Clinical Practice Guideline: Extra-Spinal Joint Manipulation / Mobilization for the Treatment of Lower Extremity Musculoskeletal Conditions

Date of Implementation: **June 19, 2014**

Product: **Specialty**

GUIDELINES

American Specialty Health - Specialty (ASH) considers lower extremity (LE) joint manipulation/mobilization medically necessary as part of a multimodal treatment plan for the treatment of LE Musculoskeletal Conditions if supported by documentation (Refer to Documentation Requirements to Substantiate Medical Necessity).

Extra-Spinal Manipulation/Mobilization and the Patellofemoral Articulation

The patella is not typically treated with grade V manipulation / high-velocity, low amplitude thrust (HVLA) joint manipulation. This articulation, however, can be treated with mobilization (Grades I - IV). Therefore, mobilization of the patella is better described as manual therapy (97140). Mobilizing the patella stretches the attaching muscles and connective tissues. The patella does not attach directly to the bones of the lower leg. The patella lies on top of the femur (thigh bone). It covers and protects the knee joint. It is attached primarily to the tendon of the quadriceps (thigh) muscle and is connected to the tibia (lower leg bone) by the patellar tendon.

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Documentation Requirements to Substantiate Medical Necessity

"Medically necessary" or "medical necessity" shall mean health care services that a healthcare practitioner/provider, exercising prudent clinical judgment, would provide to a patient for the purpose of evaluating, diagnosing, or treating an illness, injury, disease or its symptoms, and that are (a) in accordance with generally accepted standards of medical practice; (b) clinically appropriate in terms of type, frequency, extent, site, and duration; and considered effective for the patient's illness, injury, or disease; and (c) not primarily for the convenience of the patient or healthcare provider, and not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of that patient's illness, injury, or disease.

The patient's medical records should document the practitioner's clinical rationale to support LE joint manipulation/mobilization. Documentation should include the following in order to substantiate medical necessity:

1. Absence of contraindications to LE joint manipulation/mobilization in the area of treatment, including but not limited to:
    - Malignancy or Infection
    - Metabolic Bone Disease
    - Fusion or Ankylosis
    - Acute fracture or ligament rupture
    - Joint Hypermobility/Instability
2. A subjective record of a LE complaint that correlates with physical exam findings to support LE joint manipulation/mobilization.
3. Upon physical examination and as a best-practice a hypomobile joint (e.g., restricted joint play of right iliofemoral joint) should be appropriately documented. At a minimum, abnormal joint mechanics or a range of motion abnormality MUST be appropriately documented and correlated with the subjective findings of a LE complaint and other pertinent exam findings in order to support LE joint manipulation/mobilization.
4. A valid musculoskeletal diagnosis for a LE complaint for which LE joint manipulation/mobilization has been shown to be both safe and efficacious.
5. Assessment of clinically significant change in patient condition, for continued care.

CPT® Codes and Descriptions

CPT® Code	CPT® Code Description
98943	Chiropractic manipulative treatment (CMT); extraspinal, 1 or more regions *, **
97140	Manual therapy techniques (e.g., mobilization/ manipulation, manual lymphatic drainage, manual traction), 1 or more regions, each 15 minutes

* In accordance with the current version of the CPT code manual, the five extraspinal regions are: 1) the head [includes the temporomandibular joint, excluding the atlanto-occipital] region; 2) the upper extremities; 3) the lower extremities; 4) the rib cage [excluding the costotransverse and costovertebral joints]; and 5) the abdomen.

**ASH considers Chiropractic Manipulation Treatment; extraspinal, 1 or more regions to be associated with HVLA thrust joint manipulation (or Grade V Mobilization) and <u>not</u> joint mobilization (Grades I - IV).

DESCRIPTION/BACKGROUND

There is a greater body of research on the effect of manual therapy for the lower extremities in comparison to the upper extremities. There are specific conditions that have been targeted for research in the specific joints. The studies of the hip have focused on osteoarthritis (OA) conditions, studies of the knee have focused on OA and patellofemoral pain syndrome (PFPS), and the ankle has been studied for inversion sprains (Brantingham et al., 2012). There have also been limited studies on lower extremity adjustments for plantar fasciitis, cuboid syndrome, and metatarsalgia conditions.

This clinical practice guideline provides an overview of mobilization techniques as well as HVLA in relation to different lower extremity conditions.

EVIDENCE REVIEW

<u>Osteoarthritis (Hip and Knee)</u>

Hoeksma et al. (2004) compared an HLVA long axis hip manipulation with stretch treatment group to an exercise only treatment, in 109 patients (mean age: 71 years). Nine treatments were received over a 5 week period. There were follow-ups at 5 weeks, 17 weeks, and 29 weeks. Outcome assessment was the Likert scale, the SF-36, Harris Hip Score, and a walking test. Results significantly favored the manual therapy treatment group over the exercise group. These effects continued at 3 month and 6 month follow-ups after treatment. It should be noted that there was a beneficial effect on the SF-36 for the exercise group in comparison to the manual therapy group. The exercise protocol was not the same for every patient as it was tailored specifically to each patient. All exercise sessions were 25 minutes in length. Brantingham et al. pilot study (2003) was a controlled trial on 8 patients (mean age: 69 years) with hip osteoarthritis. They compared an HVLA long axis manipulation and other joint mobilizations of the hip joint compared to a placebo. There were 6 treatments over a 3 week period. Follow-up was at 1 week. Outcome assessment included the Western Ontario and McMasters Osteoarthritis Index (WOMAC), and range of movement (ROM). There was a significant effect size for the manual therapy group and ROM.

Brantingham et al. (2012) then looked at the manipulation of the full kinetic chain and its effects on symptomatic osteoarthritis (OA). The 111 patients (mean age: 42 years, ranging from 40-85 years) were divided into 2 groups. The experimental group received full kinematic chain manual therapy plus exercise. Full kinetic chain therapy included manipulation and mobilization of the soft tissue and joints such as the ankle, knee, and low back, as well as the hip. The comparison group received targeted manual therapy plus exercise. Targeted manual therapy included pre- and post- stretch of the hip, as well as a manipulation treatment. Both groups received 9 treatments over a 5 week period. Main outcome measures included the WOMAC and the Harris hip score. There was a 3 month follow-up. There were no statistically significant differences between the groups at any outcome measurement. There were within group changes that were positive, which were maintained at the 3 month follow-up.

Mosler et al. (2006) carried out a randomized controlled trial measuring hip ROM and functional assessment in 16 water polo players (mean age: 17 years). Functional assessment included endurance time for using the “eggbeater kick” to keep the body out of the water and the ability to jump. A randomized crossover design was used. Group 1 received the manual therapy which included soft tissue therapy, stretching and a lateral hip mobilization with a seat belt. Group 2 followed their usual training and recovery for water polo. Eight treatments were performed over a 4 week period. Post-measurement showed a significant increase in passive overall ROM, improvement in the jump, and an increase of 5-7 seconds in endurance time for keeping the body out of the water. A Likert-like scale, which was used in the assessment, showed no difference between groups.

There have been an increasing number of case series and single-group pretest posttest designs (SGPPD’s) examining hip OA. MacDonald et al. (2006) looked at 7 patients (median age: 62 years) and the effect of manual therapy and exercise on hip OA. They received 5 treatments over a 2–5-week period. Both grade IV and V manipulations were used. A HVLA axial elongation was used along with variable mobilization techniques. There was clinically meaningful improvement in the Harris Hip Score (HHS) and the Numeric Pain Rating Scale (NPRS). Brantingham et al. (2010) studied 18 patients with hip OA using the WOMAC, HHS, ROM, and Overall Treatment Effect (OTE) scale. Pre- and post-stretching were used along with an HVLA long axis manipulation. Manipulation was also performed on the ankle, knee, and low back as deemed necessary by the clinician. No formal exercise program was prescribed other than encouragement to increase activity and exercise safely. There were 9 treatments over 5 weeks and a 3 month follow-up. There were clinically meaningful improvements in all outcome measures. DeLuca et al. (2010) carried out a case series on 4 patients (average age: 59 years) with hip OA using pre- and post-adjustment stretches along with an HVLA long-axis hip manipulation. There were 9 treatments over a 5 week period. Outcome measures were the WOMAC and ROM. All 4 subjects had large decreases in hip pain, disability, and stiffness. There was an overall increase of 15 degrees in flexion. All of these outcomes were clinically meaningful.

Deyle et al. (2000) evaluated the effect of manual therapy and exercise in 83 patients (mean age: 61 years) for OA of the knee. The treatment group received manual therapy on the knee, ankle, hip and lumbar spine as determined by the clinician. The manual therapy was directed primarily at the knee. Manual therapy included mobilization up to grade IV or the inclusion of the thrust. They also received a home exercise program. The control group was administered sub-therapeutic ultrasound to the knee. Eight treatments were performed over a 4 week period. Outcome measures included the WOMAC and a 6 minute walk for distance. The patients who received manual therapy and exercise had statistically significant improvements in the WOMAC score and the 6 minute walk results. Beneficial effects were still seen at a 4 week, and 1 year follow-up. Deyle et al. (2005) followed up with a study comparing 2 groups of patients with OA of the knee, 1 group receiving a clinic-based treatment program versus a group with a home-based program. Subjects in the clinic treatment group received supervised exercise, individualized manual therapy, and a home exercise program over a 4-week period. Subjects in the home exercise group received the same home exercise program initially, reinforced at a clinic visit 2 weeks later. Manual therapy to the knee consisted of passive physiological and accessory movements, muscle stretching, and soft tissue mobilization, which were applied by the treating physical therapist primarily to the knee and surrounding structures. Manual treatments were also directed to the ankle, hip, and lumbar spine as deemed necessary by the clinician. Exercise programs were similar for both groups. There were 8 treatments over a 4 week period. Outcome measures included the WOMAC and the 6 minute walk. Follow-up was at 4, 8, and 52 weeks. There was a statistically significant improvement in the group that received manual therapy at 1 month follow-up. This difference between groups was not present at the 1 year follow-up, although both groups were still improved over their baseline measurements. Additionally, the clinical group was less likely to be taking medication at follow up.

