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Effects of Mulligan mobilisation on shoulder and elbow

Literature review

Metropolia University of Applied Sciences

Bachelor of Health Care

Physiotherapy

Bachelor's Thesis

10th May 2023

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Title	Effects of Mulligan mobilisation on shoulder and elbow
Number of Pages	21
Date	10 May 2023
Degree	Bachelor of Health Care
Degree Programme	Physiotherapy
Instructors	Senior Lecturer Sanna Garam Senior Lecturer Heini Maisala-McDonnell
<p>The Mulligan mobilisation explains the positional faults of joints that restrict physiological movements. Mulligan's concept of joint mobilisation has had a significant impact on manual therapy practice worldwide. Mulligan mobilisation has significant effects on shoulder and elbow joints in manual therapy. This bachelor's thesis examines the effects of Mulligan mobilisation on shoulder impingement syndrome, adhesive capsulitis, and lateral epicondylitis.</p> <p>The objective of this bachelor's thesis is to identify the effects of Mulligan mobilisation on the shoulder and elbow joints. This is a modified literature review, which was conducted on studies that were published between 2012 and 2022. The search was conducted using the databases PubMed, ScienceDirect, CINHALL Complete and a manual search. To prevent errors this bachelor's thesis only included studies that were originally published in English.</p> <p>According to the results, functional disability, pain, and pain-free range of motion have all improved statistically significantly in shoulder joint pathologies. All the articles selected for this bachelor's thesis showed significant improvement in shoulder flexion range of motion. In addition, the selected studies have shown a statistically significant reduction in functional disability, pain and grip strength in patients with lateral epicondylitis.</p> <p>This bachelor's thesis successfully presented the effects of Mulligan mobilisation technique in improving shoulder and elbow joint pathologies with reference to six research articles, which consisted of randomized control trials, systematic reviews, and experimental prospective studies.</p>	
Key Words	Mulligan, Mulligan technique, Joint mobilisation, Shoulder, Elbow

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1 Introduction

Mulligan's unique concept of joint mobilisation has significantly influenced manual therapy practice worldwide. In 1954, Mulligan graduated from the Otago school of physiotherapy in Dunedin and began his career as a physiotherapist. Mulligan had his first success in introducing the concept of Mulligan mobilisation in 1985. Mulligan had attempted performing a sustained lateral glide with active flexion to a swollen second proximal interphalangeal joint, which had restored full range of movement with complete return to function. After the introduction of mobilisation with movement, Mulligan developed sustained natural apophyseal glides and natural apophyseal glides. (Hing, Hall, Rivett, Vicenzino & Mulligan, 2015.)

The Mulligan concept emphasizes positional faults of joints that restrict physiological movement. These changes in the articular surfaces occur due to injuries or sprains in the joint. The Mulligan concept consists of three major mobilisation techniques known as mobilisation with movement, sustained natural apophyseal glides and natural apophyseal glides. Mobilisation with movement can be explained as concurrent application of a sustained passive accessory glide to a joint while the restricted physiological or functional movement is actively performed by the patient (McDowell, Johnson & Hetherington, 2014). Sustained natural apophyseal glides can be defined as the application of mobilisation with movement in the spine. The natural apophyseal glides consists of passive oscillatory movements along the plane of the facet joints. (Hing et al., 2015.)

As far as the glide force is concerned, the Mulligan concept does not follow a system of grading. Rather, the practitioner ensures that only the required amount of force is applied in the mobilisation in order to achieve improvements in the comparable sign without causing pain. The application of Mulligan mobilisation must be painless. (Hing et al., 2015.) This thesis aims to elaborate on the impact of Mulligan mobilisation on shoulder and elbow joints as its significance in manual therapy practice is well known. This bachelor's thesis examines the effects of Mulligan mobilisation on shoulder impingement syndrome, adhesive capsulitis, and lateral epicondylitis.

2 Background

Due to the high prevalence of musculoskeletal conditions, conservative approaches are in high demand globally. Often, the conservative management involves physiotherapy, medications and injections. (Satpute, Reid, Mitchell, Mackay, & Hall, 2021.) A recent conducted study strongly recommended manual therapy as a supplement intervention along with exercise (Pieters et al., 2020). The immediate effects of Mulligan mobilisation will add greater clarity to the selection of physiotherapy interventions (Satpute et al., 2021).

