An analysis of the literature on all forms of conservative management of neck pain by Aker et al. (1996) concluded that there had not been sufficient studies to adequately prove the effectiveness of any treatment approach. When, however, they combined the results of five trials on manual methods of treatment, they noted a positive effect at 1-4 weeks, equivalent to an improvement of 6.9 to 23.1 points on a 100- point scale.

In contrast to most of the work done regarding the efficacy of manual therapy some authors found no additional benefits of manual therapy. Dziedzic et al. (2005) did a pragmatic RCT to determine whether manual therapy or pulsed shortwave diathermy, in addition to advice and exercise, provide better clinical outcome at 6 months than advice and exercise alone in primary care patients with non-specific neck disorders and concluded that the addition of pulsed shortwave or manual therapy to advice and exercise did not provide any additional benefits in the physical therapy treatment of neck disorders.

Significant decreases in neck pain at rest and pain on most painful movement (P<0.001) with a significant increase in active cervical ROM after mobilization on most painful movement were reported by Kanlayanaphotporn et al. (2009). At this time, the best interpretation of the literature is that there is some evidence for effectiveness of mobilization procedures for patients with neck pain (Swenson, 2003).

(b) Studies Comparing the Effects of Manipulation vs Mobilization in Neck Pain

In the comparative studies by Cassidy et al. (1992), Gross et al. (2008) & Hurwitz et al. (1998) the patients received either a single rotational manipulation (high-velocity, low-amplitude thrust) or mobilization in the form of muscle energy technique to
check short- and long-term benefits for sub acute/chronic mechanical neck disorders. The results show that both treatments increase range of motion, but manipulation has a significantly greater effect on pain intensity. 85% of the manipulated patients and 69% of the mobilized patients reported pain improvement immediately after treatment. However, the decrease in pain intensity was greater than 1.5 times in the manipulated group (p = .05). Whereas Hurwitz et al. (2002) did a study to compare chiropractic mobilizations and manipulations in chronic neck pain patients. They reported cervical spine manipulation and mobilization yield comparable clinical outcomes.

In another randomized controlled trial by Segura et al. (2006), comparison of manipulation and mobilization was done. They reported only short-term effectiveness of manipulation in neck pain patients and proposed that the long-term effects of the intervention in the future trials need to be determined. Vernon et al. (2007) in randomized clinical trials gave high quality evidence that subjects with mechanical neck pain show clinically important improvements from a course of spinal manipulations or mobilizations. Another systematic review by Bronfort et al. (2004) provided moderate evidence on the effectiveness of SMT in patients with sub-acute and chronic neck pain.

Kolberg et al. (2010) did a study to identify effect of manipulations on 22 men with neck pain. They found reduction in pain perception and disability and marked increase in blood catalase activity after high-velocity and low-amplitude thrust in these patients.

(e) Studies Reporting the Efficacy of Manipulation with and without Exercise Therapy

In a systematic review comparing various RCTs on efficacy of manipulation, mobilization and combination of manual therapy with exercises; Gross et al. (2002) concluded that manipulation or mobilization were not effective enough, when given in isolation. A combination of general physical exercises along with manual therapy is recommended to be the most beneficial in neck pain.
Ongoing intensive or light exercise equally improves pain in the long-term, and intensive exercise is better than light exercise for objective outcomes in the medium-term (Randløv et al., 1998).

In other randomized controlled trial studies by Evans et al. (2002), neck pain patients were divided into three different groups. The first group received only rehabilitation programme including strengthening exercises, resistance exercises and cervical extension exercises. The second group was given a combination of spinal manipulative therapy and strengthening exercises. The third group received only spinal manipulative therapy with no exercises. This quality study showed the multimodal treatment approach of SMT and exercise was an effective intervention in chronic neck pain patients.

Gross et al. (2004) did randomized trials using a Cochrane format to determine if manual therapy improves pain, function and patient satisfaction in adults suffering from mechanical neck disorders. They concluded that to be more beneficial, manual therapies should be done with exercise for improving pain and patient satisfaction, which supports the results of Evans et al. (2002). Furthermore, in a recent randomized controlled trial study by Macaulay et al. (2007), it was concluded that manual therapy combined with exercise returned moderately larger improvements, although not statistically significant, improvements in pain, disability and patient perceived recovery than manual therapy alone.

