Clinical Practice Guideline: **Manipulation Under Anesthesia (MUA)**

Date of Implementation: **July 13, 2006**

Product: **Specialty**

Table of Contents

GUIDELINES

American Specialty Health – Specialty (ASH) considers one session of manipulation under anesthesia (MUA) medically necessary for the following indications:

- Adhesive capsulitis (i.e., frozen shoulder) when there is failure of conservative management, including medications with or without articular injections, home exercise programs and physical therapy for at least 6 to 8 weeks at a minimum (CPT code 23700).
- Post-traumatic or postoperative arthrofibrosis of the knee (e.g., total knee replacement, anterior cruciate ligament reconstruction) when there is failure of conservative management, including exercise and physical therapy per surgeon's recommendations (CPT code 27570).
- Reduction of a displaced fracture (e.g., vertebral, long bones) (CPT codes 22505 and 25675).
- Reduction of acute/traumatic dislocation (e.g., vertebral, perched cervical facet) (e.g., CPT code 22505).
- Chronic contracture of upper or lower extremity joint (e.g., fixed contracture from a neuromuscular condition) when there is failure of conservative management

CPG 92 Revision 20 – S
Manipulation Under Anesthesia (MUA)
Revised – February 20, 2025
To CQT for review 01/13/2025
CQT reviewed 01/13/2025
To QIC for review and approval 02/04/2025
QIC reviewed and approved 02/04/2025
To QOC for review and approval 02/20/2025
QOC reviewed and approved 02/20/2025

including range of motion exercise programs and physical therapy for at least 6 to 8 weeks at a minimum.

Manipulation under anesthesia (MUA) is considered safe and effective and is a well-established method of treatment of the above conditions. When performed for these specific conditions, MUA generally requires a single session of treatment, most often performed unilaterally, involving a single joint. Data supporting the need for, and clinical efficacy of multiple, repeat MUA treatment sessions for these specific conditions, is lacking in the peer-reviewed published medical literature.

ASH considers MUA for acute or chronic pain conditions of any of the following joints (other than those listed above as medically necessary) as unproven and thus, not medically necessary:

- Ankle (CPT code 27860)
- Cervical, thoracic or lumbar spine (e.g., CPT code 22505)
- Elbow (CPT code 24300)
- Finger (e.g., CPT code 26340, 26675)
- Hip (CPT code 27275)
- Pelvis, Sacroiliac (CPT code 27198)
- Temporomandibular (CPT code 21073)
- Thumb (CPT code 26340)
- Toe (CPT code 28635, 28665)
- Wrist (CPT code 25259)

The available evidence does not enable ASH to determine if MUA is safe or effective relative to more conservative care. Well-designed studies are needed to evaluate and confirm its place in treatment of neck and low back pain and for other pain conditions related to the above joints.

DESCRIPTION/BACKGROUND

Manipulation under anesthesia (MUA) is the use of manual manipulation of the spine or other joints while the patient is anesthetized. The addition of an anesthetic allows for manipulation under circumstances where conscious manipulation would not be effective because of pain response, spasm, muscle contracture, and/or guarding. The manipulative procedure that the physician performs depends upon the goals of the procedure, the tissues involved, and the presence of potential complications and/or contraindication(s). Treatment may include passive soft tissue stretching, oscillation of joints, and articular adjustments. In general, patients selected for MUA have generally undergone more conservative treatment and failed to improve, unless it is an urgent situation with a displaced vertebral fracture or long bone fracture. As such, in most cases, MUA is not a first line therapy for musculoskeletal conditions.

The treatment is typically performed in a hospital or surgery center with the assistance of an anesthesiologist. MUA can be performed under varying levels of anesthesia, including general anesthesia, conscious sedation, and local anesthesia. General anesthesia is the most complete form of anesthesia and requires intubation of the patient to help control their breathing and monitor their respiratory function. General anesthesia was more commonly used for MUA in the past, but its use for this procedure has declined notably over the last ten (10) years. Conscious sedation is an intermediary level of anesthesia where the patient is given intravenous or oral sedation that depresses the central nervous system. At this stage of anesthesia, a patient is conscious and does not require intubation. A patient under conscious sedation would not respond to mildly painful stimuli such as being pinched; however, they would respond to severely painful stimuli such as undergoing surgery. Proponents of MUA claim that conscious sedation allows for more patient feedback during treatment than general anesthesia. However, the use of conscious sedation does not allow for the same level of patient feedback as manipulation without any anesthesia. Local anesthesia is another option for MUA, though it is less frequently used than conscious sedation. A local anesthesia involves the injection of an anesthetizing substance at the site where the manipulation will be performed. In this type of anesthesia, the patient remains completely awake and aware of the procedure but sensations of pain are blocked in the specific area of manipulation. In addition, there are inherent risks to any type of anesthesia.

Comment on spinal MUA: while MUA of the spine may be considered professionally recognized by certain physician groups (e.g., chiropractors and osteopaths), it may also pose a health and safety risk greater than traditional high-velocity, low-amplitude (HVLA) manipulation for the spine in particular. The use of any anesthesia during joint manipulation does not allow the same level of patient feedback as manipulation without anesthesia. Patient feedback during manipulation is an important safeguard in the prevention of treatment related injury. Although safer than both general anesthesia and conscious sedation, local anesthesia is often considered inappropriate for MUA of the spine.

EVIDENCE REVIEW

Spine

Within the realm of chiropractic, spinal MUA is generally performed daily for 1 to 5 consecutive days on an outpatient basis, and is followed by a post-SMUA rehabilitation regimen, which entails 1 week of daily manipulation to maintain joint mobility and avoid re-adhesion of fibrotic tissue. Anesthesia is usually induced by intravenous Pentothal (sodium thiopental), and manipulation of the affected joints takes about 7 to 10 minutes.

An old randomized controlled trial by Siehl et al. (1971) evaluated MUA for patients with spinal nerve root compression. This study could not determine the benefits of MUA due to the design of the study, which would have required very large differences between groups to have significance.

To CQT for review 01/13/2025
CQT reviewed 01/13/2025
To QIC for review and approval 02/04/2025
QIC reviewed and approved 02/04/2025
To QOC for review and approval 02/20/2025
QOC reviewed and approved 02/20/2025

Review of the literature revealed numerous case series and reports that expounded the benefits of MUA (Aspegren et al., 1997; Ben-David et al., 1994; Cremata et al., 2005; Dreyfuss et al., 1995; Herzog, 1999; Maxwell et al., 1994; Tsai and Chou, 2005; West et al., 1999; Xiong et al., 1998). There were also two non-randomized studies evaluating the efficacy of MUA. Palmieri and Smoyak (2002) evaluated MUA versus traditional spinal manipulation in the treatment of low back pain, but their objectives were to evaluate methods useful for studying the procedure, not to determine the efficacy of MUA for spinal pain. Although more of the patients reported more improvement in pain with MUA, the intervention group received treatments other than MUA (e.g., physical therapy) that the control group did not receive. Due to the design and goal of this study, it is not possible to attribute the effects seen in the study to MUA. Kohlbeck et al. (2005) found that MUA offered benefits exceeding those of traditional spinal manipulation in chronic low back pain patients. However, this study has many limitations. The authors state that their pre-study analysis found that a sample size of 80 patients (half in each group) would be necessary to detect group differences similar to the differences they found, but their study was much smaller than this. In addition, patient selection protocols allowed patients to choose which therapy they would receive and all of those with the worst baseline pain chose to receive MUA. As such, the conclusions of this study cannot be taken to show that MUA is beneficial. Digiorgi (2013) states the evidence to support the efficacy of MUA of the spine remains largely anecdotal. There is a lack of high-quality evidence in the peer-reviewed medical literature of the effectiveness. Evidence of spinal manipulation under anesthesia consists primarily of case reports and uncontrolled case series. Limitations of current literature include small sample sizes, lack of random assignment, and limited evidence of long term benefit. Other issues include lack of detail regarding patient selection criteria, and differences in protocols reported in studies, making generalizations difficult. Guidelines from the American College of Occupational and Environmental Medicine (2007, 2008) and the Work Loss Data Institute (2011) state that spinal manipulation under anesthesia is not recommended. Colorado Division of Workers' Compensation’s guidelines on “Low back pain medical treatment” (2014) did not recommend MUA.

