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Technical Report

Medication-assisted Spinal Manipulation

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Abstract

Background context: The acceptance of spinal manipulation as a reasonable method of treating certain patients with spinal pain over the past decade has led to a renewed interest and increased use of these techniques performed in conjunction with commonly used medications and procedures. Manual therapy is increasingly being used in conjunction with anesthetics, sedatives or analgesics as well as local, epidural and intra-articular injections.

Purpose: This report provides a review of the literature and presents a description of current clinical practice methods for the application of the different techniques of medication-assisted spinal manipulation therapy followed by a discussion of the current clinical support and the published indications, contraindications and complications for each of these procedures.

Study design/setting: This technical report integrates a literature review with information gathered through personal interviews, review of medicine-assisted manipulation courses and observations of clinical procedures.

Methods: A PubMed search from 1966 to the present was performed to identify appropriate articles concerning the combination of spinal manipulation therapy with such medical procedures as the use of anesthetic, conscious sedation, local injection of analgesic, anti-inflammatory and proliferant agents and intra-articular injections. Additional articles and information were gathered through review of pertinent references, attendance of various technique specific seminars and communication with experts familiar with these procedures.

Results: Four categories of medication-assisted manipulation were identified: manipulation under general anesthesia or sedation, manipulation under epidural anesthesia with or without epidural steroid injection, manipulation under joint anesthesia/analgesia, and manipulation with injectants, such as steroids or proliferant agents. The literature consists primarily of case reports and case series with two randomized controlled trials and one cohort study.

Conclusions: Medicine-assisted spinal manipulation therapies have a relatively long history of clinical use and have been reported in the literature for over 70 years. However, evidence for the effectiveness of these protocols remains largely anecdotal, based on case series mimicking many other surgical and conservative approaches for the treatment of chronic pain syndromes of musculoskeletal origin. There is, however, sufficient theoretical basis and positive results from case series to warrant further controlled trials on these techniques.

Keywords: Spinal manipulation therapy; Anesthesia; Epidural steroidal injections; Low back pain; Proliferant injections

Introduction

Many proposed options for treatment of patients with intractable spinal pain have been available for decades but have rarely been discussed or thoroughly understood and are seldom the subject of advanced clinical research. Most clinicians will, on occasion, be asked to give an opinion about the value of such treatments, either to patients or to insurance companies. For many procedures, there is little familiarity with the technique and a dearth of literature on which to base opinion or policy. The combination of spinal manipulation with various common medical procedures represents a class of treatment options based largely on empirical evidence related in anecdotal fashion by a small subset of clinicians. The resultant limited published infor-

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mation is often difficult to find and not conducive to definitive statements regarding efficacy of treatment.

Manipulation of the spine under some form of conscious sedation or general anesthesia has been used for at least 70 years [1]. It was a fairly common procedure in many orthopedic practices between 1940 and 1965 [2–6], gradually falling out of favor because of the increasing reliance on improved surgical techniques. There was also a perceived high complication rate during a period when spinal infections, such as tuberculosis, and disc herniation were being better understood. Practitioners who used spinal manipulation without anesthesia during this period considered the manipulation techniques performed under anesthesia to be high force, long lever, high amplitude and nonspecific procedures with the potential for increased complication rates. These practitioners tended to distance themselves from these procedures and to define their techniques as less forceful and more specific than those performed under anesthesia [7]. As orthopedic manipulation went out of favor, a few osteopathic physicians with an interest in manipulation and access to medical facilities began to practice their manipulation techniques in selected patients using anesthesia, sedation and local injections [8,9], but these procedures never gained widespread acceptance. Chiropractors who currently provide the majority of manipulative therapy services in North America [10], on the other hand, were excluded from access to medical institutions and showed minimal interest in medicine-assisted manipulation techniques. A period of marked skepticism in all aspects of spinal manipulation in the 1970s and 1980s also reduced interest in this topic.

In recent years there has been increasing interest and acceptance of spinal manipulation as a treatment modality [11–13]. The experience of some chiropractors working in multidisciplinary settings has led to the recommendation of further establishment of interdisciplinary teams offering a wide range of treatment options, including manipulation therapy [14–16]. Integration of chiropractors into such settings allows chiropractors access to physicians with experience in the use of various forms of medication, including general anesthesia, analgesia, sedatives and various injection techniques. Recent advances in highly titratable and reversible intravenous anesthetics have significantly reduced risks associated with manipulation under anesthesia (MUA), analgesia and sedation [15], which can now be performed in outpatient surgical centers.