(d) Studies Reporting the Effects of Thoracic Manipulation on Neck Pain

Thoracic spine manipulation technique can possibly be used as a substitute to lessen the cervical pain; its effectiveness has been shown by Cleland et al. (2005, 2007) in neck pain patients. In their first study, they compared the efficacy of thoracic manipulation with placebo manipulation in neck pain patients. This study showed the effectiveness of thoracic spine manipulation in neck pain patients and proposed that future trials were needed to compare the effectiveness of TSM and cervical spine manipulation in neck pain patients.
In their randomized controlled study Cleland et al. (2007), compared the effectiveness of thrust versus non-thrust mobilization/manipulation at the thoracic spine in the patients with neck pain. The results suggest that thoracic spine thrust mobilization/manipulation results in significantly greater short-term reductions in pain and disability than thoracic non-thrust mobilization/manipulation in people with neck pain. However, they suggested that future trials are required to compare the effectiveness of thrust techniques at cervical and thoracic spine, spinal manipulative therapy (SMT) at thoracic spine alone, and SMT and exercise in neck pain patients.

2.4. EFFICACY OF OTHER THERAPIES IN MECHANICAL NECK PAIN

Murphy et al. (2010) did a pilot study to determine whether a 4-week period of chiropractic care improved the ability of chronic neck pain patients to respond to an 8-week period of exercise rehabilitation and concluded that chiropractic care combined with exercise and exercise alone are both effective at reducing functional disability and pain in chronic non-specific neck pain patients. Haneline and Cooperstein (2009) did a pragmatic clinical trial to know the feasibility of pragmatic trials in chiropractic practice and to find the efficacy of treatment and found the trial feasible with marked reduction in NDI scores. There were no serious adverse reactions.

Rubinstein et al. (2008) did a prospective cohort study on chiropractic patients with neck pain and concluded that self-reported benign adverse events after chiropractic care for neck pain are associated with worse short-term outcomes. Intense adverse events are associated with more neck disability and clinically relevant differences at the short-term only. However, there is no association between adverse events and worse outcomes at 3 months. Hurwitz et al. (2002) carried out their study to compare relative effectiveness of chiropractic cervical spine manipulation and mobilization and found that both yield comparable clinical outcomes.

Äng et al. (2009) did a RCT to assess preventive efficacy of a neck/shoulder exercise regimen for neck pain in air force helicopter pilots. They concluded that a supervised neck/shoulder exercise regimen was effective in reducing neck pain cases in air force helicopter pilots. This was supported by improvement in neck-flexor function post intervention in regimen members. However, no effect emerged for pain-related fear.
General strength training before the intervention predicted reduction in prevalence of pain at follow-up.

A randomized controlled trial was conducted by Sherman et al. (2009) to evaluate whether therapeutic massage is more beneficial than a self-care book for patients with chronic neck pain. They concluded that massage is safe and may have clinical benefits for treating chronic neck pain at least in the short term.

Driessen et al. (2010) did a systematic review to study the effectiveness of physical and organisational ergonomic interventions on low back pain and neck pain. There was low quality evidence that a physical ergonomic intervention was significantly more effective for reducing neck pain intensity in the short-term (that is to say curved or flat seat pan chair) and the long-term (that is to say arm board) than no ergonomic intervention. However, this review provides a solid overview of the high quality epidemiological evidence on the effectiveness of ergonomic interventions on LBP and neck pain.

Haines et al. (2009) did a Cochrane review to assess whether patient education strategies are of benefit for pain, function/disability, global perceived effect, quality of life, or patient satisfaction, in adults with neck pain with or without radiculopathy. This review has not shown effectiveness for educational interventions for neck pain of various acuity stages and disorder types and at various follow-up periods, including advice to activate, advice on stress coping skills, and neck school.

Some studies were done to study the efficacy of non-surgical and/ or non-pharmacological treatments in general for neck pain (Foster et al., 2009; Hurwitz et al., 2008 & Van der Velde, 2009). Van der Velde (2009) did a study to identify the best treatment amongst non-steroidal anti-inflammatory drugs (NSAIDs), exercise, and manual therapy for non-specific neck pain. When the objective is to maximize life expectancy and quality-adjusted life expectancy, none of the treatments were found superior.