<u>Shoulder</u>

In a Cochrane review, Green et al. (2000) examined the effectiveness of common interventions for shoulder pain. Intervention of interest included NSAIDs, intra-articular or subacromial glucocorticosteroid injection, oral glucocorticosteroid treatment, physiotherapy, MUA, hydrodilatation, or surgery. The authors concluded that there is little evidence to support or refute the effectiveness of common interventions for shoulder pain. They stated that there is a need for further well-designed clinical trials to establish a uniform method of defining shoulder disorders. An updated review in 2007 was withdrawn. A systematic review in BMJ Clinical Evidence (Speed, 2006) found that MUA plus intra-articular injection is "likely to be beneficial" for persons with frozen shoulder. The conclusions were based upon the results of two randomized controlled trials (RCTs). One RCT (*n* = 30) found that, in people with adhesive capsulitis, MUA plus intra-articular hydrocortisone injection increased recovery rates compared with intra-articular hydrocortisone injection alone at 3 months (Thomas et al., 1980). Another, weaker RCT (*n* = 98) found limited evidence that subjects having MUA plus intra-articular saline injection versus manipulation alone or manipulation plus intra-articular injection of methylprednisolone had greater improvements in range of motion (ROM), pain relief, and return to normal activities (Hamdan and Al Essa, 2003). The review noted that potential adverse effects of MUA of the shoulder include intra-articular lesions within the glenohumeral joint (Speed, 2006).

Quraishi et al. (2007) assessed the outcome of MUA and hydrodilatation as treatments for adhesive capsulitis. A total of 36 patients (38 shoulders) were randomized to receive either method, with all patients being treated in stage II of the disease process. The visual analog scale (VAS) in the hydro dilatation group were significantly better than those in the MUA group over the 6-month follow-up period. The ROM improved in all patients over the 6 months but was not significantly different between the groups. At the final follow-up, 94% of patients (17 of 18) were satisfied or very satisfied after hydrodilatation compared with 81% (13 of 16) of those who received MUA. Most patients were treated successfully, but those undergoing hydrodilatation did better than those who underwent MUA. Kivimäki and colleagues (2007) examined the effect of MUA in patients with frozen shoulder. A blinded randomized trial with a 1-year follow-up was performed at 3 referral hospitals. A total of 125 patients with clinically verified frozen shoulder were randomly assigned to the manipulation group (*n* = 65) or control group (*n* = 60). Both the intervention group and the control group were instructed in specific therapeutic exercises by physiotherapists. Clinical data were gathered at baseline and at 6 weeks and 3, 6, and 12 months after randomization. The two groups did not differ at any time of the follow-up in terms of shoulder pain or working ability. Small differences in the ROM were detected favoring the manipulation group. Perceived shoulder pain decreased during follow-up equally in the 2 groups, and at 1 year after randomization, only slight pain remained. Authors concluded that manipulation under anesthesia does not add effectiveness to an exercise program performed by patients.

Flannery et al. (2007) examined the influence of timing of MUA for adhesive capsulitis of the shoulder on the long-term outcome. A total of 180 consecutive patients with a diagnosis of adhesive capsulitis were selected from a shoulder surgery database; 145 were available for follow-up after a mean period of 62 months (range of 12 to 125). All patients underwent MUA with intra-articular steroid injection. A statistically significant improvement in range of movement, function (Oxford Shoulder Score (OSS)) and VAS was obtained following manipulation. Ninety percent of the 145 patients who successfully completed the study were satisfied with the procedure; 89% indicated that they would choose the same procedure again if the same problem arose in the opposite shoulder. Eighty-three percent of the patients had MUA performed less than 9 months from onset of symptoms (early MUA). The remainder had MUA performed after 9 to 40 months (late MUA). Patients who had early intervention had a significantly better OSS at final follow-up. There was no significant difference for mobility and pain. Theodorides et al. (2014) aimed to evaluate and determine the factors that affect short- and long-term outcome following MUA of patients with adhesive capsulitis. In total, 295 patients (315 shoulders) were sequentially recruited, and information was collected at baseline, as well as at a mean follow-up of 28 days and 3.6 years. A significant improvement in OSS and ROM was noted 1 month post MUA with females benefiting more than males. Long-term follow-up revealed that the improvement in OSS was maintained. Secondary adhesive capsulitis significantly reduced the efficacy of MUA as assessed by ROM. Other factors (age, initial ROM and OSS, and length of symptoms prior to MUA) did not significantly affect the outcome over the short- or long-term. The findings of the present study show that all patient groups had a significantly improved ROM and OSS in the short-term with long-term maintenance of improved OSS. Woods and Loganathan (2017) aimed to address the issue of why not all patients benefit from MUA. Some have persistent or recurrent symptoms. There are no clear recommendations in the literature on the optimal management of recurrent frozen shoulder after a MUA. A total of 730 patients (792 shoulders) underwent MUA during the study period. A further MUA was undertaken in 141 shoulders (17.8%), for which we had complete data for 126. The mean improvement in OSS for all patients undergoing MUA was 16 (26 to 42), and the mean post-operative OSS in those requiring a further MUA was 14 (28 to 42. Improvement was seen after a further MUA, regardless both of the outcome of the initial MUA, and of the time of recurrence. Patients with type-1 diabetes mellitus were at a 38% increased risk of requiring a further MUA, compared with the 18% increased risk of the group as a whole. Authors concluded that patients with a poor outcome or recurrent symptoms of a frozen shoulder after a MUA should be offered a further MUA with the expectation of a good outcome and a low complication rate.