This renewed interest has led to numerous, often enthusiastic, claims of success for these procedures with what appears, in certain circumstances, to be indiscriminant use in patients with spinal pain, lack of outcomes data and inconsistent protocols. There are case reports and case series describing the successful use of MUA and other medically assisted manual therapies in patients with a variety of low-back–related conditions, including chronic lumbosacral and sacroiliac strain [1,17], acute and chronic low back pain [18–23], recalcitrant low back pain and lumber radiculopathy [24,25], spinal arthritis [1,3], sciatica [1,26], lumbar disc syndrome [3–6,17,27], myofibrositis with and without disc herniation [3,5], postoperative stiffness [3,28], psoasitis [3], spondylolisthesis [3], cervical radiculopathy, cervical disc herniation, cervicogenic headache syndrome [29], cervical disc syndrome [30], constant intractable pain [31] and failed back surgery syndrome [32]. Favorable responses to medicine-assisted spinal manipulation have also been reported among patients with cervical or thoracic sprain/strain, cervicalgia, brachial neuritis, headache and knee and shoulder injuries [8,33].

This report reviews the literature and current understanding of various techniques of medication-assisted manipulation in an attempt to provide some perspective for the different categories of these therapies. This article should not be perceived as an endorsement or criticism of any of the different techniques, or a recommendation for or against their use. We have reviewed the literature with the aim of informing readers of the current state of the art of medication-assisted spinal manipulation, its rationale, different variations, currently used clinical indications, and the state of published research in support of the procedures.

Rationale

The theoretical justification for the use of manipulation in combination with various medical procedures is that the combined effect may be more successful for symptom alleviation and resolution of pain than the use of the component procedures alone. MUA or sedation is the most prevalent form of medication-assisted spinal manipulation. The rationale for the use of MUA is that anesthesia and analgesia help to eliminate or reduce pain and muscle spasm that hinder the effective use of traditional manipulation or other manual therapies [9,32,33]. Anesthesia, analgesia, or sedation administered systemically or locally is perceived as allowing the practitioner to break up joint adhesions and reduce segmental dysfunction to a greater extent than if anesthesia had not been employed [15,34,35].

Other medicine-assisted manipulation protocols use injections of steroids or proliferant agents with or without the use of anesthesia/analgesia. Steroid injections have been used with manipulation therapy in an attempt to decrease inflammation and thereby allow for greater effectiveness of the manipulation [20,23,24,26]. The injection of proliferant agents is assumed to strengthen supporting ligaments by encouraging collagen growth after manipulation, thereby allowing the effect of the manipulation to be more long lasting [22].

Definitions and techniques

Manipulation under anesthesia

Definition

MUA is the manipulation of the spine while the patient is under general anesthesia or conscious sedation. Anesthesia is employed with the goal of relieving spinal pain, muscle spasm, and protective guarding that may limit other forms of manipulation.

Reported indications

The reported clinical indications for MUA are extensive and for the most part based solely on clinical experience. They include acute or chronic cervical pain, cervicobrachial, cervicocranial, lumbar, pelvic, or lower-extremity syndromes with somatic dysfunctions that have not responded to conservative management [33]. Other authors include patients with major disability or severe musculoskeletal symptoms that may, at least temporarily, be relieved by MUA [9,32].

There is remarkable agreement in the current osteopathic and chiropractic literature concerning the basic indications for MUA [15,29,33,34]. Virtually all recent literature and current MUA guidelines [35–37] endorse a prior course of manipulation therapy without anesthesia. Failure of a 4- to 8-week trial of conservative manipulation therapy to produce significant clinical outcomes is thought to be the primary basis for considering the more aggressive MUA approach. An exception to the requirement for a prior course of conservative manual procedures is represented by patients judged to be candidates for spinal manipulation therapy but who have severe pain, muscle spasm or irritability that prevents the application of manipulation without analgesia or anesthesia.