Hurwitz et al. (2009) reviewed literature to identify, critically appraise, and synthesize literature from 1980 through 2006 on non-invasive interventions for neck pain and its
associated disorders. They concluded that therapies involving manual therapy and exercise were more effective than alternative strategies for patients with neck pain; this was also true of therapies, which include educational interventions addressing self-efficacy.

2.5. EFFECTIVENESS OF MULLIGAN’S TECHNIQUES

The literature on the efficacy of Mulligan techniques is not adequate and whatsoever research has been done so far is dominated by descriptive case report publications (Exelby, 1995, 1996 & 2001; Lincoln, 2000; Miller, 2000; and Wilson 1994, 1997 & 2001). A very few RCTs have been published by Cleland et al. (2005), Evans et al. (2002), Gross et al. (2004), Kochar and Dogra (2002), Moulson and Watson (2006) & Vicenzino (2001). As mentioned earlier, majority of the research is confined to the peripheral joints (MWM). In the following section, an attempt has been made to review all the available literature on the efficacy of Mulligan’s techniques on spinal and peripheral joints. To make it systematic, the studies have been grouped according to different joints.

Spine

Exelby (2001) cited success of MWM on a locked lumbar facet joint syndrome case. Treatment included a SNAG, central sustained glide while the patient performing the spinal movements. Again, long-term follow up was not reported. It was suggested that a number of investigative procedures like EMG, ultrasound, etc. should be used in the comparative studies to test whether there are any advantages to the use of MWMs on segmental muscle activity, kinesthetic sense and pain when compared to other passive manual therapy techniques. Later Exelby (2002), presented a paper on application of Mulligan concept on spinal conditions in which he gave the clinical examples to illustrate the concept’s application to the spine, how it has evolved and been integrated into constantly changing physiotherapy practice. Furthermore, he also suggested that lumbar SNAGs are usually preferred in the case of low back pain.
Horton (2002) used SNAGs on a locked thoracic segment, most likely the result of zygoapophyseal joint meniscoid entrapment, which responded rapidly to a modified SNAG technique. He also stated that the thoracic spine is ideally suited to SNAGs, and therefore may be the treatment of choice in acute presentations of thoracic pain when the zygoapophyseal joints are implicated. Rather than just using SNAGs to improve end range of motion, they may also have a role in correcting acute postural deformity. However, it was suggested that further investigations into anatomy and biomechanics of meniscoid would be needed to support clinical efficacy.

Recently, Moutzouri et al. (2008) investigated the application of the SNAGs technique on lumbar flexion ROM, but it did not demonstrate significant differences in flexion ROM when compared to sham mobilizations.

**Neck**

Apart from the above mentioned text studies with regard to efficacy of Mulligan techniques, some on mechanical neck pain were also found out. Hearn and Rivett (2002) stated that the cervical SNAG is a popular manual therapy technique used widely in the treatment of painful and restricted neck movement. Its clinical application has been based almost exclusively on convention with little attempt to provide a biological basis and little, if any, empirical evidence as yet to support its efficacy. Niere and Robinson (1997) carried out their study to analyze treatment outcome in a population of 112 headache patients when cervical spine dysfunction is thought to be a cause or contributing factor. The results showed significant improvement in frequency, intensity and duration of subjects’ headache two months after presenting for manipulative physiotherapy treatment. The study was subject to the limitations that exact technique used and number of techniques used was not ascertained. The results do not indicate proportion of subjects who were helped by the treatment or the extent to which individual subjects did not improve nor do they give any insight as to whether a subject’s headaches were influenced by other factors over the treatment period.

Reid et al. (2008) investigated the efficacy of SNAGs in the treatment of cervicogenic dizziness. Compared to placebo group, SNAG treatment had an immediate clinically
and statistically significant sustained effect in decreasing dizziness, cervical pain and disability caused by cervical dysfunction. Improvement in balance and range motion was observed in SNAGs group. Furthermore, Wilson (2001) summarized that the core of Mulligan’s work in symptom free joint mobilization added to muscular activity. He explained that Mulligan techniques are used to correct minor joint derangements that often display a disproportionate array of effects.

Moulson and Watson (2006) studied 16 asymptomatic subjects to investigate the relationship between the application of the cervical SNAGs to the C5/6 intervertebral joint (with cervical rotation) and indirect measures of sympathetic nervous system activity. The results suggested that cervical SNAG techniques, performed on naïve asymptomatic subjects, had a Sympathoexcitatory effect as measured by changes in skin conductance (SC) and skin temperature (ST).