Rangan et al. (2020) compared these two surgical interventions with early structured physiotherapy plus steroid injection. In this multicentre, pragmatic, three-arm, superiority randomized trial, patients referred to secondary care for treatment of primary frozen shoulder were recruited from 35 hospital sites in the UK. Participants were adults (≥18 years) with unilateral frozen shoulder, characterised by restriction of passive external rotation (≥50%) in the affected shoulder. Participants were randomly assigned (2:2:1) to receive manipulation under anaesthesia, arthroscopic capsular release, or early structured physiotherapy. Both forms of surgery were followed by postprocedural physiotherapy. Early structured physiotherapy involved mobilisation techniques and a graduated home exercise programme supplemented by a steroid injection. Both early structured physiotherapy and postprocedural physiotherapy involved 12 sessions during up to 12 weeks. The primary outcome was the Oxford Shoulder Score (OSS). We sought a target difference of 5 OSS points between physiotherapy and either form of surgery, or 4 points between manipulation and capsular release. At 12 months, OSS data were available for 189 (94%) of 201 participants assigned to manipulation (mean estimate 38·3 points, 95% CI 36·9 to 39·7), 191 (94%) of 203 participants assigned to capsular release (40·3 points, 38·9 to 41·7), and 93 (94%) of 99 participants assigned to physiotherapy (37·2 points, 35·3 to 39·2). Eight serious adverse events were reported with capsular release and two with manipulation. Authors concluded that all mean differences on the assessment of shoulder pain and function (OSS) at the primary endpoint of 12 months were less than the target differences. Therefore, none of the three interventions were clinically superior. Arthoscopic capsular release carried higher risks, and manipulation under anaesthesia was the most cost-effective.

Brealey et al. (2020) compared the clinical effectiveness and cost-effectiveness of three treatments in secondary care for adults with frozen shoulder; to qualitatively explore the acceptability of these treatments to patients and health-care professionals; and to update a systematic review to explore the trial findings in the context of existing evidence for the three treatments. Participants were adults (aged ≥ 18 years) with unilateral frozen shoulder, characterised by restriction of passive external rotation in the affected shoulder to < 50% of the opposite shoulder, and with plain radiographs excluding other pathology. The interventions were early structured physiotherapy with a steroid injection, MUA with a steroid injection and arthroscopic capsular release followed by manipulation. Post-procedural physiotherapy followed both surgical interventions. The primary outcome and end point was the Oxford Shoulder Score at 12 months post randomization. A difference of five points was considered clinically important between early structured physiotherapy and MUA or arthroscopic capsular release. Similarly, a four-point difference between MUA and arthroscopic capsular release was considered significant. The mean age of the 503 participants was 54 years; 319 were female (63%) and 150 had diabetes (30%). The primary analyses comprised 473 participants (94%). At the primary end point of 12 months, participants randomized to arthroscopic capsular release had, on average, a statistically significantly higher (better) Oxford Shoulder Score than those randomized to MUA or early structured physiotherapy. MUA did not result in statistically significantly better Oxford Shoulder Score than early structured physiotherapy. No differences were deemed of clinical importance. Serious adverse events were rare but occurred in participants randomized to surgery (arthroscopic capsular release, n = 8; manipulation under anesthesia, n = 2). Participants in the qualitative study wanted early medical help and a quicker pathway to resolve their shoulder problem. Nine studies from the updated systematic review, including UK FROST, of which only two could be pooled, and found that arthroscopic capsular release was more effective than physiotherapy in the long-term shoulder functioning of patients, but not to the clinically important magnitude used in UK FROST. Authors concluded that none of the three interventions were clearly superior. Early structured physiotherapy with a steroid injection is an accessible and low-cost option. MUA is the most cost-effective option. Arthroscopic capsular release carries higher risks and higher costs.

Song et al. (2021) aimed to evaluate the effect of MUA with intra-articular steroid injection (ISI) or not on pain severity and function of the shoulder. Data on 141 patients receiving

MUA with primary frozen shoulder (FS) refractory to conservative treatments for at least 1 month were retrospectively obtained from medical records. Propensity score matching analysis was performed between patients receiving MUA only and those receiving MUA plus ISI, and then conducted logistic regression analysis to identify the risk factors for the need to other treatments during 6-month follow-up. More improvement in terms of the SPADI pain scores and passive ROM at 2 weeks after first intervention remained in patients receiving MUA plus ISI after matching. The need to other treatments during 6-month follow-up occurred in 10.6% patients (*n* = 141). Logistic regression analysis revealed that a repeat MUA 1 week after first intervention was a protective factor and duration of disease was the only one risk factor (OR 1.080; 95% CI 1.020-1.144; P = .008) for the need to other treatments during follow-up. ISI immediately following MUA provided additional benefits in rapid relief of pain and disability for patients with refractory FS. Authors suggest that pain and disability of the shoulder may be rapidly alleviated by an earlier MUA from the onset of the symptoms and a repeat MUA 1 week after first intervention.

Rex et al. (2021) includes a recently completed multicenter randomized controlled trial (RCT), UK FROST, in the context of existing randomized evidence for the management of primary frozen shoulder in a systematic review. UK FROST compared the effectiveness of pre-specified physiotherapy techniques with a steroid injection (PTSI), manipulation under anaesthesia (MUA) with a steroid injection, and arthroscopic capsular release (ACR). This review updates a 2012 review focusing on the effectiveness of MUA, ACR, hydrodilatation, and PTSI. Nine RCTs were included. The primary outcome of patient-reported shoulder function at long-term follow-up (> 6 months and ≤ 12 months) was reported for five treatment comparisons across four studies. Authors concluded that the findings from a recent multicentre RCT provided the strongest evidence that, when compared with each other, neither PTSI, MUA, nor ACR are clinically superior. Evidence from smaller RCTs did not change this conclusion. The effectiveness of hydrodilatation based on four RCTs was inconclusive and there remains an evidence gap.

Ko et al. (2021) aimed to assess how comorbidities influence the recovery speed and clinical outcomes after MUA. Between April 2013 and September 2018, 281 consecutive primary stiff shoulders in the frozen phase treated with MUA were included in this study. They investigated the comorbidities of patients and divided them into the control (*n* = 203), diabetes mellitus (DM) (*n* = 32), hyperlipidemia (*n* = 26), and thyroid disorder (*n* = 20) groups. The range of motion (ROM) and clinical scores for each group before MUA and 1 week, 6 weeks, and 3 months after MUA were comparatively analyzed. They identified the ROM recovery time after MUA and the responsiveness to MUA. Then, subjects were subdivided into early and late recovery groups based on their recovery time and into successful and nonsuccessful MUA groups based on their responsiveness to MUA. Significant improvements in ROM and clinical scores at 3 months after MUA were observed in all groups. Significant differences in ROM among the 4 groups were also observed during follow-up (P < .05). The DM group had significantly lower ROM values, even at 3 months after MUA, compared with the control group. The ROM recovery speed after MUA was slowest in the DM group, followed by the thyroid disorder, hyperlipidemia, and control groups. Most (90.6%) of the DM group experienced late recovery. The proportion of nonsuccessful MUA was higher in the DM and thyroid disorder groups than that in the control and hyperlipidemia groups (P = .004). During follow-up, there were no differences among groups regarding the visual analog scale, University of California at Los Angeles shoulder, and Constant scores. Authors concluded that the ROM recovery speed and responsiveness to MUA for primary stiff shoulder were poorer for the DM and thyroid disorder groups than for the control group. In particular, compared with any other disease, outcomes were poorer when the comorbidity was DM. If patients have comorbidities, then they should be informed before MUA that the comorbidity could affect the outcomes of treatment.