Tucker et al. (2003) compared manipulation of the knee to non-steroidal anti-inflammatory medication (meloxicam) in OA of the knee. Sixty-three patients (mean age: 59 years) received 8 treatments over a 3 week period, or a non-steroidal anti-inflammatory drug (NSAID) once a day. Manipulation of the knee included long axis, anterior to posterior (A-P), posterior to anterior (P-A), and mobilization of the patella. Outcome measures included the Numeric Rating Scale (NRS), and the Visual Analog Scale (VAS). There was no difference between the 2 treatment groups. Side effects of NSAIDs were reported as nausea, diarrhea, and allergic responses.

Moss et al. (2007) investigated the effects of knee mobilization on pain and function in 38 subjects (age >40 years). The 3 groups were the mobilization group, the manual contact group, and the no-contact group. The manual therapy applied was a 9-minute A-P mobilization of the tibio-femoral joint. Outcome measures were algometry, and the "up and go" test. The knee mobilization group significantly reduced the "up and go" time and increases the pressure pain threshold (PPT). Results demonstrated a significantly greater mean (95% CI) percentage increase in PPT following knee joint mobilization [27.3% (20.9-33.7)] than after manual contact [6.4% (0.4-12.4)] or no-contact [-9.6% (-20.7 to 1.6)] interventions. Knee joint mobilization also increased PPT at a distal, non-painful site and reduced "up and go" time significantly more [-5% (-9.3 to 0.8)] than manual contact [-0.4% (-4.2 to 3.5)] or no-contact control [+7.9% (2.6-13.2)] interventions. The authors concluded that accessory mobilization of an osteoarthritic knee joint produces both a local and a widespread hypoalgesic effect that improved function.

Pollard et al. (2009) evaluated 43 patients (mean age: 62 years) and compared patella mobilization to a placebo/sham group. A patella mobilization was used during extension of the knee with or without thrust. A long axis thrust with internal or external rotation was also used when deemed necessary by the clinician. There were 6 treatments over a 2 week period. Outcome measures were VAS pain, and VAS result based questions. Follow-up was immediate. There was a significant difference favoring the experimental group in decreased pain, and increased function base on the questions.

Fish et al. (2008) compared the use of capsaicin, a local (topical) analgesic, massaged into the knee versus manual therapy to the knee in 60 subjects with OA (mean age: 62 years). Group 1 received capsaicin only, massaged into the knee three to four times (3-4x) per day for 3 weeks. Group 2 received a gradual increase in mobilization grades to the patella and an axial elongation thrust. They received 6 treatments over 3 weeks. Group 3 combined capsaicin therapy with manual therapy to the knee, for 6 treatments over 3 weeks. Outcome measures included the WOMAC, ROM, and Numerical Rating Scale 101 (NRS 101) pain scale. Outcomes were measured at baseline, 3 weeks, and a 1 week follow-up. There was significant within-group improvement in the manual therapy groups, but overall, there was no statistical difference between groups.

According to Bronfort et al. (2010), manipulation/mobilization for hip OA and knee OA was inconclusive but favorable. Bennell et al. (2015) found three new trials since their last review that question the role of manual therapy for hip and knee osteoarthritis. They determined that no between-group differences in outcome were detected between a multimodal program including manual therapy and home exercise, and placebo in one trial; a second trial found no benefit of adding manual therapy to an exercise program, while a third trial reported marginal benefits over usual care that were not clinically significant. They conclude that other than exercise, recent data is limited and inconclusive regarding the role of physical therapies in the treatment of osteoarthritis. These findings support earlier systematic reviews (French et al., 2011; Pinto et al., 2013). Beselga et al. (2016) completed a RCT on the immediate effects of hip mobilization with movement (MWM) on pain, ROM and function performance in patients with hip OA. Forty patients (mean age 78 ± 6 years; 54% female) completed the study. Two forms of MWM techniques (*n* = 20) or a simulated MWM (sham) (*n* = 20) were applied. For the MWM group, pain decreased by 2 points on the NRS, hip flexion increased by 12.2°, internal rotation by 4.4°, and functional tests were also improved with clinically relevant effects following the MWM. There were no significant changes in the sham group for any outcome variable. Authors concluded that pain, hip flexion ROM and physical performance immediately improved after MWM in older patients with hip OA. Future studies are required to determine the long-term effects of this intervention.

Courtney et al. (2016) hypothesized increased effectiveness of conditioned pain modulation (CPM) following application of joint mobilization, determined via measures of deep tissue hyperalgesia through examination of joint mobilization on impaired CPM in patients with moderate/severe knee OA. An examination of 40 individuals with moderate/severe knee osteoarthritis identified 29 (73%) with impaired CPM. The subjects were randomized to receive 6 minutes of knee joint mobilization (intervention) or manual cutaneous input only, 1 week apart. Deep tissue hyperalgesia was examined via pressure pain thresholds bilaterally at the knee medial joint line and the hand at baseline, postintervention, and post-CPM testing. Further, vibration perception threshold was measured at the medial knee epicondyle at baseline and post-CPM testing. Joint mobilization, but not cutaneous input intervention, resulted in a global increase in pressure pain threshold, indicated by diminished hyperalgesic responses to pressure stimulus. Further, CPM was significantly enhanced following joint mobilization. Diminished baseline vibration perception threshold acuity was enhanced following joint mobilization at the knee that received intervention, but not at the contralateral knee. Resting pain was also significantly lower following the joint intervention. Authors concluded that conditioned pain modulation was enhanced following joint mobilization, demonstrated by a global decrease in deep tissue pressure sensitivity. Joint mobilization may act via enhancement of descending pain mechanisms in patients with painful knee osteoarthritis.

Westad et al. (2019) systematically reviewed the literature to establish whether MWM treatment is effective for improving pain and function in patients with MSK conditions related to peripheral joints. Seven published trials were identified in which all trials presented positive clinical outcome in pain and function of MWM. Moderate quality evidence was found for the effectiveness of MWM in pain and function in patients with chronic ankle instability (CAI) and hip osteoarthritis (OA). Authors concluded that overall MWM interventions applied to peripheral joints seems to be superior to placebo and no intervention controls, but not in comparison with other medical or physiotherapy interventions. There is a need for more high-quality trials that investigate the short and long-term effect of a series of MWM interventions.

Welleslassie et al. (2021) reviewed the best available evidence for the effectiveness of MWMs on pain reduction and functional improvement in patients with knee osteoarthritis. A total of 15 RCTs having 704 participants were included. This systematic review suggests that there were significant differences between MWM groups and control groups in terms of visual analogue scale (VAS), Western Ontario and MacMaster Universities Osteoarthritis Index (WOMAC) scale, and flexion range of motion. Authors conclude that this systematic review demonstrated that MWM was effective to improve pain, range of motion, and functional activities in subjects with knee osteoarthritis. Karaborklu Argut et al. (2021) investigated the effectiveness of an exercise program combined with manual therapy compared with an exercise program only for pain, ROM, function, quality of life, and patient satisfaction outcomes. Forty-two patients (68.45 ± 6.3 years) scheduled for unilateral TKA as a treatment of severe osteoarthritis. Joint and soft tissue mobilizations in addition to exercise therapy were provided to the mobilization group (n = 21) while the control group received exercise therapy only (n = 21). The outcome measures were numeric pain-rating scale, knee ROMs, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, 10-meter walk test (10MWT), 5-times sit to stand test (5SST), and Short Form-12 (SF-12). Improvements in pain outcomes were significantly higher in the mobilization group than in the control group and the between-group difference in change score was 1.3 points. Additionally, there were statistically meaningful group-by-time interactions on total WOMAC score, 10MWT, and SF-12 mental component summary favoring the mobilization group. Also, patient satisfaction was higher in the mobilization group. Authors concluded that a structured exercise program combined with manual therapy can be more beneficial in improving pain, function, and patient satisfaction compared to exercise program alone for postoperative TKA patients.

Runge et al. (2022) evaluated if there was an additional benefit of combining manual therapy (MT) and exercise therapy over exercise therapy alone on pain and function in patients with hip or knee osteoarthritis. Authors included randomized controlled trials that compared MT (e.g., soft tissue mobilization, joint mobilizations) and exercise therapy to similar exercise therapy programs alone in patients with hip or knee osteoarthritis. In the 19 trials that were included, there was very low to moderate certainty of evidence that MT added benefit in the short term for pain, and combined pain, function, and stiffness (WOMAC global scale), but not for performance-based function and self-reported function. In the medium term, there was low- to very-low-certainty evidence that MT added benefit for performance-based function and WOMAC global score, but not for pain. There was high-certainty evidence that MT provided no added benefit in the long term for pain and function. Authors concluded that there was very low to moderate certainty of evidence supporting MT as an adjunct to exercise therapy for pain and WOMAC global scale, but not function in patients with knee or hip osteoarthritis in the short term. There was high certainty of evidence of no benefit for additional MT over exercise therapy alone in the long term.