2.1 Mulligan mobilisation techniques

The purpose of mobilisation with movement is to improve restricted movements or functional activities that are usually caused due to pain or stiffness of the joints. When performed according to Mulligan's principles, mobilisation with movement is supposed to produce instant and long-lasting effects. A critical aspect of the mobilisation with movement is the identification of which direction of accessory movement that results in the greatest improvement. If the comparable sign does not improve, the therapist has chosen the wrong glide direction. (Hing et al., 2015.)

Sustained natural apophyseal glides are applied to all the spinal joints including the rib cage and sacroiliac joint (Exelby, 2002). A passive accessory glide is applied to a specific motion segment while the patient actively performs the symptomatic movement. This technique can be implemented to relieve headaches, cervicogenic dizziness and restrictions in cervical motion. (Hing et al., 2015.) Natural apophyseal glides are used in the cervical and upper thoracic spine (Exelby, 2002). Glides must be applied rhythmically and without causing symptoms. (Hing et al., 2015.) Natural apophyseal glides are usually applied for a period of three to four seconds per segment. (McDowell et al., 2014.)

2.2 Shoulder

2.2.1 Shoulder Anatomy

The shoulder joint is a multi-segment joint complex, consisting of sternoclavicular, acromioclavicular, scapulothoracic and glenohumeral joint. It is a synovial joint, which performs shoulder extension, flexion, adduction, abduction, external rotation, internal rotation and circumduction. The complexity of the joint often hurdles the accurate diagnosis. The symptom modification ability and immediate effects of mobilisation with movement supports the diagnosis and treatment selection. The Mulligan mobilisation with movement approach will help in confirming the affected joint or joints supporting the treatment selection process in order to significantly improve the symptoms. (Hing et al., 2015.)

2.2.2 Shoulder Pathologies

Shoulder impingement syndrome is a pathological condition of the upper extremity, which occurs due to a structural narrowing of the subacromial space. This is mostly seen in people who take part in sports and activities that engage repetitive overhead movement. Irritation, inflammation and degradation of the anatomic structures within the subacromial space could also contribute for this condition. (Creech & Silver, 2020.)

Adhesive capsulitis, which is also called as frozen shoulder is a pathological process of the body that stimulates formation of excessive scar tissue or adhesions across the glenohumeral joint. This leads to pain, stiffness and dysfunction of the shoulder joint, negatively affecting the quality of life and daily activities. The cause of adhesive capsulitis could either be idiopathic or due to a fracture, dislocation, or articular trauma at the glenohumeral joint. (Le, Lee, Nazarian & Rodriguez, 2016.)

2.2.3 Mulligan mobilisation on shoulder

A systematic review was conducted to evaluate the effects of performing Mulligan mobilisation with movement alone and in combination with other physiotherapeutic modalities for shoulder conditions that are commonly encountered in clinical practice. This study has shown clinically relevant and statistically significant benefits of mobilisation

with movement in stage-II frozen shoulder patients when compared to other physiotherapy interventions. The mobilisation with movement has demonstrated statistically significant improvement in pain and range of motion among frozen shoulder, shoulder pain and movement dysfunction patients. The improvement achieved from mobilisation with movement was statistically significant even when the comparison group had incorporated other passive joint mobilisation techniques. (Satpute et al., 2021.)

A randomized controlled trial was conducted with 40 subjects diagnosed with adhesive capsulitis in the frozen phase. They were randomly assigned into two groups and the treatment sessions were followed-up for three months. Both groups were treated with hot pack and transcutaneous nerve stimulation. The only exception was that the first group was treated with passive stretching while the second group was given Mulligan mobilisation with movement. Three sets of ten repetitions of mobilisation with movement were applied in flexion, elevation, and internal rotation with a rest period of thirty seconds between sets. The improvements in pain, range of motion, and patient-therapist satisfaction were significantly better in the second group, who were treated with Mulligan mobilisation with movement. Mulligan's technique has proved to provide an analgesic effect in contrast to other interventions. (Doner, Given, Atalay, & Celiker, 2013.)