Salomon et al. (2022) investigated the efficacy of manipulation under anesthesia (MUA) compared to other non-surgical therapeutic strategies for patients with frozen shoulder contracture syndrome (FSCS). Five randomized controlled trials were included. The overall risk of bias (RoB) was high in 4 out of 5 of the included studies. MUA was found to be not superior in terms of reduction of pain and improvement of function when compared to cortisone injections with hydrodilatation and home exercise in the short term (3 months), and cortisone injections with hydrodilatation in the long term (>6 months). Moreover, if compared to structured physiotherapy, MUA highlighted a higher Oxford Shoulder Score at final 1-year follow up. Similar results were obtained for disability, with statistically no significant long-term differences between MUA and home exercise or structured physiotherapy. Only two trials reported adverse events. This review suggested that limited and inconsistent evidence currently exists on the efficacy of MUA compared to other non-surgical strategies in the management of patients with FSCS. Future research should focus on clinical trials with higher methodological quality.

Kraal et al. (2023) evaluated the effectiveness of MUA followed by a physiotherapy (PT) program compared to a PT program alone in patients with stage 2 Frozen Shoulder (FS). Frozen shoulder (FS) is a common cause of shoulder pain and stiffness. Conservative treatment is sufficient for the majority of patients with long-term recovery of shoulder function. Manipulation under anesthesia (MUA) is known as a well-established treatment option if conservative treatment fails. It is unknown whether MUA does indeed shorten the duration of symptoms or leads to a superior outcome compared to conservative treatment. For this study, patients between 18 and 70 years old with stage 2 FS were deemed eligible if an initial course of conservative treatment consisting of PT and intra-articular corticosteroid infiltration was considered unsatisfactory. MUA was performed by a single surgeon under interscalene block, and intensive PT treatment protocol was started within 4 hours after MUA. In the PT group, patients were referred to instructed physiotherapist, and treatment was guided by tissue irritability. The primary outcome was the Shoulder

Pain and Disability Index (SPADI) score. Secondary outcomes were pain, range of motion (ROM), Oxford Shoulder Score, quality of life, and ability to work. In total, 82 patients were included, 42 in the PT group and 40 in the MUA group. There was a significant improvement in SPADI, Oxford Shoulder Score, pain, ROM, and quality of life in both groups at 1-year follow-up. SPADI scores at three months were significantly improved in favor of MUA. MUA showed a significantly bigger increase in flexion and abduction compared to PT at all points of follow-up. No significant differences between both groups were found for all other parameters. No fractures, dislocations, or brachial plexus injuries occurred in this trial. Authors concluded that MUA in stage 2 FS can be considered safe and results in a faster recovery of ROM and improved functional outcome, measured with SPADI scores, compared to PT alone in the short term. After 1 year, except for slightly better ROM scores for MUA, the result of MUA is equal to PT.

<u>Knee</u>

MUA is indicated, with or without arthroscopy for arthrofibrosis of the knee (i.e., post ACL reconstruction), when there is <90° range of motion following surgery or trauma despite physical therapy (Magit et al., 2007). Manipulation under anesthesia has also been used to treat fibroarthrosis following total knee replacement. Following total knee arthroplasty, some patients who fail to achieve greater than 90 degrees of flexion in the early peri-operative period may be considered candidates for MUA of the knee. Manipulation under anesthesia is indicated in total knee arthroplasty having less than 90 degrees ROM 4 to 12 weeks following surgery, with no progression or regression in ROM (Pariente et al., 2006; Magit et al., 2007). Keating et al. (2007) assessed the outcomes of manipulation following total knee arthroplasty. A total of 113 knees in 90 patients underwent manipulation for post-operative flexion of less than or equal to 90 degrees at a mean of 10 weeks after surgery. Eighty-one (90%) of the 90 patients achieved improvement of ultimate knee flexion following manipulation. The average improvement in flexion from the measurement made before manipulation to that recorded at the 5-year follow-up was 35 degrees. The investigators reported that there was no significant difference in the mean improvement in flexion when patients who had manipulation within 12 weeks post-operatively were compared with those who had manipulation more than 12 weeks post-operatively. Patients who eventually underwent manipulation had significantly more pain than those who had not had manipulation. The investigators concluded that manipulation generally increases final flexion following total knee arthroplasty. They noted that patients with severe pre-operative pain are more likely to require manipulation.

Sassoon et al. (2015) investigated the results of closed manipulations performed under anesthesia (MUA) to evaluate whether it is an effective means to treat posttraumatic knee arthrofibrosis. Twenty-two patients with a mean age of 40 underwent closed MUA for posttraumatic knee arthrofibrosis. Injuries included fractures of the femur, tibia, and patella as well as ligamentous injuries and traumatic arthrotomies. The mean time from treatment to manipulation was 90 days. Mean follow-up after manipulation was 7 months. The mean premanipulation ROM arc was 59 ± 25 degrees. The mean intraoperative arc of motion, achieved at the time of the manipulation was 123 ± 14 degrees. No complications occurred during the MUA procedure. At the most recent follow-up, the mean ROM arc was 110 ± 19 degrees. Tobacco use, associated injuries, elevated body mass index, open fracture, and advanced age did not impact manipulation efficacy. Additionally, manipulations performed 90 days or more after surgical treatment provided a benefit equaling those performed more acutely. Authors concluded that MUA is a safe and effective method to increase knee ROM in the setting of posttraumatic arthrofibrosis. Improvement in ROM was noted in all patients.

Ekhtiari et al. (2017) reviewed the literature to: (a) describe existing definitions of arthrofibrosis, and (b) characterize the management strategies and outcomes of arthrofibrosis treatment in patients post ACL reconstruction. Twenty-five studies of primarily level IV evidence (88%) were included. A total of 647 patients with a mean age of 28.2 ± 1.8 years (range 14-62 years) were treated for arthrofibrosis following ACL reconstruction and followed for a mean 30.1 ± 16.9 months (range 2 months-9.6 years). Definitions of arthrofibrosis varied widely and included subjective definitions and the Shelbourne classification system. Patients were treated by one or more of: arthroscopic arthrolysis (570 patients), MUA (153 patients), oral corticosteroids (31 patients), physiotherapy (81 patients), drop-casting (17 patients), epidural therapy combined with inpatient physiotherapy (6 patients), and intra-articular interleukin-1 antagonist injection (4 patients). All studies reported improvement in range of motion post-operatively, with statistically significant improvement reported for 306 patients (6 studies, p range <0.001 to =0.05), and one study (18 patients) reporting significantly better results if arthrofibrosis was treated within 8 months of reconstruction ($p < 0.03$). The greatest improvements for extension loss were seen with drop-casting (mean 6.2° ± 0.6° improvement), whereas MUA produced the greatest improvement for flexion deficit (mean 47.8° ± 3.3° improvement). Gu et al. (2018) performed a systematic review of the literature was performed to identify studies that reported clinical outcomes for patients who underwent MUA for post-operative stiffness treatment. Repeat MUA procedures were included in the study but were analyzed separately. Twenty-two studies (1,488 patients) reported on ROM after MUA, and 4 studies (81 patients) reported ROM after repeat MUA. All studies reported pre-MUA motion of less than 90°, while mean ROM at last follow-up exceeded 90° in all studies except two. For studies reporting ROM improvement following repeat MUA, the mean pre-manipulation ROM was 80° and the mean post-manipulation ROM was 100.6°.