Pozsgai et al. (2022) investigated the effect of end-range and not end-range Maitland mobilization compared to sham manual therapy technique on pain pressure threshold (PPT) and functional measures. Sixty-six patients with mild-to-severe knee OA were included in the study. Twenty-one patients (*N*=21) received end-range Maitland mobilization (EMGr), twenty patients (*N*=20) received not end-range Maitland mobilization (nEMGr) and twenty-two patients (*N*=22) received sham manual therapy technique (CG). All interventions were performed once. Evaluation was conducted pre-, postintervention and on the following consecutive second days within a 6-day period. Outcomes were local and distant PPT, Timed Up and Go Test (TUG) and strength of passive resistance of knee at onset of pain. Local and distant PPT increased, TUG time and strength of passive resistance decreased immediately, local and distant PPT remained decreased in 6-day and 4-day period, TUG time remained decreased in 6-day period in EMGr. Local PPT increased immediately compared to baseline in nEMGr. In between group comparison, increase of local, distant PPT and strength of passive resistance endures on 2nd day, 4th day and postintervention, respectively, in EMGr compared to CG. EMGr compared to nEMGr presented significant difference on 6th day and 4th day in local and distant PPT, respectively. NEMGr presented no significant difference compared to CG on either follow-up. Authors concluded that single end-range Maitland mobilization is effective immediately and in 4-day period on pain sensitization and immediately on physical function compared to not end-range Maitland mobilization and sham manual therapy technique in knee OA. From a clinical perspective, they suggest that based on the present results, applying end-range Maitland mobilization is suggested on every second day to maintain alleviation of pain sensitization and increasing passive knee joint mobility effectively in knee OA.

Brown et al. (2024) sought to determine whether MUA had any advantage over routine care in the treatment of patients who developed arthrofibrosis following TKA. The authors identified patients who underwent primary TKA at the authors' institution between 2010 and 2014 and had flexion ≤ 100 degrees at early follow-up. Knees were grouped based on how the arthrofibrosis was treated: those who underwent MUA and those who received routine care. Knee flexion was captured preoperatively (prior to TKA), at early follow-up (prior to MUA or routine care), and at 1-year follow up. Flexion change from early follow-up to 1 year was calculated. The average flexion at 1-year follow-up was not significantly different between the two groups (106.1 ± 11.7 degrees in the routine care group versus 106.3 ± 12.8 degrees in the MUA group). The MUA group had a greater proportion of patients with flexion gains > 20 degrees at final follow-up when compared with patients who underwent routine care (56% vs. 8%, $p < 0.0001$). This study demonstrates that patients with decreased ROM at early follow-up after primary TKA can expect greater ROM increase at 1-year follow-up if they undergo MUA compared with patients who undergo routine care.

Marquez-Lara et al. (2024) evaluated the safety and efficacy of early (<3 months postoperatively) manipulation under anesthesia (MUA) for the treatment of knee arthrofibrosis in adolescent patients. In a retrospective review, 57 patients who underwent MUA for postoperative knee arthrofibrosis were identified. The time between the index surgery and MUA as well as changes in range of motion (ROM) before and after MUA were analyzed. The median age of the cohort at time of MUA was 14.5 years; 54.4% were male. Median time to MUA was 64 days after index surgery. ROM before MUA was 90.0 degrees, which improved to 130 degrees (120 to 135) after MUA. At final median follow-up of 8.9 months, mean ROM was 133 degrees (130 to 140). There were no iatrogenic fractures or physeal separations associated with MUA. 12.3% (n=7/57) failed MUA either due to the need for subsequent repeat MUA (n=2), need for lysis of adhesions (n=3) or need for surgery after MUA (n=2). Those who failed early MUA and required subsequent procedures had ROM >120 degrees at final follow-up. Authors concluded that postoperative knee arthrofibrosis can be safely and effectively treated with early (<3 mo postoperative) MUA. There were no iatrogenic fractures or physeal separations during MUA. Patients who had recurrence of motion deficits after early MUA and required further intervention, regained satisfactory knee motion at final follow-up. Although further research is warranted to better characterize risk factors for knee arthrofibrosis in adolescent patients, early recognition and MUA is a safe and effective treatment for arthrofibrosis to help patients regain full ROM without invasive intervention.

<u>Patellofemoral Pain Syndrome (PFPS)</u>

Crossley et al. (2002) compared 71 subjects (age: 40 years or younger) with patellofemoral pain (PFPS) of 1 month or longer. One group received a standard physical therapy (PT) program once a week that consisted of patellofemoral joint mobilization as well as patellar taping and exercise. The placebo group received a sham ultrasound and placebo taping. Outcomes include VAS, worst pain, and step-ups as a functional test. The standard PT group had a significant improvement in all outcomes.

Van den Dolder and Roberts (2006) investigated the effects of manual therapy on pain, ROM, and function in 38 patients (mean age: 54 years). The experimental group received 6 treatments over a 2 week period that consisted of therapeutic massage, and patellar mobilization. The control group received no treatment and remained on the waiting list for treatment. Outcome measures included a pain questionnaire, ROM, and a step up and down test. There was a significant difference for the experimental group in decreased pain during an increase of flexion in the knee. There was also an increase in function for the step test. There was not a significant difference in the Likert scale for the experimental group.

Collins et al. (2008) compared the effects of foot orthoses in PFPS with physiotherapy, and flat inserts. They compared 179 subjects (mean age: 29 years) with pain of at least six (6) weeks and allocated them into 4 groups. Group 1 received foot orthoses plus physiotherapy, group 2 received physiotherapy only, group 3 received foot orthoses only, and group 4 received flat inserts. The physiotherapy treatment included patella mobilization. They received 6 treatments over 6 weeks, followed by self-management. Outcome measures were global improvement using a Likert scale, VAS, and a functional index questionnaire. Follow-up measurements were taken at 6, 12, and 52 weeks. There was no benefit seen between foot orthoses and standard physiotherapy, and no benefit seen when the 2 were combined. All 4 groups showed significant improvement at 6 and 12 weeks that continued at the 1 year follow-up.

There have also been a number of smaller randomized controlled trials that have looked at manipulation/mobilization and patellofemoral pain syndrome (PFPS). Taylor and Brantingham (2003) examined 12 subjects and found no difference between patellar mobilizations versus mobilization and home exercise. This involved 8 treatments over a 4 week period and descriptive statistics suggested that both treatments provided benefit. Stakes et al. (2006) compared patellar mobilizations versus patellar mobilizations and HVLA-sacroiliac (SI) or lumbosacral (L/S) adjustment for 60 patients. Both groups had statistically significant improvement in NRS, but there was no difference between groups. Power was not calculated. Hillerman et al. (2006) compared axial elongation manipulation of the knee versus SI manipulation for PFPS and quadriceps inhibition/weakness. They examined 20 subjects (age 18-40) who received 1 treatment with immediate follow-up. There was a significant increase in intragroup extensor strength, which was measured on a Cybex machine, after SI manipulation. Bronfort et al. (2010) noted that moderate quality evidence exists for manual therapy of the knee and/or full kinetic chain (SI to foot) combined with multimodal or exercise therapy for the treatment of patellofemoral pain syndrome.

An interesting case report discusses the use of talocrural joint manipulation in addition to knee manipulation for patellofemoral pain. Simpson and Simon (2014) authored a case report on a 40-year-old patient with chronic patellofemoral pain. She also had a history of lateral ankle sprains. The patient was evaluated and given a physical therapy diagnosis of patellofemoral pain syndrome (PFPS), with associated talocrural and tibiofemoral joint hypomobility limiting ankle dorsiflexion and knee extension, respectively. Treatment included a high-velocity low amplitude thrust manipulation to the talocrural joint, which helped restore normal ankle dorsiflexion range of motion. The patient also received tibiofemoral joint non-thrust manual therapy to regain normal knee extension mobility prior to implementing further functional progression exercises to her home program (HEP). This case report highlights the importance of a detailed evaluation of knee and ankle joint mobility in patients presenting with anterior knee pain. Further, manual physical therapy to the lower extremity was found to be successful in restoring normal movement patterns and pain-free function in a patient with chronic anterior knee pain.

Fatimah and Waqqar (2021) sought to determine the effects of tibiofemoral joint mobilization on pain and range of motion in patients with patellofemoral pain syndrome.

Subjects comprised of patellofemoral pain syndrome patients of either gender aged 25-35 years with anterior knee pain for at least one month. The subjects were randomly allocated control group A and experimental group B. Group A received 6 stretching and strengthening exercises of hip and knee muscles with hot pack, while group B additionally received tibiofemoral joint mobilization. There were 3 sessions per week over 4 weeks for both the groups. Numeric pain rating scale, Kujala scale, algometer and goniometer were used to assess pain and range of motion at baseline and at the end of the last session. Of the 60 individuals initially assessed, 52(86.6%) were enrolled; 26(50%) in each of the two groups. The experimental group B showed significant improvement in pain, range of motion and pressure pain threshold ($p<0.05$) compared to the control group A. Group B also showed significant improvement in terms of functional activities ($p<0.05$). Authors concluded that tibiofemoral joint mobilizations with hip and knee stretching and strengthening exercises were found to be more effective in reducing pain and increasing range of motion as well as pressure pain threshold.