There is less agreement on the specific indications for MUA or the diagnoses likely to respond. Many proponents of this treatment have developed their own indications. Greenman [33] suggests that the combination of anesthesia with spinal manipulation may be useful for the treatment of chronic vertebral somatic dysfunction and chronic myofibrositis previously unresponsive to conservative care. West et al. [15] have expanded upon these indications, suggesting that MUA may be considered in lieu of spinal surgery, as an interim step in patients who are considering spinal surgery or when the combination of MUA and spinal injection might potentiate the therapeutic benefit of either treatment when used alone. Beckett and Francis [34] add that MUA may be indicated, with caution, when a patient who is a suitable candidate for manual therapy requests the procedure out of apprehension of receiving non–medicine-assisted manipulation.

More expansive lists of indications may be found in the literature [15,35], usually with little explanation as to why the treatment may be effective. These reported indications include patients with bulging, protruded, prolapsed or herniated discs without free fragment who wish to avoid surgery; frozen or fixed articulations from adhesion formation; failed low back surgery; posttraumatic syndrome injuries from acceleration/deceleration mechanisms resulting in painful exacerbations of chronic fixations; chronic recurrent neuromusculoskeletal dysfunction syndromes that are easily exacerbated and neuromusculoskeletal conditions not suited for surgery but that have reached maximum medical improvement with conservative therapies.

Literature review

The English language literature was searched using the PubMed database and such keywords as manipulation, anesthesia, analgesia, injections and sedation. Titles and abstracts of the resulting citations were reviewed in order to identify articles addressing the use of medication as an adjuvant to manipulation therapy. These articles were obtained and their references were reviewed to identify any additional articles. Clinical studies identified are listed in Tables 1 and 2. Table 1 presents a number of articles on MUA. There are no randomized control trials of MUA reported and only one cohort study [38].

The earliest MUA study we identified was published in 1930 by *The Lancet* [1]. In a detailed retrospective study of 113 patients receiving MUA over an 8-year period for low back pain, data were collected using patient questionnaires. Cases were categorized as chronic back strain, sacroiliac strain, lumbosacral strain, spinal arthritis with or without sciatica and neurotic spine. Overall, 56 (75%) of 75 patients with available data improved, and 19 (25%) did not. Patients with chronic back and sacroiliac strain responded best.

In the one cohort study appearing in the literature, Siehl et al [38] tracked 47 patients in a hospital-based orthopedic clinic with low back pain or sciatica and clinical and electromyographic (EMG) signs of nerve root compression that were assigned to receive MUA (21 subjects), nonmanipulative therapy including muscle relaxants, traction, bed rest and other conservative modalities (7 subjects) or immediate surgery (19 subjects). Clinical outcomes were reported at 6 and 12 months according to changes in EMG findings (improved, unchanged or worsened EMG status). Six- and 12-month results revealed that 5 (71%) of the patients receiving conservative treatment remained electromyographically unchanged but demonstrated an improvement in average clinical scores and relative to baseline scores. Two conservative care patients (29%) worsened electromyographically and showed a decrease in average clinical scores from baseline to 6 and 12 months. Patients receiving MUA or surgery demonstrated an improvement in averaged clinical scores at 6 months regardless of change in EMG status. Average clinical scores remained improved at 12 months when compared with the baseline scores. They concluded that MUA would probably result in long-term clinical improvement in the absence of electromyographic evidence of nerve root compression. The authors thought that patients with EMG evidence of nerve root compression were more likely to experience temporary clinical improvement but that this improvement would be transitory and surgical intervention would probably be required at some point.

Five case series appearing in the literature include patients with lumbar disc herniations [2–6]. Wilson and Ilfeld's 1952 work assessed pre- and post-MUA or sedation changes in appearance of the intervertebral disc using fluoroscopy with intraspinal pantopaque [2]. Twelve of 13 patients with a defect interpreted as a herniated intervertebral disc showed no roentgenographic alteration, and a slight increase in the size of the defect was noted in one patient. Three patients experienced temporary relief of back and leg pain, the one patient with slight increase in size of defect ex-

Table 1
Published findings of clinical studies investigating manipulation under anesthesia