A randomized control trial was conducted to identify the long-term efficacy of Mulligan mobilisation and Maitland mobilisation among patients with idiopathic adhesive capsulitis. Forty-five individuals were equally assigned for three treatment groups. Group A was treated with Maitland mobilisation while group B was treated with Mulligan mobilisation. In addition, both groups had followed up an exercise programme and group C had only participated the exercise programme. The data was collected pre-intervention and post-intervention after 4 weeks of treatment. The follow-up was conducted after two weeks of post-intervention. The pain intensity, functional status and range of motion were measured using visual analogue scale, shoulder pain and disability index and goniometer, respectively. Treatments were conducted as three sessions per week for twelve sessions. Everyone was instructed to follow a daily home exercise programme. Three sets of ten repetitions of Mulligan's mobilisation were applied for external rotation and abduction. The physiological movement was performed only till pain-free range. The improvements in group A and B were statistically significant compared to group C. Group B showed significant improvement in shoulder abduction visual analogue scale

and shoulder pain and disability index scores compared to group A. There was no considerable change in shoulder external rotation. This study has identified Mulligan mobilisation to be more effective than Maitland mobilisation in treating idiopathic adhesive capsulitis. (Ranjana, Sahay, Banerjee, Bhushan, & Equebal, 2016.)

2.3 Elbow

2.3.1 Elbow anatomy

The elbow joint consists of humeroradial, proximal radioulnar and humeroulnar joints. It is a hinge joint, which allows elbow flexion and extension. The characteristics of mobilisation with movement are beneficial in improving and maintaining mobility of the elbow. Mobilisation with movement produces immediate improvement in tennis elbow by working the involved muscles. Two randomized controlled trials have proven that combining mobilisation with movement with exercises can speed up resolution to a similar percentage as a corticosteroid injection while avoiding long recovery time and high recurrence rates. (Hing et al., 2014.) Multiple studies have shown Mulligan's mobilisation with movement as a technique that reduces pain immediately. It also increases strength especially, pain-free grip strength, pain pressure threshold and function of elbow in patients with tennis elbow. (Skirven, Osterman, Fedorczyk & Amadio, 2010.)

2.3.2 Elbow pathologies

Lateral epicondylitis, also known as tennis elbow, is a pathology that causes pain around the lateral side of the elbow. The pain may travel down the forearm, when lifting or bending the elbow. This often occur due to overuse or repetitive action of the muscles that surrounds the elbow joint. Bony prominence could develop at the lateral side of the elbow because of strained muscles, micro tears, and inflammation. The pain may restrict the movements of elbow. (Buchanan & Varacallo, 2019.)

2.3.3 Mulligan mobilisation on elbow

The lateral glide mobilisation with movement technique, as described by Vicenzino et al. (2001) is conducted by physiotherapist while mobilising the proximal forearm laterally and holding the mobilisation till the client performs pain-free gripping action for six

repetitions with 15-second rest periods. Another case study was conducted on a fifty-one-year-old male patient who was diagnosed with chronic lateral epicondylitis of right elbow. He has shown a mechanical dysfunction at the elbow, which could be due to chronic lateral epicondylitis. (Jones & Rivett, 2004.)

The following treatment was conducted for four days. He was treated with mobilisation with movement with a lateral glide at the elbow and gripping action. A manual therapy belt was used to sustain a comfortable pain-free lateral glide force. The patient had completely pain-free gripping movement after the first day of treatment. In the second day of treatment, the patient had reported a relief of symptoms and the ability to write and type as he continued with the self-management treatment programme which included the application of a lateral glide from the unaffected/ left hand. The pain with moderate gripping force was eliminated after the second day of treatment. In the third day, resisted isometric wrist and finger extension were conducted with the lateral glide. The patient gained full pain-free grip strength and isometric finger and wrist strength. In the fourth day of treatment, the same method was conducted with holding each contraction for three seconds. The therapist has prescribed exercises to improve control of the forearm muscles and self-mobilisation as a follow up. Mobilisation with movement with a lateral glide at the elbow has proved to correct the medial radial displacement, immediately relieving the pain experienced in gripping while restoring the normal function. (Jones & Rivett, 2004.)

3 Aims and methods

3.1 Aim

The objective of this bachelor's thesis is to identify the effects of Mulligan mobilisation on shoulder and elbow joints. The identification of the effects of Mulligan mobilisation would support and influence the implementation of this technique in the management of shoulder and elbow joint pathologies.