Rehman and Riaz (2021) compared the effect of randomization with movement and Mulligan knee taping on anterior knee pain, hamstring flexibility and physical performance of the lower limb. Participants of both genders having patellofemoral pain were randomized into mobilization with movement group A and Mulligan knee taping group B. Both the groups were treated for 2 days per week for 2 consecutive weeks. Outcome was measured using the numeric pain rating scale, the Kujala pain rating scale, the active knee extension test and the time-up-and-go test. Assessments were taken at baseline, and at 2nd and 6th weeks post intervention. Of the 34 participants, there were 50% in each of the two groups. Group A showed significant improvement in terms of pain, while group B had better hamstring flexibility. Both the groups showed a significant difference for all outcome variables post-intervention. Authors concluded that mobilization with movement was found to be more effective in the treatment of patellofemoral pain and associated knee functional performance. Coelho et al. (2021) investigated the immediate effect of 3 ankle mobilization techniques on dorsiflexion ROM, dynamic knee valgus, knee pain, and patient perceptions of improvement in women with patellofemoral pain and ankle dorsiflexion restriction. A total of 117 women with patellofemoral pain who display ankle dorsiflexion restriction were divided into 3 groups: ankle mobilization with anterior tibia glide ($n = 39$), ankle mobilization with posterior tibia glide ($n = 39$), and ankle mobilization with anterior and posterior tibia glide ($n = 39$). The participants received a single session of ankle mobilization with movement technique. Dorsiflexion ROM (weight-bearing lunge test), dynamic knee valgus (frontal plane projection angle), knee pain (numeric pain rating scale), and patient perceptions of improvement (global perceived effect scale). The outcome measures were collected at the baseline, immediate postintervention (immediate reassessment), and 48 hours postintervention (48 h reassessment). There were no significant differences between the 3 treatment groups regarding dorsiflexion ROM and patient perceptions of improvement. Compared with mobilization with anterior and posterior tibia glide, mobilization with anterior tibia glide promoted greater increase in dynamic knee valgus and greater knee pain reduction at immediate reassessment. Also compared with mobilization with anterior and posterior tibia glide, mobilization with posterior tibia glide promoted greater knee pain reduction at immediate reassessment. Authors concluded that in this sample, the direction of the tibia glide in ankle mobilization accounted for significant changes only in dynamic knee valgus and knee pain in the immediate reassessment.

Kim et al. (2022) investigated the effect of foot intervention, talonavicular joint mobilization (TJM) and foot core strengthening (FCS), on PFPS. Forty-eight patients with PFPS were enrolled in the study. Participants were randomly assigned in a 1:1:1 ratio to three groups, and received 12 sessions of TJM, FCS, and blended. The primary outcomes were pain while the secondary outcomes were lower extremity function, valgus knee, foot posture, and muscle activity ratio measured at baseline, after 12 sessions, and at the 4-week follow-up. Authors concluded foot interventions including TJM and FCS is effective for pain control and function improvement in individuals with PFPS. Neal et al. (2022) sought to determine the effects of nonsurgical treatments on pain and function in people with patellofemoral pain (PFP). Authors extracted homogenous pain and function data at short- (≤3 months), medium- (>3 to ≤12 months) and long-term (>12 months) follow-up. Interventions demonstrated primary efficacy if outcomes were superior to sham, placebo, or wait-and-see control. Interventions demonstrated secondary efficacy if outcomes were superior to an intervention with primary efficacy. 65 RCTs were included. Four interventions demonstrated short-term primary efficacy: knee-targeted exercise therapy for pain and function, combined interventions for pain and function, foot orthoses for global rating of change, and lower-quadrant manual therapy for function. Two interventions demonstrated short-term secondary efficacy compared to knee-targeted exercise therapy: hip-and-knee-targeted exercise therapy for pain and function, and knee-targeted exercise therapy and perineural dextrose injection for pain and function.

<u>Ankle Inversion Sprains and Gait Dysfunction</u>

A pilot study by Pellow and Brantingham (2001) examined the effectiveness of adjusting the ankle when treating subacute and chronic grade I and grade II inversion sprains. 30 subjects (mean age: 24 years) received HVLA adjustment to the mortise joint, or a placebo treatment from a detuned ultrasound device for 5 minutes. They received 8 treatments over a 4 week period. Outcome measures included the Short-Form McGill Pain Questionnaire (SF-MPQ), NPRS 101, goniometer readings for dorsiflexion, algometry, and a functional ankle test. Evaluation occurred at the first treatment, final treatment, and a 1 month follow-up. Both groups showed improvement but the group receiving the adjustment had significantly better results in reduction of pain, dorsiflexion, and increased ankle function. Green et al. (2001) examined the effects of an A-P talus mobilization with Rest, Ice, Compression, Elevation (RICE) and tape versus RICE and tape alone. A total of 41 subjects (mean age 25.5 years) with acute ankle sprain (less than 72 hours) were evaluated for ROM, pain, and gait. Gait factors included speed, stride length, and single leg support time. The groups received 6 treatments or less over 2 weeks. Outcomes were measured before and after each treatment. The experimental group required fewer treatments to achieve full pain-free dorsiflexion. This group also had a significant increase in gait speed. Stride length and single leg support time were similar for both groups. Eisenhart et al. (2003) compared the effect of an osteopathic manipulative treatment with rest, ice, compression, and elevation (RICE) therapy and NSAIDs versus the standard care of RICE and NSAIDs only. The manipulation used was determined by the osteopath and based on their clinical assessment. Patients 18 and older (average age: 30 years) presenting to the emergency department for an acute grade I or grade II ankle sprain were randomly assigned to the experimental group or the standard care group. Patients in the experimental group received 1 treatment. Outcome measures were edema improvement, ROM, and a pain scale. Follow-up was 5-7 days later. Both groups were improved at the week follow-up, but the experimental group had a significant difference in reduced edema, and pain levels. There was also an improvement in ROM, but this was not significant.

Collins et al. (2004) investigated if a Mulligan's mobilization with movement (MWM) could improve dorsiflexion and relieve pain in a subacute population following a grade II inversion sprain. Patients (*n*=16; mean age=28 years) were randomly assigned to the experimental group or the control group, in which a sham mobilization was applied. The mobilization consisted of a P-A force to the distal leg while stabilizing the foot and talus. Three sets of 10 repetitions were applied. Outcome measures were weight bearing dorsiflexion, PPT, and hot and cold thermal pain thresholds. There was 1 treatment with pre- and post-measures. There was a significant improvement in dorsiflexion with MWM, however there was no effect on mechanical and pain threshold measures. Vicenzino et al. (2006) examined the effect on MWM weight bearing, MWM non-weight bearing, and a control group on ROM in 16 subjects (mean age: 19 years) with chronic recurrent ankle sprains. This was a double-blind randomized crossover experimental study with repeated measures. The ROM measures were posterior talar glide and dorsiflexion. The MWM technique provided significant improvement in ROM compared to the control group. There was no significant difference observed for MWM performed in the weight bearing versus the non-weight bearing position. Lopez-Rodriguez et al. (2007) examined the effects of talocrural joint manipulation on stabilometric and baropodometric measures in 52 patients (mean age: 22 years) with a grade II ankle sprain greater than 5 days in duration. The experimental group received an HVLA ankle axial adjustment, and then an HVLA A-P talar adjustment. The control group received a placebo holding position. A force platform was used to measure the proprioceptive effects. The data collected included bilateral anterior and posterior load, percentage of load on the forefoot and rear foot, mean pressure, maximum pressure, and distance between the center of gravity of the foot and center of gravity of the body. The experimental group showed a clear difference in modification of balance forces and proprioceptive effects. The results were inconclusive as to whether this was a benefit for patients with an ankle sprain.

Vaillant et al. (2009) evaluated the effect of massage and mobilization of the feet and ankles on clinical balance performance in elderly people. Manual therapy was performed on 28 subjects (mean age: 78.8 years) with foot and ankle dysfunction and plantar myofascial dysfunction. Group 1 had mobilization and manipulation to all joints of the foot and ankle three times (3x) per foot for 20 minutes. Group 2 had demagnetized magnets placed on the feet for 20 minutes. After 1 week, both groups crossed over to the other treatment group. Outcome measures included the One Leg Balance test (OLB), Timed Up and Go (TUG), and the Lateral Reach test (LR). Measurements were pre- and post-treatment. There was a significant improvement after manual therapy in the OLB and the TUG tests. The LR did not improve significantly. Yeo and Wright (2011) investigated the initial effects of an accessory mobilization technique in 13 patients (mean age: 29 years) with subacute grade II ankle inversion sprains. Mean duration of pain/injury was 5 weeks. The treatment group received an A-P mobilization on the distal talus using a 1 minute oscillation with a 30 second rest 3 times. The control group had no contact on the ankle by the therapist. Outcome measures were dorsiflexion, PPT, VAS during functional activity, and ankle functional scores. There was significant improvement in dorsiflexion ROM and PPT during the treatment condition, however there were no effects on the other measures.

Loudon et al. (2014) completed a systematic review to summarize the effectiveness of manual joint techniques in treatment of lateral ankle sprains. Outcome measures included were pain level, ankle range of motion, swelling, functional score, stabilometry and gait parameters. The majority of the articles only assessed these outcome measures immediately after treatment. No detrimental effects from the joint techniques were revealed in any of the studies reviewed. Authors concluded that for acute ankle sprains, manual joint mobilization diminished pain and increased dorsiflexion range of motion. For treatment of subacute/chronic lateral ankle sprains, these techniques improved ankle range-of-motion, decreased pain and improved function. Cruz-Diaz et al. (2014) evaluated the effects of joint mobilization with movement on dynamic postural control and on the self-reported instability of patients with chronic ankle instability (CAI). Ninety patients with a history of recurrent ankle sprain, self-reported instability, and a limited dorsiflexion range of motion, were randomly assigned to either the intervention group (Joint Mobilizations, 3 weeks, two sessions per week) the placebo group (Sham Mobilizations, same duration as joint mobilization) or the control group, with a 6 month follow-up. Results demonstrate that the application of joint mobilization resulted in better ROM, self-reported instability and postural control in the intervention group when compared with the placebo or the control groups. These results suggest that joint mobilization could be applied to patients with recurrent ankle sprain to help restore their functional stability. Authors conclude that the mobilization with movement technique presented by Mulligan, and based on the joint mobilization accompanied by active movement, appears as a valuable tool to be employed by therapists to restore ankle function after a recurrent ankle sprain history. ROM restriction, subjective feeling of instability and dynamic postural control are benefiting from the joint mobilization application.