Author(s) Date	Study design Number of patients	Condition	Medication	Manual therapy	Outcome
Riches EW 1930	Retrospective review 75	Back pain	Nitrous oxide and ether	Long-lever techniques (forcible flexion and extension of spine; rotatory movement of pelvis)	75% Improved 25% Not improved
Wilson JN and Ilfeld FW 1952	Case series 18	Herniated intervertebral disc	thiopental (n=2) or 1/150 g Scopolamine, 100 mg Meperidine, 3 g secobarbital (n=16)	Long-lever rotary technique	Baseline myelographic studies indicating herniated intervertebral disc—changes observed after SMT: No change in 12 patients Slight increase in defect for 1 patient No defect identified in 5 patients
Siehl D and Bradford W 1952	Case series 87	Low back pain	thiopental	Mobilization of lumber spine and sacroiliac joints	Excellent: 31% Good: 36% Fair: 22% Poor: 11%
Mensor MC 1955	Case series 205	Lumbar intervertebral disc syndrome	IV sodium Pentothal	Long-lever techniques	Excellent: 27% Good: 24% Fair: 16% Immediate failure: 25% Delayed failure: 7%
Siehl D 1963	Case series 666	Back pain	At the discretion of anesthesiologist, usually pentothal or surital	Mobilization	Good: 60% Fair: 30% Poor: 10%
Chrisman DO et al. 1964	Case series with non-MUA "comparison" group 39 cases 22 comparison	Lumbar intervertebral disc syndrome	IV thiopental sodium with succinyl-choline	Long-lever rotatory techniques	Excellent: 28% Good: 26% Fair: 10% Immediate failure: 8% Delayed failure: 28%
Siehl D et al. 1971	Cohort study 47	Lumbar nerve root compression syndrome	General anesthesia	Osteopathic manipulation of lumbar spine	Average clinical scores improved from baseline to 6 and 12 months regardless of improved, unchanged or worsened EMG status
Morey LW 1973	Medical records review 119 (93 low back and 26 cervical spine extremities)	Low back, cervical spine and extremities musculoskeletal disorders	General anesthesia	Mobilization, stretching, long-lever thrusts	Low back / Cervical Spine and extremities Excellent: 26% / 19% Good: 59% / 69% Fair: 13% / 8% No change: 2% / 4%
Krumhansl BR and Nowacek CJ 1986	Case series 171	Intractable spinal pain	thiopental plus inhalant, such as nitrous oxide; fentanyl plus droperidol drip for cervical manipulation	Stretching, long-lever techniques	Pain-based scale: 25% cured 50% much improved 20% better, but 5% failure

(continued)

Table 1
(continued)

Author(s) Date	Study design Number of patients	Condition	Medication	Manual therapy	Outcome
Francis R 1989	Case report	Low back pain	thiopental	Stretching, short-lever adjustment	Resolution of pain
Mennell J 1990	Case series 32	Cervical spine pain	Nitrous oxide or thiopental	Joint-specific therapeutic technique	Outcomes for MUA patients not separated from outcomes for all manipulation patients
Greenman PE 1992	Case report	Painful stiffness of cervical spine	General anesthesia	Mobilization with impulse (high-velocity, low-amplitude thrust technique)	Improved cervical mobility, reduction in pain with no further nausea and vomiting
Alexander GK 1993	Case report	Recurrent HNP with epidural fibrosis	IV thiopental	Stretching and mobilization	Avoidance of surgery
Hughes BL 1993	Case report	Cervical disk syndrome	thiopental	Lower-velocity, high-amplitude thrust	Patient reported improvement
Davis CG et al. 1993	Case reports	Low back pain with sciatica	Nitrous oxide, sodium pentothal, midazolam, propofol, and succinyl-choline	Passive stretching, short-lever thrusts	0–10 Pain scale (10 being worst pain) Patient 1: improvement from 9+ to 2 Patient 2: improvement from 9+ to 3 Both patients had increased lumbar ROM
West DT et al. 1999	Case series 177	Acute and chronic spinal pain disorders	IV midazolam 0.5–1.0 mg/kg propofol	Passive stretching, osseous short-lever arm adjustive technique	ROM: CS 47% improvement LS 83% improvement VAS: CS 62% improvement LS 60% improvement Medication use: 58% reduction
Herzog J 1999	Case report	Cervical disk herniation, Cervical radiculopathy, and associated cervicogenic headache syndrome	methohexital or propofol	Stretching, short-lever low-velocity thrust	Pain scale improvement, 90% improvement of neck and upper back pain, headaches 95% better
Total patients	1,525				

CS = cervical spine; EMG = electromyographic; HNP = herniated nucleus pulposus; IV = intravenous; LS = lumbar spine; MUA = manipulation under anesthesia; ROM = range of motion; VAS = visual analog scale.