3.2 Search strategy

3.2.1 Data collection

The search was done on the databases PubMed, ScienceDirect, CINHAL Complete and manual search. This bachelor's thesis was conducted on studies that were published between years 2012 and 2022. The intention behind this was to include the most recent publications related to the effects of Mulligan mobilisation on shoulder and elbow. The inclusion and exclusion criteria were summarized in the table 1. The search words used were Mulligan mobilization, Mulligan mobilisation, shoulder, glenohumeral joint and elbow. The words were entered to the databases in the following format: (("Mulligan mobilization") OR ("Mulligan mobilisation")) AND ((Shoulder) OR ("Glenohumeral joint") OR (Elbow)). This bachelor's thesis had only included studies that were originally published in English language to eliminate errors.

3.2.2 Inclusion and exclusion criteria

The inclusion and exclusion criteria were applied during the data collection process to keep up the quality and standard of this bachelor's thesis. The inclusion and exclusion criteria were applied for the purpose of achieving the expected aim of this thesis.

Table 1. Inclusion and exclusion criteria implemented for the data collection process

	Inclusion criteria	Exclusion criteria
Publication year	After year 2012	Before year 2012
Publication language	Studies published in English	Studies that are translated or published in other languages
Method	All type of study methods in articles	Articles that are not relevant

Contents	Articles that included shoulder and elbow conditions treated with Mulligan mobilisation	Articles that are not related to shoulder and elbow conditions and Mulligan mobilisation
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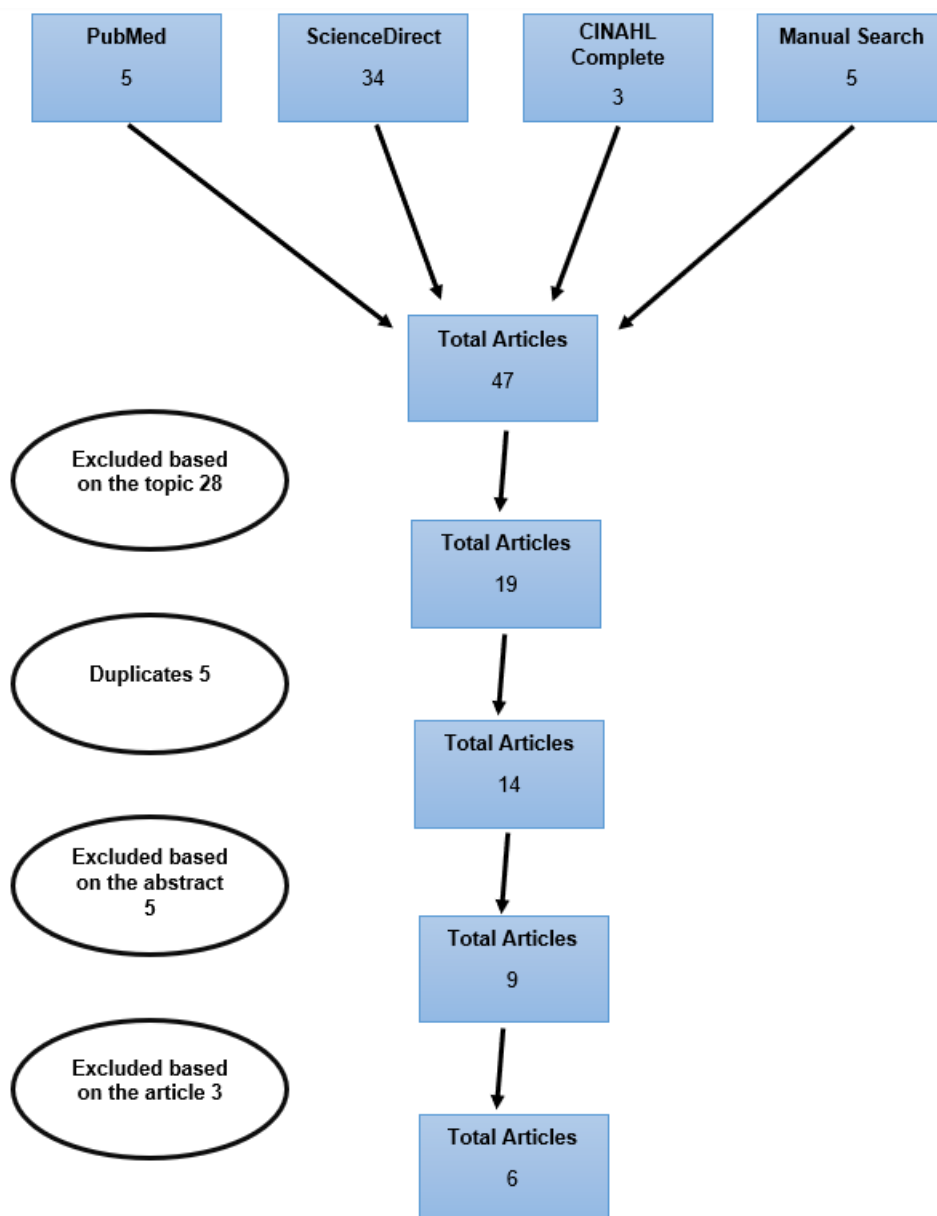