McNaira et al. (2007) reported a 44 year old case of cervical pain. In the morning the patient had woken with pain, stiffness and loss of ROM. The treatment undertaken involved grade 3 down slope mobilization on the left side at C5-C6 and C6-C7 in supine lying. This technique was then progressed by placing the subject in upright position and SNAGs were performed at C6. Immediately following the treatment, the patient reported a considerable decrease in pain and less difficulty in movement and decreased stiffness. However, the results of single case studies cannot be generalized for a wide population.

Chhabra et al. (2008) in their study attempted to prove the effectiveness of self-SNAG over conventional physiotherapy management in chronic neck pain among computer professionals. This study depicted that group receiving self-SNAGs showed better carry over effect during treatment phase and more during follow up phase as compared to group receiving conventional physiotherapy alone. Nevertheless, they again failed to prove the exact mechanism behind this improvement.

**Elbow**

Abbott et al. (2001a) investigated the initial effects of elbow MWM in lateral epicondylalgia patients and concluded that Mulligan MWM was effective in enabling
a previously painful active movement to be performed pain-free during the application of the MWM. It resulted in a significant increase in both pain-free grip strength and maximum grip strength from pre-intervention to post-intervention. As a result, they concluded that MWM might be a useful intervention modality in the rehabilitation of patients with LE.

In another study Abbott (2001b) suggested that the MWM causes a neurophysiologically mediated decrease in resting muscle tone and found that restriction of shoulder rotation range of motion (ROM) is present in patients with lateral epicondylalgia, probably due to a facilitated level of shoulder rotator muscle tone. Shoulder internal and external rotation ROM increases significantly following MWM to the elbow, in subjects with unilateral tennis elbow. He also suggested the need for further research into the neurophysiologic effects of manual therapies and their applications to neuromuscular pain syndromes.

In a randomized double blind controlled study on tennis elbow patients by Vicenzino (2001), subjects were divided into placebo and MWM groups. It was reported that the MWM group showed immediate and effective hypoalgesic effects as compared to the control group. A single case study was undertaken by Vicenzino and Wright (1995) in which technique involving lateral glide to the elbow was given while patient performing pain aggravating activities. Although single case study limits the generalization of the results and challenges its applicability in clinical ambience, it does provide evidence of the beneficial response obtained by the use of technique in patients affected by tennis elbow. Another investigation by Vicenzino et al. (2000) on the tennis elbow patients to evaluate the effects of the same elbow lateral glide technique on pain free grip (PFGs) strength and pressure pain threshold (PPT) showed positive results with MWM. However, McLean et al. (2002) cited that on increasing the force applied while giving MWMLE did not improve the PFG strength any further.

The initial pain relieving effect of the MWMLE technique for lateral epicondylalgia was evaluated by the studies done by (Vicenzino, 2001; and Paungmali et al., 2003a). The results of the studies demonstrated an immediate and substantial increase in PFG
in the order of 46 to 48% and PPT improved approximately 10% following treatment, which was significantly greater than placebo and control. Drawback of these studies is the lack of long-term follow up.

Bisset et al. (2006) carried out another systematic review of physical therapy interventions used in the management of Lateral epicondylalgia (LE). Due to inclusion of meta-analysis in their design, Bisset and colleagues excluded studies not achieving 50% quality score so as to prevent low quality studies from affecting overall results. The studies published up till 2003 have been included in this review. This review also identified the evidence of elbow mobilization in the short-term follow up along with stretching and strengthening exercises and recommended that the long-term effectiveness of joint manipulations needs to be further studied. However, Mulligan’s mobilizations with movement (MWM) based studies were excluded from this review as they were considered mechanism based studies evaluating only short-term effectiveness. This is contrary to the systematic review by Herd and Meserve (2008) that supported the application of MWMs for both short-term and long-term effectiveness in the management of LE, though there was lack of sufficient studies to evaluate the effectiveness of any particular intervention on its own. Conflicting results from these above mentioned systematic reviews leave the practicing clinicians in a state of dilemma of choosing the best intervention for treating patients with chronic LE.