Harkey et al. (2014) determined the immediate effects of a Maitland grade III anterior-to-posterior joint mobilization on spinal-reflex and corticospinal excitability in the fibularis longus (FL) and soleus (SOL), DFROM, and dynamic postural control. Thirty patients with CAI randomized into a mobilization (n = 15) or control (n = 15) group. Spinal-reflex excitability was measured with the Hoffmann reflex, while corticospinal excitability was evaluated with transcranial magnetic stimulation. Spinal-reflex and corticospinal excitability of the SOL and FL were not altered in the mobilization or control group. Dorsiflexion ROM increased immediately after the mobilization but not in the control group, while dynamic postural control was unchanged in both groups. Authors concluded that a single joint-mobilization treatment was efficacious at restoring ROM in participants with CAI; however, excitability of spinal reflex and corticospinal pathways at the ankle and dynamic postural control were unaffected. Hoch et al. (2014) examined the effect of a 2-wk anterior-to-posterior joint-mobilization intervention on instrumented measures of single-limb-stance static postural control and ankle arthrokinematics in adults with CAI. Twelve subjects received 6 treatments sessions of talocrural grade II joint traction and grade III anterior-to-posterior joint mobilization over 2 wk. No significant differences were identified in any measures of postural control or ankle arthrokinematics. Authors concluded that the 2-wk talocrural joint-mobilization intervention did not alter instrumented measures of single-limb-stance postural control or ankle arthrokinematics. Despite the absence of change in these measures, this study continues to clarify the role of talocrural joint mobilization as a rehabilitation strategy for patients with CAI.

Park et al. (2018) aimed to compare the effects of a 4-week program of MWM training with those of static muscle stretching (SMS). Ankle dorsiflexion passive range of motion (DF-PROM), static balance ability (SBA), the Berg balance scale (BBS), and gait parameters (gait speed and cadence) were measured in patients with chronic stroke. Twenty patients with chronic stroke participated in this study. Patients in both groups underwent standard rehabilitation therapy for 30 min per session. In addition, MWM and SMS techniques were performed three times per week for 4 weeks. Ankle DF-PROM, SBA, BBS score, and gait parameters were measured after 4 weeks of training. After 4 weeks of training, the MWM group showed significant improvement in all outcome measures compared with baseline ($p < 0.05$). Furthermore, SBA, BBS, and cadence showed greater improvement in the MWM group compared to the SMS group ($p < 0.05$). Authors concluded that MWM training, combined with standard rehabilitation, improved ankle DF-PROM, SBA, BBS scores, and gait speed and cadence. Thus, MWM may be an effective treatment for patients with chronic stroke, however given the small sample size, further study is warranted. Weerasekara et al. (2018) assessed the clinical benefits of joint mobilization for ankle sprains. After screening of 1530 abstracts, 56 studies were selected for full-text screening, and 23 were eligible for inclusion. Eleven studies on chronic sprains reported sufficient data for meta-analysis. Clinically relevant outcomes (dorsiflexion range, proprioception, balance, function, pain threshold, pain intensity) were assessed at immediate, short-term, and long-term follow-up points. Meta-analysis revealed significant immediate benefits of joint mobilization compared with comparators on improving posteromedial dynamic balance, but not for improving dorsiflexion range, static balance, or pain intensity. Joint mobilization was beneficial in the short-term for improving weight-bearing dorsiflexion range compared with a control. Authors concluded that joint mobilization appears to be beneficial for improving dynamic balance immediately after application, and dorsiflexion range in the short-term. Long-term benefits have not been adequately investigated. Kosik and Gribble (2018) investigated the evidence to support ankle joint mobilization for improving performance on the SEBT in patients with chronic ankle instability (CAI). A total of 3 peer-reviewed articles were retrieved, 2 prospective individual cohort studies and 1 randomized controlled trial. Only 2 articles demonstrated favorable results following 6 sessions of ankle joint mobilization. Authors concluded that despite the mixed results, the majority of the available evidence suggests that ankle joint mobilization improves dynamic postural control. These inconsistent results and the limited high-quality studies indicate that there is level C evidence to support the use of ankle joint mobilization to improve performance on the SEBT in patients with CAI.

Vallandingham et al. (2019) conducted a systematic review with meta-analysis assessing the effectiveness of joint mobilizations for improving dorsiflexion range of motion (DFROM) and dynamic postural control in individuals with chronic ankle instability. Included studies examined the isolated effects of joint mobilizations to enhance DFROM and dynamic postural control in individuals with chronic ankle instability Random-effects meta-analyses were conducted for each outcome measure and comparison. Positive Ess indicated better outcome scores in the intervention group than in the control group and at postintervention than at preintervention. Meta-analysis revealed weak and moderate Ess for overall control-to-intervention and pre-post DFROM analyses. Overall, dynamic postural control meta-analysis revealed moderate control-to-intervention and weak and moderate Ess for pre-post analyses. Authors concluded that grade A evidence exists that joint mobilizations can mildly improve DFROM among individuals with chronic ankle instability compared with controls and preintervention. Additionally, they observed grade B evidence that indicated conflicting effects of joint mobilizations on dynamic postural control compared with controls and preintervention.

Weerasekara et al. (2020) investigated the evidence for the effectiveness of MWM's in isolation for ankle sprains. Eighty-two full-texts were included after screening 1,707 of title and abstracts. Six full-texts were included and data were extracted based on the outcomes of range of movement, balance or pain from patients with sub-acute to chronic sprains. Authors concluded weight-bearing MWM appears to be beneficial for improving weight-bearing dorsiflexion immediately after application for chronic recurrent ankle sprains compared to no treatment or sham. Long-term benefits have not been adequately investigated. Meyer et al. (2020) examined the effect of serial MWM application on dorsiflexion range of motion (DFROM). A total of 18 adults (13 females; age = 29 [12.87] y; DFROM = 30.26° [4.60°]) with decrease dorsiflexion (<40°) participated. Inclusion criteria consisted of a history of ≥1 ankle sprain, ≥18 years old, no lower-extremity injury in the last 6 months, and no history of foot/ankle surgery. Participants completed a single data collection session consisting of 10 individual sets of MWMs. DFROM was taken at baseline and immediately after each intervention set. DFROM was measured with a digital inclinometer on the anterior aspect of the tibia during the weight-bearing lunge test with the knee straight and knee bent. Analysis of variances examined DFROM changes over time. Post hoc analysis evaluated sequential pairwise comparisons and changes from baseline at each time point. Analysis of variance results indicated a significant time main effect for weight-bearing lunge test with knee bent and a nonsignificant effect for weight-bearing lunge test with knee straight. Authors concluded that MWMs significantly improved acute knee bent DFROM and indicated that after 2 sets of MWMs, no further DFROM improvements were identified. Future research should investigate the lasting effects of DFROM improvements with variable MWM dosages.

Hernández-Guillén et al. (2022) established whether a talus mobilization-based manual therapy intervention may be effective for increasing range of motion and balance in older adults with limited ankle mobility due to the ageing process. In this randomized clinical trial, 42 community-dwelling older adults with limited ankle mobility were allocated to an experimental or a control group. The experimental intervention consisted of six sessions of anteroposterior talus mobilization, whereas the control intervention was a sham treatment. Baseline change in weight and non-weight bearing ankle range of motion (ROM), balance outcome in terms of the Timed up and go (mobility and dynamic balance), Single-leg stand (static balance and stability), Functional reach (margins of stability) and Romberg tests (static balance) were assessed. Forty participants completed the study. Participants who received six sessions of manual therapy showed greater improvements in the Timed up and go, Functional reach and Single-leg stand tests than participants who received a sham intervention. Both groups presented similar performance in post-treatment static balance measures. Authors noted that an anteroposterior talus mobilization-based manual therapy intervention is effective for increasing ankle ROM, with a positive effect on dynamic balance, mobility and stability in community-dwelling older adults with limited ankle mobility.

Jaffri et al. (2022) investigated the effects of midfoot joint mobilization and a 1-week home exercise program, compared with a sham intervention, and home exercise program on pain, patient-reported outcomes, ankle-foot joint mobility, and neuromotor function in young adults with chronic ankle instability. Twenty participants with chronic ankle instability were instructed in a stretching, strengthening, and balance home exercise program and were randomized a priori to receive either midfoot joint mobilizations (forefoot supination, cuboid glide, and plantar first tarsometatarsal) or a sham laying of hands on the initial visit. Changes in foot morphology, joint mobility, strength, dynamic balance, and patient-reported outcomes assessing pain, physical, and psychological function were assessed pre to post treatment and 1 week following post treatment. Participants crossed over to receive the alternate treatment and were assessed pre to post treatment and 1 week following. Linear modeling was used to assess changes in outcomes. Participants demonstrated significantly greater perceived improvement immediately following midfoot mobilization in the single assessment numeric evaluation, and global rating of change, and greater improved 1-week outcomes in rearfoot inversion mobility, plantar flexion mobility, and posteromedial dynamic balance compared to the sham intervention. Authors concluded that greater perceived improvement and physical signs were observed following midfoot joint mobilization. Yin et al. (2022) aimed to determine whether routine rehabilitation training combined with the Maitland mobilization is more effective than routine rehabilitation training alone in patients with chronic ankle instability. A total of 48 subjects were divided into three groups: EG (Maitland mobilization and routine rehabilitation), CG (routine rehabilitation), and SG (sham mobilization and routine rehabilitation). The intervention was performed three times each week for 4 weeks, for a total of 12 sessions. Before and after the intervention, the muscle strength, star excursion balance test (SEBT), weight-bearing dorsiflexion range of motion (WB-DFROM), ankle range of movement, Cumberland ankle instability tool (CAIT), self-comfort visual analog scale (SCS-VAS), and self-induced stability scale (SISS-VAS) were assessed. The results showed that the improvement of SEBT, WB-DFROM, and active ankle range of movement without the pain in EG was more obvious to the subjects than CG and SG, but the improvement of the self-report of ankle severity and muscle strength was not. Compared with routine rehabilitation training alone, routine rehabilitation training combined with Maitland mobilization for patients with chronic ankle instability may provide more benefit in terms of balance and ankle range of movement than routine rehabilitation alone, but the improvement in muscle strength was not evident enough to the subjects.