Figure 1. Flowchart of search process

Figure 1 represents the search process of this bachelor's thesis. This bachelor's thesis has used the databases PubMed, ScienceDirect, CINAHL and manual search. The total number of articles were filtered based on the topic, abstract, articles' texts and duplicates. Only six articles were eligible for this bachelor's thesis.

4 Results

Six articles were confirmed for this bachelor's thesis after thorough reading. The articles taken for the results were filtered according to the inclusion and exclusion criteria of this thesis from following databases which include, PubMed, ScienceDirect, CINAHL Complete and manual search.

Table 2. Results and conclusion of the final six articles

Authors and year	Purpose of the study	Methods	Participants	Intervention	Results and conclusion
Delgado-Gil et al., 2015	To identify the effects of mobilisation with movement on pain and range of motion among unilateral shoulder impingement syndrome patients.	A repeated-measures, double-blinded, randomized controlled trial	42 patients with unilateral shoulder pain medically diagnosed as shoulder impingement syndrome.	Patients in the mobilisation with movement group were treated by applying an accessory posterior-lateral glide in the humeral head combined with active shoulder flexion. The sham group was instructed to perform shoulder flexion while the therapist positioned his hands without ap-	Patients in the mobilisation with movement group showed significant improvement in pain and pain-free shoulder flexion and external rotation than patients who received a sham intervention.

				plying any pressure. Three sets of 10 repetitions were applied for 4 days over 2 weeks.	
Stathopoulos, Dimitriadis & Koumantakis, 2019	To present an updated systematic review and meta-analysis on effectiveness of mobilisation with movement techniques on range of motion.	Systematic review and meta-analysis	18 RCTs were included in the systematic review and thirteen RCTs were included in the meta-analysis.	Studies of databases MEDLINE, CINAHL, Embase, PEDro, Cochrane Library, and Google Scholar which were performed between August 2008 and January 2018. The studies were assessed based on their titles, abstracts, and articles' texts.	This study has proved that the mobilisation with movement produced clinically significant improvement in shoulder flexion, abduction, internal and external rotation in patients experiencing adhesive capsulitis, when compared to sham, passive, or no therapeutic intervention. The improvement in shoulder flexion among patients with shoulder impingement syndrome was statistically and clinically significant. The improvement in shoulder abduction, scap-tion and external rotation were statistically nonsignificant in patients with

					shoulder impingement syndrome.
Khalil, Tanveer, Hanif & Ahmad, 2022	To compare the effects of Mulligan technique and muscle energy technique on adhesive capsulitis.	A randomized controlled trial	78 patients diagnosed with unilateral idiopathic stage I and II adhesive capsulitis between 35-60 years.	The participants were randomly allocated into two groups, where group A was treated with Mulligan mobilisation technique while group B was treated with muscle energy technique. The study was conducted for a period of six weeks.	The pain, functional disability and range of motion were measured using visual analogue scale, shoulder pain and disability index and goniometer, respectively. Group A has showed significantly better results compared to group B. Mulligan mobilisation technique was found to be more effective in treating adhesive capsulitis compared to muscle energy technique in increasing shoulder range of motion and decreasing pain and functional disability.
Lucado, Dale, Vincent, & Day, 2019	To identify the assistance of joint mobilisations in the recovery of lateral elbow tendinopathy.	A systematic review with meta-analysis	20 studies had met the inclusion criteria for this review. Of the twenty studies, only eight studies were examined for the effects of mobilisation with	Studies of databases CINAHL, PubMed, and PEDro up to June 2017 were used to conduct a comprehensive English language literature	The collective data demonstrated a moderate positive effect of mobilisation with movement on improving the visual analogue scale pain rating and grip strength. This study