Table 2
Published findings of clinical studies investigating various other medicine-assisted manipulation techniques*

Author(s) Date Procedure*	Study design Number of Patients	Condition	Medication	Manual therapy	Outcome
Warr AC et al. 1972 MUEA with ESI	Case series 500	Chronic lumbosciatic syndrome	40 ml of 0.75% lignocaine 80 mg methylprednisolone 25 mg hydrocortisone acetate 300–500 mg propanidid with 0.6 mg IV atropine (2/3 patients) General anesthesia (1/3 patients)	Rotation of spine, bilateral stretching of sciatic nerve	63% success rate (success = complete or near complete relief of all symptoms)
Ben-David B and Raboy M 1994 MUEA with ESI	Case reports 3	Low back pain	8 ml of 1.5% lidocaine 80 mg methylprednisolone	Short-lever technique	80%–100% pain resolution, improved function
Nelson L et al. 1997 MUEA with ESI	Case series 10	Chronic low back pain	10 mg diazepam (oral) 4 cc of 2% lidocaine, 3.5 cc saline 15 mg betamethasone	Short-lever technique	Mean improvement of 25% on "Improvement Scale"
Aspegren DD et al. 1997 MUEA with ESI	Case reports 2	Recalcitrant lumbar radiculopathy	8 cc of 0.25% bupivicaine hydrochloride 2 cc betamethasone	Passive stretching, short-lever technique	Pain reduction, improved ROM
Brown JH 1960 Pressure caudal anesthesia with and without steroid injection	Case series 62	Low back pain with sciatic neuropathy	Morphine, scopolamine 20–30 cc of 1% lidocaine 40 mg. hydrocortisone tertiary-butylacetate Saline	Long-lever technique	Excellent: 53% Good: 31% No therapeutic effect: 16%
Dreyfuss P et al. 1995 MUJA	Case reports 4	Recalcitrant low back pain	Intra-articular injection of corticosteroid and anesthetic	Mobilization and/or short-lever high-velocity, low-amplitude maneuvers	90%–100% pain resolution
Ongley MJ et al. 1987 Proliferant with SMT	RCT 40 cases, 41 controls	Chronic low back pain	IV diazepam Maximum of 60 ml 0.5% lignocaine dextrose 25%, glycerine 25%, phenol 2.5%	Long-lever lumbar roll	Statistically significant differences favoring the experimental over the placebo groups for: Disability Index Visual Analog Scale Pain diagram
Blomberg S et al. 1994 Steroid injections with SMT	RCT 48 cases, 53 controls	Low back pain	triamcinolone	Mobilization, muscle stretching thrust techniques	Statistically significant differences favoring the experimental group over the conventional treatment group for: ROM Standardized physical examination Low back examination and neurologic findings

*Procedures: MUEA, ESI, MUJA, SMT.

ESI = Epidural steroid injection; IV = intravenous; MUEA = Manipulation under epidural anesthesia; MUJA = Manipulation under joint anesthesia/analgesia; RCT = randomized controlled trial; ROM = range of motion; SMT = Spinal manipulation therapy.

perienced transitory worsening of leg and back pain and the remaining patients' symptomatology remained unchanged. In a first study by Siehl and Bradford published the same year [3], 33% of the subjects with herniated discs demonstrated good results (good results defined as a symptom-free patient who returned to normal activity; fair results defined as a patient who demonstrated improvement and returned to relatively normal activity with some residual symptoms, or who temporarily responded but later required surgery or another MUA; poor results defined as little or no improvement or aggravation of symptoms), but those with positive myelographic findings had only temporary relief. Seventy-one percent of the patients with disc herniation in Siehl's follow-up study [5] reported at least temporary improvement. However, 50% eventually required surgery. Of the patients with myofibrositis without herniation, 96% reported successful (good or fair) outcomes. Mensor's study [4] included 205 patients with a clinical diagnosis of intervertebral disc rupture only (no myelography was performed). After an average follow-up of 22.8 months, 51% of the patients reported satisfactory results. In Chrisman et al.'s study [6], 10 of 12 (83%) of the subjects with negative myelograms reported good or excellent results after a 3-year follow-up, whereas 10 of 27 subjects (37%) with positive myelograms reported similar results.