Shoulder

Teys et al. (2006) conducted a double blinded randomized-controlled trial with 24 subjects, to investigate the initial effects of the Mulligan’s MWM technique on shoulder ROM in the plane of scapula and PPT in participants with anterior shoulder pain. Significant and clinically meaningful improvements in both ROM and PPT occur immediately after post-treatment, however, both the duration of these effects and mechanism by which this occurs remained unexplored. Restraints of this study were that the long-term effects of the MWM were not measured. Only measures of impairment (ROM, PPT) were made, but no measures of function or disability were considered. But in the past, several case studies/series have shown that continued
treatment with a MWM coincided with a resolution of the condition on function and disability measures (Hsieh et al., 2002; Kochar and Dogra, 2002; Vicenzino and Wright, 1995).

Another case reporting efficacy of Mulligan technique (SMWAM) was by Scaringe et al. (2002) in which they concluded that shoulder function was improved after using spinal mobilizations with arm movement in a 50 years old golfer with chronic shoulder arm and neck pain. In this case study, multiple techniques (Postero-lateral glide on humerus with scapular stabilization, spinal MWM with shoulder abduction, Cervical spine manipulations) were applied making it difficult to delineate the specific effects of a certain treatment.

DeSantis (2006) reported the use of MWM in 27 years old male referred to physical therapy with a diagnosis of supraspinatus tendinopathy secondary to impingement. This case report provided the preliminary, albeit low-level evidence that MWM may be an effective technique in improving function and active ROM and decreasing pain in the patient. After 12 sessions, there was a decrease from moderate pain 7/10 to little or no pain 0-1/10 during active shoulder abduction. Range was improved from 95 to 180° in 12 treatment sessions and an improvement in the shoulder pain and disability index (SPADI) score from 43 to 8% and ADL difficulty score more than 2. Furthermore, it was a case study without any generalization. Another drawback was that sufficient evidence based data was not available on the diagnosis (supraspinatus tendinopathy).

**Ankle**

Extensive research has been carried out on the efficacy of Mulligan techniques in ankle sprain cases. Recent researches have suggested that a positional fault of fibula on tibia contributes to the ankle joint instability in cases of acute and chronic ankle sprain. Mulligan (1999) suggested that in case of plantar flexion/inversion injuries excessive anterior displacement of talus is believed to occur with residual of the anterior talofibular ligament. It was proven by Hubbard et al. (2006) & Hubbard and Hertel (2008). However, both these studies did not give any description of the manual therapy techniques used to resolve this pathology and the proposed mechanism behind
it, thus, again leaving the clinicians unaware of the effect of their treatment procedures.

Collins et al. (2004) studied whether a Mulligan mobilization with movement technique improves talocrural dorsiflexion, following ankle sprain and to measure the initial effects on pressure and thermal pain threshold. Fourteen subjects with grade 2 lateral ankle sprains were studied. They concluded that there was a significant immediate improvement in dorsiflexion but no noteworthy improvements in pressure and thermal pain threshold measures. Although it was demonstrated that correction of positional fault was responsible for the observed change in dorsiflexion, bony position was not measured. Kavanagh (1999) conducted a quasi-experimental study to measure the movement occurring during MWM in ankle sprain cases. She found out that 2 out of 6 acutely sprained cases showed a greater amount of movement per unit force than normal. She hypothesized there would be a greater range of anterior-posterior movement possible at the distal fibula if a positional fault of the fibula occurred after an ankle sprain. Drawback was that conclusion relied on the data of 2 cases only, and hence, challenges the credibility of the results obtained and their applicability in clinical ambience. Mulligan’s dorsiflexion mobilization with movement technique significantly increases talocrural dorsiflexion initially after application in sub-acute ankle sprain. The absence of hypoalgesic post-application suggests a predominant mechanical rather than hypoalgesic effect behind the technique’s success. Though the results were satisfactory but conclusion relied on 2 cases only. Furthermore, effect on pain and ROM was not reported.