			movement on pain, grip strength and function.	search. The quality of all selected studies were rated using the PEDro scale.	has also reported a medium positive effect of mobilisation with movement on pain and disability according to the patient-rated tennis elbow evaluation questionnaire.
Bagade & Verma, 2015	To compare the effect of Mulligan mobilisation with movement and Hydrocortisone injection on chronic lateral epicondylitis.	An experimental prospective study, 24 weeks follow up study	30 patients diagnosed with chronic lateral epicondylitis having a history of minimum two flare up episodes and acute exacerbation.	Two groups were created with equal number of patients. One group was treated with hydrocortisone injection while the other group was treated with mobilisation with movement. The assessment was done using the visual analogue scale and disabilities of the arm, shoulder, and hand questionnaire.	The group treated with mobilisation with movement had significant reduction in the pain score and decreased disabilities of the arm, shoulder, and hand score at the end of six months of the treatment, proving mobilisation with movement technique as an effective treatment that provides long-term results in patients with chronic lateral epicondylitis.
Akbar et al., 2021	To identify the effects of Cyriax manual therapy and Mulligan technique on grip strength and	A double blinded, randomized clinical trial	66 patients diagnosed with Lateral epicondylitis between 20 – 50 years.	The group treated with Mulligan technique was given ten minutes of mobilisation with	The lower scores of patient-rated tennis elbow evaluation questionnaire indicate no disability or minimum disability

	functional outcomes in lateral epicondylitis patients.			movement on elbow. The patient was positioned in supine position, with an internally rotated shoulder, pronated forearm, and extended elbow. Ten repetitions were applied for six seconds with fifteen seconds of rest in between.	while the higher scores show higher disability. The number of physiotherapy sessions and basic treatments were the same for both groups. The improvement of grip strength and functional ability in the group treated with Mulligan mobilisation were statistically significant post-treatment.
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Delgado-Gil et al. (2015) has conducted a randomized controlled trial with forty-two patients who were equally divided into a mobilisation with movement group and a sham manual contact group. After two weeks of treatment, the 2 x 2 ANOVA has revealed a noticeable decrease in the shoulder pain intensity during shoulder flexion in the mobilisation with movement group. The mixed model ANOVA has identified a great increase in shoulder flexion and external rotation in patients receiving mobilisation with movement. (Delgado-Gil et al., 2015.)

Stathopoulos, Dimitriadis & Koumantakis (2019) have conducted an updated systematic review to identify the effectiveness of mobilisation with movement on range of motion. This study has included 18 randomized controlled trials, which showed statistically significant improvement in shoulder flexion after receiving mobilisation with movement for shoulder impingement syndrome. The mobilisation with movement has proved to give statistically significant improvement in shoulder flexion, abduction, external and internal rotation among individuals with adhesive capsulitis. (Stathopoulos, Dimitriadis & Koumantakis, 2019.)

Khalil, Tanveer, Hanif & Ahmad (2022) have conducted a study to compare the effects of Mulligan mobilisation and muscle energy technique among adhesive capsulitis patients. This study has shown significant post-intervention improvements in shoulder pain, functional disability and range of motion in the Mulligan mobilisation group compared to the muscle energy technique group. Lucado, Dale, Vincent, & Day (2019) has conducted a systematic review including 20 studies to identify whether the joint mobilisations are effective in improving disability, pain and grip strength among patients with lateral epicondylitis, which showed a positive effect of mobilisation with movement on improving pain, grip strength and function.