Authors concluded that MUA remains an efficacious, minimally invasive treatment option for post-operative stiffness following total knee arthroplasty (TKA). MUA provides clinically significant improvement in ROM for most patients, with the best outcomes occurring in patients treated within 12 weeks post-operatively. Neuman et al. (2018) completed a study on risk factors, outcomes, and timing of MUA after TKA. Clinical variables were compared between patients who underwent MUA and those who did not; variables that differed were utilized to identify an appropriately matched control group of non-MUA patients. The MUA group was divided into early (MUA ≤6 weeks from index) and late (>6 weeks) subgroups. Flexion values at multiple time points were compared. In total, 1,729 TKA patients were reviewed; MUA was performed in 62 patients. TKA patients undergoing MUAs were younger, more likely to be current smokers, and more likely to have undergone prior knee surgery. Even in patients with severe initial postoperative limitations in ROM, MUA within 6 weeks may allow for final outcomes that are equivalent to those experienced by similar patients not requiring manipulation.

Archunan et al. (2021) aimed to ascertain the prevalence, determine the influencing factors, and evaluate the efficacy of MUA as a treatment option. For the study, stiffness was defined as flexion contracture of >15 degrees and/or flexion of <75 degrees. Demographic data included co-morbidities, previous knee surgery, pre-operative and post-operative ROM, anesthetic techniques and use of nerve blocks, type of prosthesis, ligament balancing including release, mobility post-surgery, patient motivation, physiotherapy, complications, and final ROM post-MUA. Of the 1,350 patients evaluated, 33 (2.44%) had stiffness defined by the above-outlined criteria and required intervention. Thirty-one patients underwent MUA as a first-line treatment. No complications arose following MUA. One patient (0.07%) required arthroscopic arthrolysis while another patient (0.07%) required revision arthroplasty due to patellar maltracking. Following manipulation, mean flexion contracture decreased from 8 degrees to 3.6 degrees, and mean flexion improved from 51.8 degrees to 93.2 degrees. Arc of motion improved in 100% of patients but it is important to note that multiple manipulations were performed in seven patients. Authors concluded that stiffness after TKA can be difficult to treat and can result in prolonged morbidity and dissatisfaction. This retrospective study highlights the effectiveness of MUA as a first-line treatment option leading to improved outcomes especially if done early.

Sala et al. (2022) completed a retrospective study determined the outcome of MUA and identified the factors affecting it. The final sample consisted of 150 MUAs performed on 145 patients. The parameters of interest were ROM and Knee Society Score (KSS) or Oxford Knee Score (OKS). The mean of 26° gain in flexion and the mean of 3° gain in extension were noticed at post-MUA follow-up when compared with the ROM preceding MUA. The mean post-MUA-FU flexion was 99° and the mean post-MUA-FU extension deficit was 4°. KSS (121 vs. 129) and OKS (29 vs. 28) were similar before and after MUA. The early timing of MUA was associated with better gain in flexion -0.04, while we found no association between the timing of MUA and flexion after MUA -0.004. High BMI was associated with better gain in flexion 0.8. Authors found that ROM improved substantially after MUA. The gain in flexion decreased as the time between TKA and MUA increased. DeFrance et al. (2022) sought to determine whether MUA was associated with an increase in the rate of revision TKA within 2 years of MUA. A total of 49,310 patients within a single institution who underwent primary TKA were identified from 1999 to 2019. Data were matched at a 1:3 ratio (TKA with and without MUA, respectively) based on age, sex, and body mass index. A matched comparison cohort was conducted, with the MUA cohort having 575 patients and the no MUA cohort having 1,725 patients. A statistically significant increase in the rate of noninfectious etiology revision TKA was found in the MUA cohort (7.3%) compared with the no MUA cohort (4.9%; P=.034). The most common reason for revision TKA after MUA was persistent stiffness, including arthrofibrosis and ankylosis; however, aseptic loosening, ligamentous instability, and periprosthetic fracture were found to be responsible for 21.4% of revision TKA procedures. Although MUA is a commonly performed procedure for treating stiffness after primary TKA, the orthopedic surgeon should counsel patients on the association of increased rate of revision TKA after MUA, most commonly, persistent stiffness.

Haffar et al. (2022) performed a systematic review to compare the outcomes of manipulation under anaesthesia (MUA), arthroscopic lysis of adhesions (aLOA), and revision TKA (rTKA) for arthrofibrosis and stiffness following TKA. A total of 40 studies were included: 21 on rTKA, 7 on aLOA, and 14 on MUA. The mean or median post-operative arc ROM was > 90° in 6/20 (30%) rTKA, 5/7 (71%) aLOA, and 7/10 (70%) MUA studies. Post-operative Knee Society (KSS) clinical and functional scores were the greatest in patients who underwent MUA and aLOA. As many as 43% of rTKA patients required further care compared to 25% of aLOA and 17% of MUA patients. Authors concluded that stiffness following TKA remains a challenging condition to treat. Nonetheless, current evidence suggests that patients who undergo rTKA have poorer clinical outcomes and a greater need for further treatment compared to patients who undergo MUA or aLOA.

Thomas et al. (2023) compared the 2-year complication rates of arthroscopic lysis of adhesions (ALA) and MUA and range-of-motion (ROM) outcomes for ALA, early MUA (<3 months after TKA), and delayed MUA (>3 months after TKA). This retrospective cohort study included 425 patients undergoing ALA or MUA after primary TKA from 2001 to 2018. Demographics, clinical variables, and complication rates were collected from clinical records. ALA patients were younger (55.2 versus 58.9 years, P < 0.001) and underwent surgery later from the index TKA (12 versus 1.9 months, P < 0.001). The Charlson Comorbidity Index was higher in the MUA group. Preoperative ROM was significantly worse in the MUA cohort but did not differ between groups after the procedure or at 2 years. Demographics and ROM outcomes were equivalent between early MUA and delayed MUA. The incidence of repeat arthrofibrosis (7.1%) and revision arthroplasty (2.4%) was similar between ALA and MUA cohorts while ALA patients had significantly more surgical site infections (3.8%) compared with MUA patients (0.47%, P = 0.017). Equivalent ROM outcomes were seen between ALA, early MUA, and delayed MUA for the treatment of arthrofibrosis after TKA. However, this study demonstrated a markedly higher complication rate, particularly surgical site infection, after ALA, suggesting that MUA may be the preferred option for treating arthrofibrosis at both early and late time points.

Akhtar et al. (2024) evaluated the functional and clinical outcomes of early versus delayed MUA for stiffness following TKA. Stiffness following TKA is often treated with MUA. However, there is debate regarding the timing of MUA, with many recommending against MUA beyond 3 months after TKA. Included were 14 studies analyzing 13,445 knees, 72.1% of which underwent early MUA and 27.8% of which underwent delayed MUA. Of the 14 studies, 10 defined early MUA as being performed within 3 months of the index TKA. Pre-MUA and post-MUA knee flexion for the early/delayed groups was 71.3°/77.9° and 103.0°/96.1°, respectively. Upon meta-analysis, pre-MUA knee flexion was significantly higher in the delayed group, whereas post-MUA flexion was similar in both groups. The mean gain in knee flexion for the early and delayed groups was 32.0°/19.2°. The surgical complication and revision TKA rates for the early and delayed groups were 4.9%/10.3% and 5%/9%, respectively. A meta-analysis found the risk of surgical or medical complications and revision TKA to be significantly higher in the delayed MUA group. Authors concluded that although post-MUA knee flexion was similar in patients undergoing early and delayed MUA following TKA, the mean gain in flexion for early patients was nearly double that of delayed patients. Delayed patients also had significantly higher risks of surgical or medical complications and revision TKA following MUA.