Cuboid Syndrome

Jennings and Davies (2005) described the examination, evaluation, and treatment of the cuboid syndrome following a lateral ankle sprain in a case series report. Seven patients were seen 1 to 8 weeks following a lateral ankle sprain with a chief complaint of lateral ankle/midfoot pain. In these 7 patients, the presence of cuboid syndrome was identified independently by 2 examiners. Treatment consisted of a cuboid manipulation. All 7 patients returned to sports activities following 1 to 2 treatments consisting of the “cuboid whip” manipulation. No recurrence of symptoms was reported upon immediate return to competition or during the remainder of the season (mean follow-up, 5.7 months; range, 2 to 8 months). Authors concluded that based on those 7 patients, results suggest that patients who are properly diagnosed with cuboid syndrome and receive the cuboid manipulation can return to competitive activity within 1 or 2 visits without injury recurrence. Patterson (2006) described cuboid syndrome in an article explaining the etiology of this syndrome, its clinical diagnosis in relation to differential diagnoses, commonly administered treatment techniques, and patient outcomes. Medical professionals must be aware that any lateral foot and ankle pain may be the result of cuboid syndrome. Once properly diagnosed, cuboid syndrome responds exceptionally well to conservative treatment involving specific cuboid manipulation techniques. Other methods of conservative treatment including therapeutic modalities, therapeutic exercises, padding, and low dye taping techniques are used as adjuncts in the treatment of this syndrome. Immediately after the manipulation is performed, the patient may note a decrease or a complete cessation of their symptoms. Occasionally, if the patient has had symptoms for a longer duration, several manipulations may be warranted throughout the course of time. Due to the fact radiographic imaging is of little value, the diagnosis is largely based on the patient's history and a collection of signs and symptoms associated with the condition. Additionally, an understanding of the etiology behind this syndrome is essential, aiding the clinician in the diagnosis and treatment of this syndrome. After the correct diagnosis is made and a proper treatment regimen is utilized, the prognosis is excellent.

Durall (2011) completed a review of cuboid syndrome. Cuboid syndrome is thought to arise from subtle disruption of the arthrokinematics or structural congruity of the calcaneocuboid joint, although the precise pathomechanic mechanism has not been elucidated. Fibroadipose synovial folds (or labra) within the calcaneocuboid joint may play a role in the cause of cuboid syndrome, but this is highly speculative. The symptoms of cuboid syndrome resemble those of a ligament sprain. Currently, there are no definitive diagnostic tests for this condition. Case reports suggest that cuboid syndrome often responds favorably to manipulation and/or external support. Durall concluded that evidence-based guidelines regarding cuboid syndrome are lacking. Consequently, the diagnosis of cuboid syndrome is often based on a constellation of signs and symptoms and a high index of suspicion. Unless contraindicated, manipulation of the cuboid should be considered as an initial treatment. Patla et al. (2015) authored a case report is to describe the treatment of a patient with a three year history of posterior tibialis tendinopathy utilizing a combination of cuboid manipulation and exercise. The patient was a 23-year old female recreational runner and collegiate basketball player reporting a three year history of chronic left ankle and lower leg pain. Outcome measures included the numeric pain rating scale, lower extremity functional scale, strength, passive joint mobility, and functional activities including running distance. Standard care for the treatment of tendinopathy was followed for six weeks with minimal functional improvements. Manipulation was then used at this joint to restore mobility. This intervention resulted in an immediate reduction in symptoms and improved functioning. Both muscle strengthening and functional task training were implemented post manipulation. At discharge, the patient reported full recovery and no pain with running 14 miles. Her lower extremity functional score improved to 78/80, posterior tibialis strength increased to 4/5 and the patient was able to perform 12 single leg heel raises without pain. Authors concluded that by restoring cuboid internal rotation mobility, associated midtarsal pronation, and lower extremity neuromuscular control, the posterior tibialis muscle was able to perform efficiently, thus resolving the chronic tendinopathy and returning the patient to optimum functional ability of running.

Plantar Fasciitis

Kashif et al. (2021) compared the effectiveness of subtalar randomization technique on pain and functional disability compared to conventional physiotherapy in patients with plantar fasciitis. Patients of either gender aged 30-60 years presenting with complaints of heel and foot pain, a limited range of motion at the ankle joint due to heel pain, and pain in the morning when taking the first steps or after prolonged rest participated in the study. The participants were randomly assigned to intervention group A, that received subtalar randomization, and control group B treated with therapeutic ultrasound. The groups received two treatment sessions per week over 3 weeks. Patients in both the groups received stretching and rigid tapping as standard treatment. Visual analogue scale and the foot and ankle disability inventory were used to measure pain and functional disability. Of the 60 patients enrolled, 52(86.6%) completed the study. There were significant differences in terms of pain between the two groups. Group A showed more reduction in functional disability than group B. Authors concluded that subtalar mobilization with movement was found to be effective in reducing pain and functional disability than conventional treatment in patients with plantar fasciitis.

Peripheral Joint Pathologies

Stathopoulos et al. (2018) provided an updated systematic review and meta-analysis regarding the effectiveness of mobilization with movement (MWM) techniques on range of motion (ROM). Included were 18 studies with 753 participants in 10 separate meta-analyses for ROM. All studies were classified as high quality or medium quality. Peripheral joint MWM seems to produce better therapeutic results in comparison to sham, passive, other active, or no therapeutic approach, regarding improvement of joint ROM in specific peripheral joint pathologies, consistently in all movement directions for shoulder adhesive capsulitis and hip pain. Authors concluded that mobilization with movement produced a statistically and clinically significant ROM increase consistently in all movement directions for shoulder adhesive capsulitis and hip pain. However, for shoulder impingement, shoulder pain/dysfunction, hamstring tightness, knee osteoarthritis, and chronic ankle instability pathologies, a therapeutic benefit regarding ROM could not be clearly established.

Plummer and Leonard (2022) investigated whether mobilization with movement (MWM) is an effective method of treatment for reducing knee pain and increasing knee ROM in individuals being treated for knee pain and limited knee ROM. The literature searched were peer-reviewed articles that investigated the effects of MWM as a therapy to reduce knee pain and increase knee ROM. Authors determined that MWM was shown to be an effective treatment for reducing knee pain and increasing knee ROM in individuals who experience knee pain and knee limited ROM.

PRACTITIONER SCOPE AND TRAINING

Practitioners should practice only in the areas in which they are competent based on their education training, and experience. Levels of education, experience, and proficiency may vary among individual practitioners. It is ethically and legally incumbent on a practitioner to determine where they have the knowledge and skills necessary to perform such services.

It is best practice for the practitioner to appropriately render services to a patient only if they are trained, equally skilled, and adequately competent to deliver a service compared to others trained to perform the same procedure. If the service would be most competently delivered by another health care practitioner who has more skill and expert training, it would be best practice to refer the patient to the more expert practitioner.

Best practice can be defined as a clinical, scientific, or professional technique, method, or process that is typically evidence-based and consensus driven and is recognized by a majority of professionals in a particular field as more effective at delivering a particular outcome than any other practice (Joint Commission International Accreditation Standards for Hospitals, 2020).

Depending on the practitioner's scope of practice, training, and experience, a member's condition and/or symptoms during examination or the course of treatment may indicate the need for referral to another practitioner or even emergency care. In such cases it is prudent for the practitioner to refer the member for appropriate co-management (e.g., to their primary care physician) or if immediate emergency care is warranted, to contact 911 as appropriate. See the *Managing Medical Emergencies (CPG 159 – S)* clinical practice guideline for information.

References

Abbott JH, Robertson MC, Chapple C, et al. Manual therapy, exercise therapy, or both, in addition to usual care, for osteoarthritis of the hip or knee: a randomized controlled trial. 1: clinical effectiveness. *Osteoarthritis Cartilage*. 2013;21(4):525-534. doi:10.1016/j.joca.2012.12.014

Alshami AM. Knee osteoarthritis related pain: a narrative review of diagnosis and treatment. *Int J Health Sci (Qassim)*. 2014;8(1):85-104. doi:10.12816/0006075

American Medical Association. (current year) Current Procedural Terminology (CPT) Current year (rev. ed.), Chicago: AMA.