O’Brien and Vicenzino (1998) did case studies to investigate the effect of a MWM for lateral ankle pain in 2 male patients following acute ankle sprain. Sustained posterior glide with cephaloid inclination to the distal fibula was given while the patient doing active inversion at the ankle with passive overpressure. It resulted in the reduction of positional fault at inferior tibiofibular joint. Downside of the study was the short control period implicated in one of the two patients and in the results comparison was made between actively treated patient and natural resolution.
Thumb

There are not many reports on correction of positional fault of 1st MCP joint. Folk (2001) described the use of MWM in a 39 years old female who had injured her thumb during a fall on to her outstretched hand. A sustained internal rotation of the first proximal phalanx about its longitudinal axis with manual fixation of the first metacarpal bone abolished the pain and allowed the patient to move into full pain free extension. He concluded that the MCP joint dysfunction following the injury might have manifested as a positional fault that led to the patient’s symptoms and that the MWM reduced the positional fault. Hsieh et al. (2002) reported the same result in a 79 years old female who injured her right thumb (hyper abduction of the MCP joint) during a fall. On the basis of MRI findings it was proved that the long-term pain relieving effects are independent of permanent changes in the positional fault. Backstrom (2002) reported a case of trauma induced stiffness pain and limited function of the thumb. The author ascribed much of the success in outcomes to the MWM but the inclusion of many other treatments may have compromised this assertion. However, the results of these single case studies cannot be generalized to a wide area of population, and thus, are not much significant clinically.

Straight Leg Raising (SLR)

In low backache cases traction SLR, compression SLR and BLR techniques are believed to be helpful in increasing range of motion in the case of straight leg raising. BLR is extremely useful in the case of gross limitation of bilateral straight leg raise. Hall et al. (2006) conducted a pilot study to investigate the effects of Mulligan traction SLR on ROM in patients with LBP. Results provided the preliminary evidence. Hall et al. (2005) postulated that single intervention of Mulligan BLR technique resulted in improvement in range of SLR 24 hour later but not immediately after the intervention. This was marginal evidence and further studies were required to verify the findings.

Certainly it can be summarized that at present, published research on the clinical application of MWM especially in regard to the treatment of patients with cervical spine is inadequate or altogether unavailable. Moreover, none of the studies has successfully explained the exact mechanism behind the correction of this problem.
Furthermore, most of the studies have failed to report the long-term effects of the Mulligan’s techniques. Also, majority of the studies were single case studies or case reports, and thus, their results cannot be generalized to a larger population.

2.6. OUTCOME MEASURES AND THEIR APPLICATIONS

Pietrobon et al. (2002) stated that an increasing number of clinicians and clinical researchers are considering and incorporating the functional measures, as functional scales measure the impact of a disease on the performance of common daily activities. They also stressed that it is essential for the self-report measures to possess the characteristics of reliability and validity, and are responsive enough to identify changes in function when a true change has occurred.

**Reliability** is the extent to which a particular measurement is repeatable. Test-retest reliability is the ability of a questionnaire to repeatedly capture similar scores on two separate occasions of test administration, over which time the patient has not exhibited a change in their condition (Cleland et al., 2006).

**Validity** is the extent to which an instrument measures exactly what it is intended to measure. Construct validity is the determination of how the scores on a questionnaire compare with scores obtained with a reference standard (Cleland et al., 2006).

**Responsiveness** is the ability of an instrument to detect small but important clinical changes, such as the minimal clinically important difference (Cleland et al., 2006).

2.6.1. Range of Motion (ROM)

Range of motion (ROM) of the cervical spine is an integral component of clinical assessment (Schoening and Hannan 1964) and it is well correlated with cervical pain (Hagen et al., 1997; and Jordan et al. and 1997). It has also been used as an outcome measure for spinal mobilizations and manipulations (Nilsson et al., 1996; and Cassidy et al., 1992).

ROM of lower cervical spine is being measured by bubble inclinometer. Bubble inclinometer was first introduced by Schenker in 1956. American Medical
Association (AMA, 1993) has accepted the inclinometer as “a feasible and potentially accurate method of measuring spine mobility”. It consists of a 360-degree scale with a fluid filled circular tube containing a small air bubble. It is a gravity dependent Goniometer, which uses the gravity’s effect on fluid level to measure joint position and motion. When compared to universal Goniometer, inclinometers are easier to use, as they do not have to be aligned with bony landmarks or centered over the axis of motion. Inclinometers are reliable and valid measurement tools for cervical spine range of motion (Hoving et al., 2005; Rabel et al., 2008; and Saur et al., 1996). However, inclinometers are difficult to use on small joints (Clarkson, 2000) and where there is soft tissue deformity or edema (Moore 1984; and Miller, 1985).