Whereas these earlier studies investigated MUA or sedation for patients with low back pain, three subsequent works included patients with cervical spine–related pain [9,31,39]. In Morey's 1973 review [9] of medical records involving manipulation of the cervical or lumbar spine under anesthesia over a period of 3 years, a total of 119 cases were recorded with 93 involving lumbar spine manipulation and 26 involving manipulation of the cervical spine. Treating physicians reported excellent or good results in 79 lumbar spine cases (85%), fair results in 12 (13%) and no change in 2 cases (2%). Excellent or good results were reported in 23 cervical spine cases (88%), fair in 2 (8%) and no change in 1 patient (4%). In a study published in 1986, Krumhansl and Nowacek [31] reported results of 171 patients receiving MUA of the lumbar and/or cervical spine previously unresponsive to treatment by physicians or physical therapists and to manual therapy without anesthesia. Outcomes were reported as 25% of patients being "cured," 50% as "much improved," 20% as "better, but" and 5% as "failure." Somewhat similar results were reported in a 1990 article by Mennell [39] assessing 100 consecutive cases of patients with pain arising from the cervical spine. Thirty-two of these patients received cervical spine MUA, 51 were manipulated without anesthesia and 17 did not receive any spinal manipulation therapy. Data specific to the MUA cases were not presented, but overall results of patients receiving spinal manipulation with or without use of anesthesia reveal 25 patients (30%) with symptoms cured, 29 (35%) with marked improvement, 24 (29%) with moderate improvement and no change in 5 (6%).

A number of case reports can be found in the literature detailing successful application of MUA in patients with low back and leg pain [17,28,30,32], painful stiffness of the cervical spine with intractable nausea [33], and cervical disc herniation, radiculopathy and associated cervicogenic headache [29]. Resolution of symptoms or marked improvement was reported in these case reports of patients previously unresponsive to prior surgeries or conservative care consisting of spinal manipulation without anesthesia, physical therapy modalities, traction, or anti-inflammatory and pain medications.

A recent case series by West et al. [15] presents the results of 168 patients with acute and chronic spinal pain disorders who completed a series of MUA treatments. Average visual analog scale (VAS) scores improved 4.6 points (on a scale of 0 to 10 points) 6 months after MUA for patients with cervical pain. Patients with lumbar pain improved an average of 4.31 points over the same period. Decrease in time out of work and less use of prescription pain mediation were also reported for both groups.

Protocol

Most protocols recommending MUA do not consider this a stand-alone treatment. These protocols require a prior trial of conservative management followed by mobilization and manipulation techniques with the use of general anesthesia and a course of post-MUA rehabilitation involving continued stretching and strengthening exercises and palliative postprocedure pain management. Early manipulation techniques employed typically by osteopaths and orthopedic practitioners favored long-lever, more general maneuvers. Current procedures more commonly use specific, short-lever, high velocity low amplitude thrusts characteristic of chiropractic and modern osteopathic adjustive techniques in addition to mobilization.

A typical MUA procedure involves placing the patient in a twilight anesthesia by a board-certified anesthesiologist while the clinician with the aid of a skilled assistant provides specific mobilization and manipulation techniques to the affected joints and spinal regions. Patients are instructed to abstain from food or drink for 8 to 12 hours before the procedure. Intravenous administration of propofol has been the most commonly recommended anesthetic agent, although many practitioners also use midazolam to provide amnesia. Before the procedure the patient is connected to a cardiac monitor, blood pressure cuff and oximeter. A small intravenous catheter is inserted in the patient's arm. The manipulation and mobilization take approximately 10 to 20 minutes. Although both high- and low-velocity thrusts are employed, the recommended force of the manipulation is described as much less and more cautious than when anesthesia is not used [15,30,32,35,37]. High-velocity thrusts are employed to break up intersegmental adhesions, whereas low-velocity mobilization is used to passively stretch soft tissue. Once the procedure is completed, the patient is transferred to a recovery room and monitored by the attending anesthesiologist until vital signs are stable. An attending nurse should continue monitoring the patient, who may be offered oral fluids and a light snack once the fluids are well tolerated.