Bennell KL, Buchbinder R, Hinman RS. Physical therapies in the management of osteoarthritis: current state of the evidence. *Curr Opin Rheumatol*. 2015;27(3):304-311. doi:10.1097/BOR.0000000000000160

Bennell KL, Hinman RS, Metcalf BR, et al. Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial. *Ann Rheum Dis*. 2005;64(6):906-912. doi:10.1136/ard.2004.026526

Beselga C, Neto F, Alburquerque-Sendín F, Hall T, Oliveira-Campelo N. Immediate effects of hip mobilization with movement in patients with hip osteoarthritis: A randomised controlled trial. *Man Ther*. 2016;22:80-85. doi:10.1016/j.math.2015.10.007

Brantingham J, Williams A, Parkin-Smith G, Weston P, Wood T. A controlled, prospective pilot study into the possible effects of chiropractic manipulation in the treatment of osteoarthritis of the hip. European Journal of Chiropractic. 2003;51:149-66

Brantingham JW, Bonnefin D, Perle SM, et al. Manipulative therapy for lower extremity conditions: update of a literature review. *J Manipulative Physiol Ther*. 2012;35(2):127-166. doi:10.1016/j.jmpt.2012.01.001

Brantingham JW, Globe GA, Cassa TK, et al. A single-group pretest posttest design using full kinetic chain manipulative therapy with rehabilitation in the treatment of 18 patients with hip osteoarthritis. *J Manipulative Physiol Ther*. 2010;33(6):445-457. doi:10.1016/j.jmpt.2010.06.005

Bronfort G, Haas M, Evans R, Leininger B, Triano J. Effectiveness of manual therapies: the UK evidence report. *Chiropr Osteopat*. 2010;18:3. Published 2010 Feb 25. doi:10.1186/1746-1340-18-3

Brown ML, Vaz KM, McCauley JC, May L, Colwell CW Jr. Who Benefits from Manipulation under Anesthesia Following Total Knee Arthroplasty?. J Surg Orthop Adv. 2024;33(1):33-36.

Coelho BAL, Rodrigues HLDN, Almeida GPL, João SMA. Immediate Effect of Ankle Mobilization on Range of Motion, Dynamic Knee Valgus, and Knee Pain in Women With Patellofemoral Pain and Ankle Dorsiflexion Restriction: A Randomized Controlled Trial With 48-Hour Follow-Up. J Sport Rehabil. 2021;30(5):697-706. Published 2021 Dec 29. Doi:10.1123/jsr.2020-0183

Collins N, Crossley K, Beller E, Darnell R, McPoil T, Vicenzino B. Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomised clinical trial. *BMJ*. 2008;337:a1735. Published 2008 Oct 24. doi:10.1136/bmj.a1735

Collins N, Teys P, Vicenzino B. The initial effects of a Mulligan's mobilization with movement technique on dorsiflexion and pain in subacute ankle sprains. *Man Ther*. 2004;9(2):77-82. doi:10.1016/S1356-689X(03)00101-2

Courtney CA, Steffen AD, Fernández-de-Las-Peñas C, Kim J, Chmell SJ. Joint Mobilization Enhances Mechanisms of Conditioned Pain Modulation in Individuals With Osteoarthritis of the Knee [published correction appears in J Orthop Sports Phys Ther. 2016 Apr;46(4):313]. *J Orthop Sports Phys Ther*. 2016;46(3):168-176. doi:10.2519/jospt.2016.6259

Crossley K, Bennell K, Green S, Cowan S, McConnell J. Physical therapy for patellofemoral pain: a randomized, double-blinded, placebo-controlled trial. *Am J Sports Med*. 2002;30(6):857-865. doi:10.1177/03635465020300061701

Cruz-Díaz D, Lomas Vega R, Osuna-Pérez MC, Hita-Contreras F, Martínez-Amat A. Effects of joint mobilization on chronic ankle instability: a randomized controlled trial. *Disabil Rehabil*. 2015;37(7):601-610. doi:10.3109/09638288.2014.935877

de Luca K, Pollard H, Brantingham J, Globe G, Cassa T. Chiropractic management of the kinetic chain for the treatment of hip osteoarthritis: an Australian case series. *J Manipulative Physiol Ther*. 2010;33(6):474-479. doi:10.1016/j.jmpt.2010.06.004

Deyle GD, Henderson NE, Matekel RL, Ryder MG, Garber MB, Allison SC. Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee. A randomized, controlled trial. *Ann Intern Med*. 2000;132(3):173-181. doi:10.7326/0003-4819-132-3-200002010-00002

Deyle GD, Allison SC, Matekel RL, et al. Physical therapy treatment effectiveness for osteoarthritis of the knee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. *Phys Ther*. 2005;85(12):1301-1317

Durall CJ. Examination and treatment of cuboid syndrome: a literature review. *Sports Health*. 2011;3(6):514-519. doi:10.1177/1941738111405965

Eisenhart AW, Gaeta TJ, Yens DP. Osteopathic manipulative treatment in the emergency department for patients with acute ankle injuries. *J Am Osteopath Assoc*. 2003;103(9):417-421

Fatimah I, Waqqar S. Effects of tibiofemoral mobilization in patients of Patellofemoral pain syndrome. J Pak Med Assoc. 2021;71(11):2506-2510. Doi:10.47391/JPMA.04-585

Fish D, Kretzmann H, Brantingham JW, Globe G, Korporaal C, Moen J. A randomized clinical trial to determine the effect of combining a topical capsaicin cream and knee joint mobilization in the treatment of osteoarthritis of the knee. J Amer Chiropr Assoc. 2008;45:8-23

French HP, Brennan A, White B, Cusack T. Manual therapy for osteoarthritis of the hip or knee - a systematic review. *Man Ther*. 2011;16(2):109-117. doi:10.1016/j.math.2010.10.011

Green T, Refshauge K, Crosbie J, Adams R. A randomized controlled trial of a passive accessory joint mobilization on acute ankle inversion sprains. *Phys Ther*. 2001;81(4):984-994

Harkey M, McLeod M, Van Scoit A, et al. The immediate effects of an anterior-to-posterior talar mobilization on neural excitability, dorsiflexion range of motion, and dynamic balance in patients with chronic ankle instability [published correction appears in J Sport Rehabil. 2015 May;24(2):197]. *J Sport Rehabil*. 2014;23(4):351-359. doi:10.1123/jsr.2013-0085

Hernández-Guillén D, Roig-Casasús S, Tolsada-Velasco C, García-Gomáriz C, Blasco JM. Talus mobilization-based manual therapy is effective for restoring range of motion and enhancing balance in older adults with limited ankle mobility: A randomized controlled trial. Gait Posture. 2022;93:14-19. Doi:10.1016/j.gaitpost.2022.01.005

Hillermann B, Gomes AN, Korporaal C, Jackson D. A pilot study comparing the effects of spinal manipulative therapy with those of extra-spinal manipulative therapy on quadriceps muscle strength. *J Manipulative Physiol Ther*. 2006;29(2):145-149. doi:10.1016/j.jmpt.2005.12.003

Hoch MC, Mullineaux DR, Andreatta RD, et al. Effect of a 2-week joint mobilization intervention on single-limb balance and ankle arthrokinematics in those with chronic ankle instability. *J Sport Rehabil*. 2014;23(1):18-26. doi:10.1123/jsr.2012-0125

Hoeksma HL, Dekker J, Ronday HK, et al. Comparison of manual therapy and exercise therapy in osteoarthritis of the hip: a randomized clinical trial. *Arthritis Rheum*. 2004;51(5):722-729. doi:10.1002/art.20685

Jaffri A, Fraser JJ, Koldenhoven RM, Hertel J. Effects of Midfoot Joint Mobilization on Perceived Ankle-Foot Function in Chronic Ankle Instability: A Crossover Clinical Trial. J Sport Rehabil. 2022;31(8):1031-1040. Published 2022 Jun 25. doi:10.1123/jsr.2021-0462

Jansen MJ, Viechtbauer W, Lenssen AF, Hendriks EJ, de Bie RA. Strength training alone, exercise therapy alone, and exercise therapy with passive manual mobilisation each reduce pain and disability in people with knee osteoarthritis: a systematic review. *J Physiother*. 2011;57(1):11-20. doi:10.1016/S1836-9553(11)70002-9

Jennings J, Davies GJ. Treatment of cuboid syndrome secondary to lateral ankle sprains: a case series. *J Orthop Sports Phys Ther*. 2005;35(7):409-415. doi:10.2519/jospt.2005.35.7.409

Karaborklu Argut S, Celik D, Kilicoglu OI. The Combination of Exercise and Manual Therapy Versus Exercise Alone in Total Knee Arthroplasty Rehabilitation: A Randomized Controlled Clinical Trial. PM R. 2021;13(10):1069-1078. doi:10.1002/pmrj.12542

Kashif M, Albalwi A, Alharbi A, Iram H, Manzoor N. Comparison of subtalar mobilization with conventional physiotherapy treatment for the management of plantar fasciitis. J Pak Med Assoc. 2021;71(12):2705-2709. Doi:10.47391/JPMA.1049

Kim HJ, Cho J, Lee S. Talonavicular joint mobilization and foot core strengthening in patellofemoral pain syndrome: a single-blind, three-armed randomized controlled trial. BMC Musculoskelet Disord. 2022;23(1):150. Published 2022 Feb 15. Doi:10.1186/s12891-022-05099-x

Kosik KB, Gribble PA. The Effect of Joint Mobilization on Dynamic Postural Control in Patients With Chronic Ankle Instability: A Critically Appraised Topic. *J Sport Rehabil*. 2018;27(1):103-108. doi:10.1123/jsr.2016-0074

López-Rodríguez S, Fernández de-Las-Peñas C, Alburquerque-Sendín F, Rodríguez-Blanco C, Palomeque-del-Cerro L. Immediate effects of manipulation of the talocrural joint on stabilometry and baropodometry in patients with ankle sprain. *J Manipulative Physiol Ther*. 2007;30(3):186-192. doi:10.1016/j.jmpt.2007.01.011