Dual inclinometry allows the user to compensate for extraneous motion by providing measurements of the upper thoracic spine. This benefit is reflected in the smaller ROM values reported by dual inclinometry than by single inclinometry for all active motions. However, dual inclinometry has not been tested adequately for reliability. Only one study (Mayer et al., 1993) reported ROM values for lateral bending and Flexion extension, despite its recommendation in the American Medical Association guidelines for disability evaluation (Doege, 1993).

2.6.2. Neck Disability Index (NDI)

The Neck Disability Index (NDI) is a commonly used neck pain questionnaire. It is modelled after the Oswestry Back Disability questionnaire (Ralph et al., 2007). The NDI contains 10 items, seven related to activities of daily living, two related to pain, and one item related to concentration. Each item is scored ranging from 0 (no pain or disability) to 5 (severe pain and disability); and the total score is expressed as a percentage, with higher scores corresponding to greater disability. The NDI has shown to be reliable and valid for patients with neck pain (Cleland et al., 2006 & 2008; Hains et al. 1998; Hoving et al., 2003; McCarthy and Grevit, 2000; and Ricardo et al., 2002) and has excellent test-retest properties (Ralph et al., 2007).

McCarthy and Grevit (2000) examined the validity of NDI on 100 neck pain patients to draw a comparison of the NDI with Short form 36 (SF36). The test-retest reliability and the concurrent validity between the two questionnaire scores were assessed using
Pearson correlation. The individual scores for each of the ten items of the NDI were correlated to the total disability score categories. Both questionnaires showed robust internal consistency and the NDI had significant correlation to all eight domains of the SF36 (p<0.001). The individual scores for each of the ten items had significant correlation with the total disability score (p<0.001). The test-retest reliability of the NDI was acceptable. The study concluded that NDI has good reliability and validity and it stands up well to the SF36.

Cleland et al. (2006) in a cohort study on patients with cervical radiculopathy undergoing physical therapy examined the test-retest reliability; construct validity, and minimum levels of detectable and clinically important change for the Neck Disability Index (NDI) and Patient Specific Functional Scale (PSFS). They concluded that NDI exhibits fair to moderate test-retest reliability in patients with mechanical neck pain, whereas PSFS exhibits superior reliability and construct validity in cervical radiculopathy patients.

Ralph et al. (2007) compared the sensitivity to change of the Neck Disability Index (NDI) and the Neck Bournemouth Questionnaire (NBQ) in patients with chronic uncomplicated neck pain. This study concluded that the NDI and the NBQ have similar responsiveness and internal validity, and thus, can appropriately be used in patients with chronic neck pain. Both are sensitive to change and acceptable internal consistency and therefore would be efficient outcome tools in studies of chronic neck pain.

En et al. (2008) carried out their study to evaluate the construct and content validity of the Neck Disability Index (NDI) and the Neck Pain and Disability Scale (NPAD) in patients with chronic non-traumatic neck pain. Both the NDI and the NPAD include most of the functional problems common to this patient group, and display good content validity.

Cleland et al. (2008), in their study, examined the psychometric properties like test-retest reliability, construct validity, and minimum levels of detectable and clinically important change for the Neck Disability Index (NDI) and the numeric rating scale (NRS) for pain in a cohort of patients with neck pain. They reported that both NDI
and NRS exhibit fair to moderate test-retest reliability and showed adequate responsiveness in patients with mechanical neck pain.

2.6.3. McGill Pain Questionnaire

Melzack (1975) developed the McGill Pain Questionnaire (MPQ) that has become one of the most widely used pain measurement tools that provides sensory, affective, site, pain pattern, and intensity information. It is both useful and valid for acute, chronic, musculoskeletal, post-surgical and neuropathic pain (Srinivasa, 2005; Melzack and Katz, 2001).

Kilminster and Graham (2002) compared the psychometric properties of the McGill Pain Questionnaire (MPQ) with the 17-item Short Pain Inventory (SPI) in 60 outpatients with osteoarthritic knee pain. The SPI measures the emotional aspects of pain well and the McGill assesses the physical or sensory aspects of pain better than any other available method.