Bagade & Verma (2015) has reported according to a 24-week follow-up study, which was conducted to determine effects of Mulligan mobilisation with movement in the treatment of chronic lateral epicondylitis. Mean visual analogue scale at rest and post activity, and functional status have shown significant improvement post-treatment. (Bagade & Verma, 2015). Akbar et al. (2021) has conducted a randomized controlled trial to determine the impact of Mulligan technique and Cyriax manual therapy on grip strength and functional outcomes in lateral epicondylitis patients, which revealed significant improvement in post-treatment grip strength and functional outcomes among patients who were treated with Mulligan technique. In accordance with the referred articles, the significant effects of Mulligan mobilisation on shoulder and elbow were identified via this bachelor's thesis.

5 Discussion

The aim of this bachelor's thesis is to identify the positive effects of Mulligan mobilisation on shoulder and elbow joints. The identification of the effects of Mulligan mobilisation would encourage and impact the use of this approach in the treatment of shoulder and elbow joint diseases. The effects of Mulligan mobilisation techniques on shoulder and elbow pathologies have resulted in positive outcomes post-intervention. Mulligan mobilisation is one of the effective manual therapy techniques in the field of physiotherapy. There are three techniques in Mulligan mobilisation which include, sustained natural apophyseal glides, natural apophyseal glides and mobilisation with movements. The technique of mobilisation with movement is implemented to improve the symptoms of pain and stiffness of the extremities. (McDowell, Johnson & Hetherington, 2014.)

This bachelor's thesis has shown the effects of Mulligan mobilisation in patients with shoulder impingement syndrome, adhesive capsulitis, and lateral epicondylitis. This technique works on correcting positional faults, restoring function and reducing pain, while giving immediate and long-lasting results (Akbar et al., 2021). The search was conducted on different databases including PubMed, ScienceDirect and CINAHL Complete. The results of this bachelor's thesis were based on six articles that were selected out of forty-seven articles. As per the exclusion criteria the rest of articles were excluded to clearly present the purpose of this thesis.

Delgado-Gil et al. (2015), Stathopoulos, Dimitriadis & Koumantakis (2019) and Khalil, Tanveer, Hanif & Ahmad (2022) were conducted to identify the effects of mobilisation with movement on range of motion among adhesive capsulitis and shoulder impingement syndrome patients. The results have presented statistically significant improvement in functional disability, pain and pain-free range of shoulder flexion, external rotation, abduction, internal and external rotation in shoulder joint pathologies. The improvement in shoulder flexion range of motion was most significantly seen in all the articles selected for this bachelor's thesis.

Lucado, Dale, Vincent, & Day (2019), Bagade & Verma (2015) and Akbar et al. (2021) were conducted to recognize the effects of mobilisation with movement technique for lateral elbow tendinopathy and lateral epicondylitis of the elbow. The results have presented the effectiveness of mobilisation with movement on improving symptoms of lateral epicondylitis. The selected studies have shown a statistically significant improvement in functional disability, pain and grip strength post-treatment. This bachelor's thesis has successfully presented the effects of Mulligan mobilisation technique in improving shoulder and elbow joint pathologies with reference to six research articles, which consisted of randomized control trials, systematic reviews and experimental prospective studies.

References

- Akbar, N. & Sharif, F. & Afzal, W. & Ahmad, A. & Gilani, S.A. & Mohyudin, S.A. 2021. Effects of Cyriax manual therapy versus Mulligan technique on grip strength and functional outcomes in patients with lateral epicondylitis. *Journal Riphah college of rehabilitation sciences*, 09(02), pp.48–52. doi:10.53389/jrcrs.2021090202.
- Bagade, V.K. & Verma, C. 2015. Effect of Mulligan mobilization with movement (MWM) in the treatment of chronic lateral epicondylitis: 24 weeks follow-up study. *Indian journal of physiotherapy and occupational therapy - An international journal*, 9(4), p.199. doi:10.5958/0973-5674.2015.00172.0.
- Buchanan, B.K. & Varacallo, M. 2019. Tennis Elbow (Lateral Epicondylitis). [online] Nih.gov. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK431092/>.
- Creech, J.A. & Silver, S. 2020. Shoulder Impingement Syndrome. [online] PubMed. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK554518/>.
- Delgado-Gil, J.A. & Prado-Robles, E. & Rodrigues-de-Souza, D.P. & Cleland, J.A. & Fernández-de-las-Peñas, C. & Albuquerque-Sendín, F. 2015. Effects of mobilization with movement on pain and range of motion in patients with unilateral shoulder impingement syndrome: A randomized controlled trial. *Journal of manipulative and physiological therapeutics*, 38(4), pp.245–252. doi:10.1016/j.jmpt.2014.12.008.
- Doner, G. & Guven, Z. & Atalay, A. & Celiker, R. 2013. Evaluation of Mulligan's technique for adhesive capsulitis of the shoulder. *Journal of rehabilitation medicine*, 45(1), pp.87–91. doi:10.2340/16501977-1064.
- Exelby, L. 2002. The Mulligan concept: Its application in the management of spinal conditions. *Manual therapy*, 7(2), pp.64–70. doi:10.1054/math.2001.0435.
- Hing, W. & Hall, T. & Rivett, D. & Vicenzino, B. & Mulligan, B. 2015. The Mulligan concept of manual therapy - textbook of techniques.