Loudon JK, Reiman MP, Sylvain J. The efficacy of manual joint mobilisation/manipulation in treatment of lateral ankle sprains: a systematic review. *Br J Sports Med*. 2014;48(5):365-370. doi:10.1136/bjsports-2013-092763

MacDonald CW, Whitman JM, Cleland JA, Smith M, Hoeksma HL. Clinical outcomes following manual physical therapy and exercise for hip osteoarthritis: A case series. *J Orthop Sports Phys Ther*. 2006;36(8):588-599. doi:10.2519/jospt.2006.2233

Marquez-Lara A, Padget W, Wall EJ, Parikh SN. Manipulation Under Anesthesia is Safe and Effective for Management of Early Postoperative Knee Arthrofibrosis in

Adolescent Patients. J Pediatr Orthop. 2024;44(1):e84-e90. doi:10.1097/BPO.0000000000002562

Meyer JE, Rivera MJ, Powden CJ. The Evaluation of Joint Mobilization Dosage on Ankle Range of Motion in Individuals With Decreased Dorsiflexion and a History of Ankle Sprain. *J Sport Rehabil*. 2020;30(3):347-352. Published 2020 Sep 24. doi:10.1123/jsr.2020-0114

Mosler AB, Blancha PD, Hiskins BC. The effect of manual therapy on hip range of motion, pain and eggbeater kick performance in water polo players. Physical Therapy in Sport. 2006;7:128-36

Moss P, Sluka K, Wright A. The initial effects of knee joint mobilization on osteoarthritic hyperalgesia. *Man Ther*. 2007;12(2):109-118. doi:10.1016/j.math.2006.02.009

Neal BS, Bartholomew C, Barton CJ, Morrissey D, Lack SD. Six Treatments Have Positive Effects at 3 Months for People With Patellofemoral Pain: A Systematic Review With Meta-analysis. J Orthop Sports Phys Ther. 2022;52(11):750-768. doi:10.2519/jospt.2022.11359

Park D, Lee JH, Kang TW, Cynn HS. Four-week training involving ankle mobilization with movement versus static muscle stretching in patients with chronic stroke: a randomized controlled trial. *Top Stroke Rehabil*. 2019;26(2):81-86. doi:10.1080/10749357.2018.1550614

Patla C, Lwin J, Smith L, Chaconas E. Cuboid manipulation and exercise in the management of posterior tibialis tendinopathy: a case report. *Int J Sports Phys Ther*. 2015;10(3):363-370

Patterson SM. Cuboid syndrome: a review of the literature. *J Sports Sci Med*. 2006;5(4):597-606. Published 2006 Dec 15

Pellow JE, Brantingham JW. The efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and grade II ankle inversion sprains. *J Manipulative Physiol Ther*. 2001;24(1):17-24. doi:10.1067/mmt.2001.112015

Peterson DH and Bergmann TF. Chiropractic technique: principles and procedures. 2nd ed. St. Louis, MO: Mosby; 2002

Pinto D, Robertson MC, Abbott JH, Hansen P, Campbell AJ; MOA Trial Team. Manual therapy, exercise therapy, or both, in addition to usual care, for osteoarthritis of the hip or knee. 2: economic evaluation alongside a randomized controlled trial. *Osteoarthritis Cartilage*. 2013;21(10):1504-1513. doi:10.1016/j.joca.2013.06.014

Pinto D, Robertson MC, Hansen P, Abbott JH. Cost-effectiveness of nonpharmacologic, nonsurgical interventions for hip and/or knee osteoarthritis: systematic review. *Value Health*. 2012;15(1):1-12. doi:10.1016/j.jval.2011.09.003

Plummer S, Leonard J. Mobilization With Movement as Therapy to Reduce Knee Pain and Increase Knee Range of Motion. J Sport Rehabil. 2022;31(7):950-953. Published 2022 Jun 20. doi:10.1123/jsr.2021-0294

Pollard H, Ward G, Hoskins W, Hardy K. The effect of a manual therapy knee protocol on osteoarthritic knee pain: a randomised controlled trial. *J Can Chiropr Assoc*. 2008;52(4):229-242

Pozsgai M, Udvarácz K, Péter IA, Than P, Nusser N. Effect of single end-range and not end-range Maitland mobilization on pressure pain threshold and functional measures in knee osteoarthritis: randomised, controlled clinical trial. Eur J Phys Rehabil Med. 2022;58(5):774-783. doi:10.23736/S1973-9087.22.07506-2

Rehman M, Riaz H. Comparison of mobilization with movement and Mulligan knee taping on Patellofemoral pain syndrome. J Pak Med Assoc. 2021;71(9):2119-2123. doi:10.47391/JPMA.04-658

Runge N, Aina A, May S. The Benefits of Adding Manual Therapy to Exercise Therapy for Improving Pain and Function in Patients With Knee or Hip Osteoarthritis: A Systematic Review With Meta-analysis. J Orthop Sports Phys Ther. 2022;52(10):675-A13. doi:10.2519/jospt.2022.11062

Simpson BG, Simon CB. Lower extremity thrust and non-thrust joint mobilization for patellofemoral pain syndrome: a case report. *J Man Manip Ther*. 2014;22(2):100-107. doi:10.1179/2042618613Y.0000000042

Southerst D, Yu H, Randhawa K, et al. The effectiveness of manual therapy for the management of musculoskeletal disorders of the upper and lower extremities: a systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *Chiropr Man Therap*. 2015;23:30. Published 2015 Oct 27. doi:10.1186/s12998-015-0075-6

Stakes N, Myburgh C, Brantingham J, Moyer R, Jensen M, Globe G. A prospective randomized clinical trial to determine efficacy of combined spinal manipulation and patella mobilization compared to patella mobilization alone in the conservative management o patellofemoral pain syndrome. Journal of American Chiropractic Association. 2006;43:11-18.

Stathopoulos N, Dimitriadis Z, Koumantakis GA. 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. *J Manipulative Physiol Ther*. 2019;42(6):439-449. doi:10.1016/j.jmpt.2019.04.001

Taylor K, Brantingham J. An investigation into the effect of exercise combined with patella mobilization/manipulation in the treatment of patellofemoral pain syndrome. European Journal of Chiropractic. 2003;51:5-17

Tucker M, Brantingham J, Myburgh C. The relative effectiveness of a non-steroidal anti-inflammatory medication (meloxicam) versus manipulation in the treatment of osteoarthritis of the knee. European Journal of Chiropractic. 2003;50:163-84

Vaillant J, Rouland A, Martigné P, et al. Massage and mobilization of the feet and ankles in elderly adults: effect on clinical balance performance. *Man Ther*. 2009;14(6):661-664. doi:10.1016/j.math.2009.03.004

Vallandingham RA, Gaven SL, Powden CJ. Changes in Dorsiflexion and Dynamic Postural Control After Mobilizations in Individuals With Chronic Ankle Instability: A Systematic Review and Meta-Analysis. *J Athl Train*. 2019;54(4):403-417. doi:10.4085/1062-6050-380-17

van den Dolder PA, Roberts DL. Six sessions of manual therapy increase knee flexion and improve activity in people with anterior knee pain: a randomised controlled trial. *Aust J Physiother*. 2006;52(4):261-264. doi:10.1016/s0004-9514(06)70005-8

Vicenzino B, Branjerdporn M, Teys P, Jordan K. Initial changes in posterior talar glide and dorsiflexion of the ankle after mobilization with movement in individuals with recurrent ankle sprain. *J Orthop Sports Phys Ther*. 2006;36(7):464-471. doi:10.2519/jospt.2006.2265

Weerasekara I, Osmotherly P, Snodgrass S, Marquez J, de Zoete R, Rivett DA. Clinical Benefits of Joint Mobilization on Ankle Sprains: A Systematic Review and Meta-Analysis. *Arch Phys Med Rehabil*. 2018;99(7):1395-1412.e5. doi:10.1016/j.apmr.2017.07.019

Weerasekara I, Deam H, Bamborough N, et al. Effect of Mobilisation with Movement (MWM) on clinical outcomes in lateral ankle sprains: A systematic review and meta-analysis. *Foot (Edinb)*. 2020;43:101657. doi:10.1016/j.foot.2019.101657

Weleslassie GG, Temesgen MH, Alamer A, Tsegay GS, Hailemariam TT, Melese H. Effectiveness of Mobilization with Movement on the Management of Knee Osteoarthritis: A Systematic Review of Randomized Controlled Trials. *Pain Res Manag*. 2021;2021:8815682. Published 2021 May 3. doi:10.1155/2021/8815682

Westad K, Tjoestolvsen F, Hebron C. The effectiveness of Mulligan's mobilisation with movement (MWM) on peripheral joints in musculoskeletal (MSK) conditions: A systematic review. *Musculoskelet Sci Pract*. 2019;39:157-163. doi:10.1016/j.msksp.2018.12.001

Yeo HK, Wright A. Hypoalgesic effect of a passive accessory mobilisation technique in patients with lateral ankle pain. *Man Ther*. 2011;16(4):373-377. doi:10.1016/j.math.2011.01.001

Yin Y, Yu Z, Wang J, Sun J. Effectiveness of the Rehabilitation Training Combined with Maitland Mobilization for the Treatment of Chronic Ankle Instability: A Randomized Controlled Trial. Int J Environ Res Public Health. 2022;19(22):15328. Published 2022 Nov 20. doi:10.3390/ijerph192215328