2.6.4. Visual Analogue Scale (VAS)

VAS is a subjective outcome measurement where patients judge the intensity of their pain on a scale of 0-10, which is in the form of a 10cm straight line (Dixon and Bird, 1981). On this 0-10 scale, zero denotes no pain and ten denotes severe pain intensity (Kochar and Dogra, 2002). The validity and reliability of VAS measures has previously been established (Bigatti and Cronan, 2002; Bijur et al., 2001; Langley and Sheppeard, 1985; & Stan et al., 1999). Stratford et al. (1993) further reported that PFGS and VAS scores are the measures most commonly utilised in the trials assessing change-over-time in LE.

The objective of the study by Gallagher et al. (2000) was to assess the validity and reliability of the visual analog scale (VAS) in the measurement of acute abdominal pain, and to identify the minimum clinically significant difference in VAS scores among patients with acute abdominal pain. The study was undertaken in preparation for a randomized clinical trial of opioid use in acute abdominal pain and concluded that the VAS is a methodologically sound instrument for quantitative assessment of
acute abdominal pain and for detecting clinically important changes in such pain. Boonstra et al. (2008) carried out their study to determine the reliability and concurrent validity of a visual analogue scale (VAS) as a single-item instrument measuring disability in chronic pain patients. For the reliability study a test-retest design and for the validity study a cross-sectional design was used. The conclusion of the study was that the reliability of the VAS for disability is moderate to good. Because of a weak correlation with other disability instruments and a strong correlation with the VAS for pain, however, its validity is questionable. Blicer et al. (2004) in their study compared the validity & reliability of VAS with neck pain and disability scale. They found these instruments equally reliable in neck pain patients.

2.6.5. Anxiety Scale

The State-Trait Anxiety Inventory (STAI) has been used extensively in research and clinical practice since its introduction more than four decades before (Spielberger, 1966). While the early studies were concerned primarily with the effects of stress and anxiety on learning and performance, the STAI has been used increasingly in investigations of stress-related psychiatric and medical disorders, and as an outcome measure in research on biofeedback and various forms of therapeutic interventions. Evidence of the expanded interest in state-trait anxiety research can be seen in State-Trait Anxiety Inventory: A Comprehensive Bibliography, which was recently compiled by the test author (Spielberger, 1983).

In the bibliography of STAI research, Spielberger (1983) reveals a marked increase in the number of studies using the STAI in investigations of psychiatric and psychosomatic disorders, and in the assessment of changes in anxiety in investigations of the treatment of these disorders. Psychiatric research with the STAI has included investigations of neurosis by Hogg-Johnston et al. (1980), Sipos et al. (1979) & Richtofen and Mellor (1980); depression by Gotlib and Robinson (1982), Hollon and Kendall (1980), Mathew et al. (1982) & Shaffer et al. (1981); and schizophrenia by Evans and Dinning (1980), Falloon et al. (1981) & Jensen (1982). The STAI has also been used extensively to investigate the role of anxiety in patients suffering from asthma by Kurata et al. (1976); headaches by Blanchard et al. (1982), Hart (1982) &
Mathew et al. (1980); insomnia by Carr-Kaffashan and Woolfolk (1979); and other forms of psychosomatic illnesses such as colitis, dermatitis, duodenal ulcers, and infectious mononucleosis by Brooks and Richardson (1980) & Latimer et al. (1980).

The STAI has been used in a number of recent studies of hypertension and coronary heart diseases by Rosenman and Chesney (1981). While patients with hypertension generally have significantly higher T-Anxiety scores than normotensive patient controls as suggested by Crane (1981), no systematic relationship has been instituted between anxiety and Type-behaviour, a major risk for coronary heart disease (Chesney et al., 1981).

The review of literature presented in this chapter has been found to be quite useful in designing the present study. The selection of variables and their levels, sample and sampling techniques, statistical analysis and theoretical models are based upon the knowledge and information gained from the previous studies. However, it may be added that no study in the literature has been found to be directly impinging upon the present study. For example, no study is available on the Mulligan concept directly being applied in cervical spine pain and stiffness. No doubt, there are some studies on shoulder, elbow, ankle and lumbar spine, etc. Further, there has not been any study available in literature checking the efficacy of Mulligan concept on long-term basis, which is the topic of present study. In majority of the studies, single subject design or series of cases (5 or so) have been used, whereas in the present study analysis of covariance design with control group and large number (N) are used with multiple groups.