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. Arthrofibrosis is a multifactorial process that results in decreased knee range of motion (ROM). Manipulation under anesthesia (MUA) is commonly regarded as the preferred initial treatment of arthrofibrosis following total knee arthroplasty (TKA). There have been no well-controlled studies demonstrating that MUA effectively increases ROM in patients who develop arthrofibrosis after TKA when compared with routine care. 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 mo postoperatively) MUA for the treatment of knee arthrofibrosis in adolescent patients. Authors hypothesized that early MUA could restore normal knee motion with a low complication rate and without the need for more invasive intervention. In a retrospective review, 57 patients who underwent MUA for postoperative knee arthrofibrosis were identified. 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.

Fracture and/or Dislocation

MUA is also considered a well-established and successful treatment for some types of fractures (e.g., vertebral, long bones) and acute/traumatic dislocations (e.g., perched cervical facet). It is typically performed with surgical repair and other medically necessary procedures such as arthroscopy. When performed in this context, MUA is considered incidental to the base procedure.

Chronic Joint Contracture

A joint contracture is a limitation in the passive range of motion of a joint. Joint contractures prevent normal movement of the associated body part and can result from a variety of causes such as spasticity or prolonged immobilization. Intra-articular adhesions and peri-articular adhesions, as well as capsular, ligament and muscle shortening, and tightness may develop. As a result, activities of daily living and other functions may be adversely affected due to the decreased mobility. In many cases, contractures can be successfully treated nonoperatively with aggressive physical therapy or splinting with restoration of functional range of motion. When conservative treatment fails more aggressive treatment may necessary and includes anesthetic block, maximal stretching, and in some cases, serial casting (Garden, 2002). For joint contracture deformities, extra-articular and intra-articular soft tissue releases are considered standard treatment (Paley, 2003). Surgical treatments include tenotomy, tendon lengthening and joint capsule release. Manipulation under anesthesia, involving maximal passive stretching may be considered standard treatment and is often performed in combination with serial casting and/or surgical release when less aggressive treatments have failed.

Elbow

Published peer reviewed supporting the safety and effectiveness of using manipulation under anesthesia of the elbow is limited to retrospective case series, involve small sample populations and lack control groups (Araghi et al., 2012; Tan. Et al., 2006; Chao et al., 2002; Gaur et al., 2003). Few studies support clinical effectiveness for the treatment of joint stiffness/fibrosis when other conservative measures, such as bracing and splinting, have failed to improve range of motion. There is insufficient evidence in the peer-reviewed published literature and lack of consensus among professional societies to support the effectiveness of MUA as treatment for arthrofibrosis of the elbow. Spitler et al. (2018) evaluated the safety and efficacy of manipulation under anesthesia (MUA) for posttraumatic elbow stiffness. Comparison of improvement between the early and late MUA groups found a significant difference ($P < 0.001$) in mean flexion arc improvement from premanipulation to postmanipulation, favoring the early group. Authors concluded that MUA is a safe and effective adjunct to improving motion in posttraumatic elbow stiffness when used within 3 months from the original injury or time of surgical fixation. After 3 months, MUA does not reliably increase elbow motion.

TMJ

Available evidence for MUA for temporomandibular joint syndrome is limited to small, uncontrolled studies with limited follow-up. Foster et al. (2000) conducted an uncontrolled prospective study of manipulation of the temporomandibular joint under anesthesia. The investigators reported that of the 55 patients available for participation in this study, 15 improved, 15 did not, 6 showed partial improvement, and 19 were not treated. The median pre-treatment opening was 20 mm (range of 13 to 27). Among those who improved after manipulation, the median opening after treatment was 38 mm (range of 35 to 56). The investigators reported that some of those who improved experienced a return of TMJ clicking but not of joint or muscle tenderness. There is insufficient evidence in the peer-reviewed published literature to support the effectiveness of MUA as treatment for TMJ syndrome.

Other Joints and Conditions

Evidence in the medical literature evaluating the use of MUA for management of pain conditions involving one or more (i.e., multiple joints, whole body MUA) of other major joints such as the hip, ankle, toe, elbow, and wrist, is lacking. Due to insufficient evidence conclusions cannot be made regarding the clinical utility or safety and efficacy of MUA involving other single or multiple joints for pain management. There is a paucity of evidence supporting the use of MUA for the treatment of disorders of other body joints such as the hip, ankle, knee, and wrist.

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 and whether the services are within their scope of practice.

It is best practice for the practitioner to appropriately render services to a member 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 training, it would be best practice to refer the member 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)* policy for information.

References

Akhtar M, Razick D, Seibel A, Asad S, Shekhar A, Shelton T. Outcomes of Early Versus Delayed Manipulation Under Anesthesia for Stiffness Following Total Knee Arthroplasty: A Systematic Review and Meta-Analysis. J Arthroplasty. 2024;39(11):2872-2879. doi:10.1016/j.arth.2024.05.059

Araghi A, Celli A, Adams R, Morrey B. The outcome of examination (manipulation) under anesthesia on the stiff elbow after surgical contracture release. Shoulder Elbow Surg. 2010 Mar;19(2):202-8

Archunan M, Swamy G, Ramasamy A. Stiffness After Total Knee Arthroplasty: Prevalence and Treatment Outcome. Cureus. 2021;13(9):e18271. Published 2021 Sep 25

Aspegren, D. D., Wright, R. E., & Hemler, D. E. (1997). Manipulation under epidural anesthesia with corticosteroid injection: two case reports. *Journal of Manipulative and Physiological Therapeutics*, *20*(9), 618-621

Ben-David, B., & Raboy, M. (1994). Manipulation under anesthesia combined with epidural steroid injection. *Journal of Manipulative and Physiological Therapeutics*, 17(9), 605-609

Brealey S, Northgraves M, Kottam L, Keding A, Corbacho B, Goodchild L, Srikesavan C, Rex S, Charalambous CP, Hanchard N, Armstrong A, Brooksbank A, Carr A, Cooper C, Dias J, Donnelly I, Hewitt C, Lamb SE, McDaid C, Richardson G, Rodgers S, Sharp E, Spencer S, Torgerson D, Toye F, Rangan A. Surgical treatments compared with early structured physiotherapy in secondary care for adults with primary frozen shoulder: the UK FROST three-arm RCT. Health Technol Assess. 2020 Dec;24(71):1-162. Doi: 10.3310/hta24710. PMID: 33292924; PMCID: PMC7750869

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

Buchalter D, Schaffler BC, Manjunath A, et al. Stiffness After Total Knee Arthroplasty A Review. Bull Hosp Jt Dis (2013). 2024;82(1):15-20

Chao EK, Chen AC, Lee MS, Ueng SW. Surgical approaches for nonneurogenic elbow heterotopic ossification with ulnar neuropathy. J Trauma. 2002 Nov;53(5):928-33

Cremata, E., Collins, S., Clauson, W., Solinger, A. B., & Roberts, E. S. (2005). Manipulation under anesthesia: a report of four cases. *Journal of Manipulative and Physiological Therapeutics, 28*(7), 526-533

DeFrance MJ, Cheesman QT, Hameed D, DiCiurcio WT, Harrer MF. Manipulation Under Anesthesia Is Associated With an Increased Rate of Early Total Knee Arthroplasty Revision. Orthopedics. 2022;45(5):270-275. Doi:10.3928/01477447-20220608-01