Jones, M. A. & Rivett, D. A. 2004. Clinical reasoning for manual therapists. A chronic case of mechanic's elbow. Chapter 6.

Khalil, R. & Tanveer, F. & Hanif, A. & Ahmad, A. 2022. Comparison of mulligan technique versus muscle energy technique in patients with adhesive capsulitis. *Journal of the Pakistan medical association*, 72(2). doi:10.47391/jpma.1678.

Le, H.V. & Lee, S.J. & Nazarian, A. & Rodriguez, E.K. 2016. Adhesive capsulitis of the shoulder: review of pathophysiology and current clinical treatments. *Shoulder & Elbow*, [online] 9(2), pp.75–84. doi:https://doi.org/10.1177/1758573216676786.

Lucado, A.M. & Dale, R.B. & Vincent, J. & Day, J.M. 2019. Do joint mobilizations assist in the recovery of lateral elbow tendinopathy? A systematic review and meta-analysis. *Journal of hand therapy*, 32(2), pp.262-276.e1. doi: 10.1016/j.jht.2018.01.010.

McDowell, J.M. & Johnson, G.M. & Hetherington, B.H. 2014. Mulligan concept manual therapy: standardizing annotation. *Manual therapy*, 19(5), pp.499–503. doi: 10.1016/j.math.2013.12.006.

Pieters, L. & Lewis, J. & Kuppens, K. & Jochems, J. & Bruijstens, T. & Joossens, L. & Struyf, F. 2020. An update of systematic reviews examining the effectiveness of conservative physical therapy interventions for subacromial shoulder pain. *Journal of orthopaedic & sports physical therapy*, 50(3), pp.131–141. doi:10.2519/jospt.2020.8498.

Ranjana & Sahay, P. & Banerjee, D. & Bhushan, V. & Equebal, A. 2016. Long term efficacy of Maitland mobilization versus Mulligan mobilization in idiopathic adhesive capsulitis of shoulder: A randomized controlled trial. *Indian journal of physiotherapy and occupational therapy - An international journal*, 10(4), p.91. doi:10.5958/0973-5674.2016.00126.x.

Satpute, K. & Reid, S. & Mitchell, T. & Mackay, G. & Hall, T. 2021. Efficacy of mobilization with movement (MWM) for shoulder conditions: a systematic review and meta-analysis. *Journal of manual & manipulative therapy*, pp.1–20. doi:10.1080/10669817.2021.1955181.

Skirven, T. M. & Osterman, A. L. & Fedorczyk, J. M. & Amadio, P. C. 2010. Rehabilitation of the hand and upper extremity. Manual therapy in the management of upper extremity musculoskeletal disorders. Chapter 120. (Sixth Edition)

Stathopoulos, N. & Dimitriadis, Z. & Koumantakis, G.A. 2019. Effectiveness of Mulligan's mobilization with movement techniques on range of motion in peripheral joint pathologies: A systematic review with meta-analysis between 2008 and 2018. *Journal of manipulative and physiological therapeutics*, 42(6), pp.439–449. doi: 10.1016/j.jmpt.2019.04.001.

Vicenzino, B. & Paungmali, A. & Buratowski, S. & Wright, A. 2001. Specific manipulative therapy treatment for chronic lateral epicondylalgia produces uniquely characteristic hypoalgesia. *Manual Therapy*, [online] 6(4), pp.205–212. doi:<https://doi.org/10.1054/math.2001.0411>.