Digiorgi D. Spinal manipulation under anesthesia: a narrative review of the literature and commentary. Chiropr Man Therap. 2013 May 14;21(1):14

Dodenhoff RM, Levy O, Wilson A, Copeland SA. Manipulation under anesthesia for primary frozen shoulder: effect on early recovery and return to activity. J Shoulder Elbow Surg. 2000;9:23–6

Dreyfuss, P., Michaelsen, M., & Horne, M. (1995). MUJA: manipulation under joint anesthesia/analgesia: a treatment approach for recalcitrant low back pain of synovial joint origin. *Journal of Manipulative and Physiological Therapeutics*, *18*(8), 537-546

ECRI. (2003). Manipulation Under Anesthesia for Low-Back Pain. *Health Technology Assessment Information Service: Windows on Medical Technology*, 1-33

Ekhtiari S, Horner NS, de Sa D, et al. Arthrofibrosis after ACL reconstruction is best treated in a step-wise approach with early recognition and intervention: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2017;25(12):3929-3937

Fitzsimmons SE, Vazquez EA, Bronson MJ. How to treat the stiff total knee arthroplasty?: a systematic review. Clin Orthop Relat Res. 2010 Apr;468(4):1096-106

Flannery O, Mullett H, Colville J. Adhesive shoulder capsulitis: Does the timing of manipulation influence outcome? Acta Orthop Belg. 2007;73(1):21-25

Gaur A, Sinclair M, Caruso E, Peretti G, Zaleske D. Heterotopic ossification around the elbow following burns in children: results after excision. J Bone Joint Surg Am. 2003 Aug;85-A(8):1538-43

Ghani H, Maffulli N, Khanduja V. Management of stiffness following total knee arthroplasty: A systematic review. Knee. 2012 Apr 23

Gordon, R. C. (2001). An evaluation of the experimental and investigational status and clinical validity of manipulation of patients under anesthesia: a contemporary opinion. *Journal of Manipulative and Physiological Therapeutics*, *24*(9), 603-611

Gordon R, Cremata E, Hawk C. Guidelines for the practice and performance of manipulation under anesthesia. Chiropr Man Therap. 2014 Feb 3;22(1):7

Green S, Buchbinder R, Glazier R, Forbes A. Interventions for shoulder pain. Cochrane Database Syst Rev. 2000;(2):CD001156. Review. Update in: Cochrane Database Syst Rev. 2006;(4):CD001156

Greenman, P. E. (1992). Manipulation with the patient under anesthesia. *The Journal of the American Osteopathic Association*, *92*(9), 1159-1160, 1167-1170

Gu A, Michalak AJ, Cohen JS, Almeida ND, McLawhorn AS, Sculco PK. Efficacy of Manipulation Under Anesthesia for Stiffness Following Total Knee Arthroplasty: A Systematic Review. J Arthroplasty. 2018 May;33(5):1598-1605

Haffar A, Goh GS, Fillingham YA, Torchia MT, Lonner JH. Treatment of arthrofibrosis and stiffness after total knee arthroplasty: an updated review of the literature. Int Orthop. 2022;46(6):1253-1279. Doi:10.1007/s00264-022-05344-x

Haldeman, S., Chapman-Smith, D., & Petersen, D., Jr. (1993). *Guidelines for Chiropractic Quality Assurance and Practice Parameters: Proceedings of the Mercy Center Consensus Conference*

Hamdan TA, Al-Essa KA. Manipulation under anaesthesia for the treatment of frozen shoulder. Int Orthop. 2003;27(2):107-9. Epub 2002 Sep 13

Herzog, J. (1999). Use of cervical spine manipulation under anesthesia for management of cervical disk herniation, cervical radiculopathy, and associated cervicogenic headache syndrome. *Journal of Manipulative and Physiological Therapeutics*, *22*(3), 166-170

Hughes, B. L. (1993). Management of cervical disk syndrome utilizing manipulation under anesthesia. *Journal of Manipulative and Physiological Therapeutics*, *16*(3), 174-181

Hyman, S. A., Rogers, W. D., & Bullington, J. C., 3rd. (1990). Cervical osteotomy and manipulation in ankylosing spondylitis: successful general anesthesia after failed local anesthesia with sedation. *Journal of Spinal Disorders*, *3*(4), 423-426

Ipach I, Mittag F, Lahrmann J, Kunze B, Kluba T. Arthrofibrosis after TKA - Influence factors on the absolute flexion and gain in flexion after manipulation under anaesthesia. BMC Musculoskelet Disord. 2011 Aug 12;12:184

Issa K, Banerjee S, Kester MA, Khanuja HS, Delanois RE, Mont MA. The effect of timing of manipulation under anesthesia to improve range of motion and functional outcomes following total knee arthroplasty. J Bone Joint Surg Am. 2014 Aug 20;96(16):1349-57

Issa K, Kapadia BH, Kester M, Khanuja HS, Delanois RE, Mont MA. Clinical, objective, and functional outcomes of manipulation under anesthesia to treat knee stiffness following total knee arthroplasty. J Arthroplasty. 2014 Mar;29(3):548-52

Keating EM, Ritter MA, Harty LD, Haas G, Meding JB, Faris PM, Berend ME. Manipulation after total knee arthroplasty. J Bone Joint Surg Am. 2007 Feb;89(2):282-6

Kivimäki J, Pohjolainen T, Malmivaara A, et al. Manipulation under anesthesia with home exercises versus home exercises alone in the treatment of frozen shoulder: A randomized, controlled trial with 125 patients. J Shoulder Elbow Surg. 2007;16(6):722-726

Ko YW, Park JH, Youn SM, Rhee YG, Rhee SM. Effects of comorbidities on the outcomes of manipulation under anesthesia for primary stiff shoulder. J Shoulder Elbow Surg. 2021;30(8):e482-e492

Kohlbeck, F. J., Haldeman, S., Hurwitz, E. L., & Dagenais, S. (2005). Supplemental care with medication-assisted manipulation versus spinal manipulation therapy alone for patients with chronic low back pain. *Journal of Manipulative and Physiological Therapeutics, 28*(4), 245-252

Kraal T, de Wit Y, The B, et al. Improved range of motion after manipulation under anesthesia versus physiotherapy for stage two frozen shoulder: a randomized controlled trial. JSES Int. 2023;8(2):293-298. Published 2023 Dec 6

Lee, A. S., MacLean, J. C., & Newton, D. A. (1994). Rapid Traction for Reduction of Cervical Spine Dislocation. *Journal of Bone and Joint Surgery*: *Britain*, *76*(B), 352-356

Magit D, Wolff A, Sutton K, Medvecky MJ. Arthrofibrosis of the knee. J Am Acad Orthop Surg. 2007 Nov;15(11):682-94

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

Maund E, Craig D, Suekarran S, Neilson A, Wright K, Brealey S, Dennis L, Goodchild L, Hanchard N, Rangan A, Richardson G, Robertson J, McDaid C. Management of frozen shoulder: a systematic review and cost-effectiveness analysis. Health Technol Assess. 2012;16(11):1-264.

Maxwell, H. A., & Turner, P. G. (1994). Dislocation of the Austin Moore hemiarthroplasty: is closed manipulation justified? *Journal of the Royal Colleges of Surgeons of Edinburgh and Ireland*, *39*(6), 370-371

Mohammed R, Syed S, Ahmed N. Manipulation under anesthesia for stiffness following knee arthroplasty. Ann R Coll Surg Engl. 2009 Apr;91(3):220-3

Namba RS, Inacio M. Early and late manipulation improve flexion after total knee arthroplasty. J Arthroplasty. 2007 Sep;22(6 Suppl 2):58-61

Newman ET, Herschmiller TA, Attarian DE, Vail TP, Bolognesi MP, Wellman SS. Risk Factors, Outcomes, and Timing of Manipulation Under Anesthesia After Total Knee Arthroplasty. J Arthroplasty. 2018 Jan;33(1):245-249

Palmieri, N. F., & Smoyak, S. (2002). Chronic low back pain: a study of the effects of manipulation under anesthesia. *Journal of Manipulative and Physiological Therapeutics*, *25*(8), E8-E17

Pivec R, Issa K, Kester M, Harwin SF, Mont MA. Long-term outcomes of MUA for stiffness in primary TKA. Knee Surg. 2013 Dec;26(6):405-10

Quraishi NA, Johnston P, Bayer J, et al. Thawing the frozen shoulder. A randomised trial comparing manipulation under anaesthesia with hydrodilatation. J Bone Joint Surg Br. 2007;89(9):1197-1200

Randsborg PH, Tajet J, Negård H, Røtterud JH. Manipulation under Anesthesia for Stiffness of the Knee Joint after Total Knee Replacement. Arthroplast Today. 2020 Jun 28;6(3):470-474

Rangan A, Brealey SD, Keding A, Corbacho B, Northgraves M, Kottam L, Goodchild L, Srikesavan C, Rex S, Charalambous CP, Hanchard N, Armstrong A, Brooksbank A, Carr A, Cooper C, Dias JJ, Donnelly I, Hewitt C, Lamb SE, McDaid C, Richardson G, Rodgers S, Sharp E, Spencer S, Torgerson D, Toye F; UK FROST Study Group. Management of adults with primary frozen shoulder in secondary care (UK FROST): a multicentre, pragmatic, three-arm, superiority randomised clinical trial. Lancet. 2020 Oct 3;396(10256):977-989. doi: 10.1016/S0140-6736(20)31965-6

Rex SS, Kottam L, McDaid C, et al. Effectiveness of interventions for the management of primary frozen shoulder : a systematic review of randomized trials. Bone Jt Open. 2021;2(9):773-784

Sala J, Jaroma A, Sund R, Huopio J, Kröger H, Sirola J. Manipulation under anesthesia after total knee arthroplasty: a retrospective study of 145 patients. Acta Orthop. 2022;93:583-587. Published 2022 Jun 21. doi:10.2340/17453674.2022.3167

Salomon M, Pastore C, Maselli F, Di Bari M, Pellegrino R, Brindisino F. Manipulation under Anesthesia versus Non-Surgical Treatment for Patients with Frozen Shoulder Contracture Syndrome: A Systematic Review. Int J Environ Res Public Health. 2022;19(15):9715. Published 2022 Aug 7. doi:10.3390/ijerph19159715

Sheridan MA, Hannafin JA. Upper extremity: emphasis on frozen shoulder. Orthop Clin North Am. 2006 Oct;37(4):531-9

Siehl, D., & Bradford, W. (1952). Manipulation of the low Back under General Anesthesia. *Journal of the American Osteopathic Association*, *52*(4), 239-242

Siehl, D., Olson, D. R., Ross, H. E., & Rockwood, E. E. (1971). Manipulation of the lumbar spine with the patient under general anesthesia: evaluation by electromyography and clinical-neurologic examination of its use for lumbar nerve root compression syndrome. *Journal of the American Osteopathic Association, 70*(5), 433-440

Song C, Song C, Li C. Outcome of manipulation under anesthesia with or without intra-articular steroid injection for treating frozen shoulder: A retrospective cohort study. Medicine (Baltimore). 2021;100(13):e23893

Speed C. Shoulder pain. In: BMJ Clinical Evidence. London, UK: BMJ Publishing Group; February 2006

Spitler CA, Doty DH, Johnson MD, Nowotarski PJ, Kiner DW, Swafford RE, Jemison DM. Manipulation Under Anesthesia as a Treatment of Posttraumatic Elbow Stiffness. J Orthop Trauma. 2018 Aug;32(8):e304-e308

Tan V, Daluiski A, Simic P, Hotchkiss RN . Outcome of open release for post-traumatic elbow stiffness. J Trauma 2006 Sep:6(13);673-8

Theodorides AA, Owen JM, Sayers AE, Woods DA. Factors affecting short- and long-term outcomes of manipulation under anaesthesia in patients with adhesive capsulitis of the shoulder. Shoulder Elbow. 2014 Oct;6(4):245-56.Tsai, S. W., & Chou, C. S. (2005). A case report of manipulation under anesthesia of posttraumatic type II occipital-atlantoaxial rotatory subluxation in a 4-year-old girl. *Journal of Manipulative and Physiological Therapeutics*, *28*(5), 352-355

Thomas NP, Liu C, Varady N, Iban YC, Schwab PE, Chen AF. High Complication Rate Associated With Arthroscopic Lysis of Adhesions Versus Manipulation Under Anesthesia for Arthrofibrosis After Total Knee Arthroplasty. J Am Acad Orthop Surg. 2023 Feb 15;31(4):e216-e225. doi: 10.5435/JAAOS-D-22-00430. Epub 2022 Dec 21. PMID: 36728979

Vastamäki H, Vastamäki M. Motion and pain relief remain 23 years after manipulation under anesthesia for frozen shoulder. Clin Orthop Relat Res. 2013 Apr;471(4):1245-50.

Vezeridis PS, Goel DP, Shah AA, Sung SY, Warner JJ. Postarthroscopic arthrofibrosis of the shoulder. Sports Med Arthrosc. 2010 Sep;18(3):198-206

W-Dahl A. Manipulation under anesthesia: to do or not to do, that is the question. Acta Orthop. 2022;93:682-683. Published 2022 Jul 15. doi:10.2340/17453674.2022.4344

Wang JP, Huang TF, Hung SC, Ma HL, Wu JG, Chen TH. Comparison of idiopathic, post-trauma and post-surgery frozen shoulder after manipulation under anesthesia. Int Orthop. 2007 Jun;31(3):333-7. Epub 2006 Aug 23

West, D. T., Mathews, R. S., Miller, M. R., & Kent, G. M. (1999). Effective management of spinal pain in one hundred seventy-seven patients evaluated for manipulation under anesthesia. *Journal of Manipulative and Physiological Therapeutics, 22*(5), 299-308

Witvrouw E, Bellemans J, Victor J. Manipulation under anaesthesia versus low stretch device in poor range of motion after TKA. Knee Surg Sports Traumatol Arthrosc. 2012 Aug 3

Woods DA, Loganathan K. Recurrence of frozen shoulder after manipulation under anaesthetic (MUA): the results of repeating the MUA. Bone Joint J. 2017 Jun;99-B(6):812-817

Xiong, X. H., Bean, A., Anthony, A., Inglis, G., & Walton, D. (1998). Manipulation for cervical spinal dislocation under general anaesthesia: serial review for 4 years. *Spinal Cord, 36*(1), 21-24