When fluids and food are tolerated and the vital signs remain stable, the patient may be discharged to a responsible adult escort for transportation away from the facility [40].

The specific manipulative and mobilization procedures depend on each patient and the area of pain and/or dysfunction. All range of motion mobilizations to any region of the spine and extremities are performed with full knowledge of both active and passive end range exhibited by the patient in a fully conscious state. Current guidelines recommend the presence of a primary physician and assisting physician who have both undergone adequate training in MUA procedures. An assistant is necessary to position and stabilize the sedated patient.

Current protocols suggest that patient response to the first MUA procedure should determine the need, if any, for further procedures [40]. These guidelines suggest the recovery of at least 80% normal function (as determined for the individual patient by prior examination and history) indicates no need for serial procedures. Recovery of less than 70% function but accompanied by some measurable improvement may indicate the need for a second MUA procedure. Continuing improvement that fails to reach the 80% threshold may indicate the need for a third MUA procedure [40]. Attempts to establish less arbitrary criteria are quashed by the lack of studies with methodology appropriate for determining efficacy and dose response.

For cervical complaints, passive stretching of the soft tissues is accomplished in separate maneuvers emphasizing various range of motion movements, such as axial traction, forward flexion, lateral flexion and rotation of the cervical spine while the patient is in a supine position (Fig. 1). After isolating the segments to be manipulated, a controlled manipulative thrust is directed to the involved joints. The cervical spine is placed in slight lateral flexion with minimal rotation, and the thrust employed is typically much lighter than used with fully conscious patients (Fig. 2).

If the thoracic spine is to be treated, the patient remains supine with the arms crossed over the chest. Typically, the practitioner isolates the segments by rolling the patient to one side just enough to place a loose fist that acts as a fulcrum under the thoracic spine. The patient is returned to a supine position, and the clinician places a hand on the patient's crossed arms. A slight anterior-to-posterior thrust is applied, and the procedure is repeated until all segments identified by prior patient history and physical examination have been addressed (Fig. 3).

A number of stretches are applied to the lumbar spine and pelvis for patients with complaints involving the low back. Straight leg raise mobilization with dorsiflexion of the foot is applied, as well as a variety of knee-to-chest maneuvers (Fig. 4). Stretches are applied bilaterally. Traction of the leg with the hip in neutral, internal and external rotation is often applied. Mobilization of the hips and pelvic girdle may also be accomplished by flexing the patient's lower extremity at the knee and placing the foot on the table around the level of the patient's contralateral inner thigh (Fabere-

Fig. 1. The practitioner (right) administers axial traction to the cervical spine, cupping the patient's posterior skull with his left hand while he cradles the patient's jaw with his right hand. The first assistant (left) stabilizes the patient with bilateral shoulder/upper trapezius contacts. The anesthesiologist steps aside to allow the clinician access to the patient's head and neck area during cervical spine mobilization and manipulation. During all other maneuvers, the anesthesiologist monitors the patient from the head of the table.

Patrick maneuver) followed by external and internal rotation at the hip. Traction of the lumbar spine is often applied by bringing the patient's knees to the chest while contacting the lumbar and/or sacral spine. The patient is rolled from the supine to a side-lying position with the lower extremity in flexion. Additional mobilization may be applied before manipulation of the lumbar spine and sacroiliac joints (Fig. 5). The patient is returned to a supine position at the completion of all MUA procedures and usually transported to a recovery room for observation until ready for discharge from the facility.

Virtually all current guidelines and authors describing MUA protocols recommend a 2- to 6-week period of post-MUA rehabilitation therapy. Continued mobilization and manipulation is recommended, as well as appropriate application

Fig. 2. The clinician (right) administers cervical spine manipulation using a specific low-amplitude, short-lever technique with minimal thrusting force. The clinician's lower (left) hand and arm are used solely to stabilize the patient's head and neck while the upper (right) hand delivers a controlled thrust. The first assistant stabilizes the patient's body by holding the shoulders.

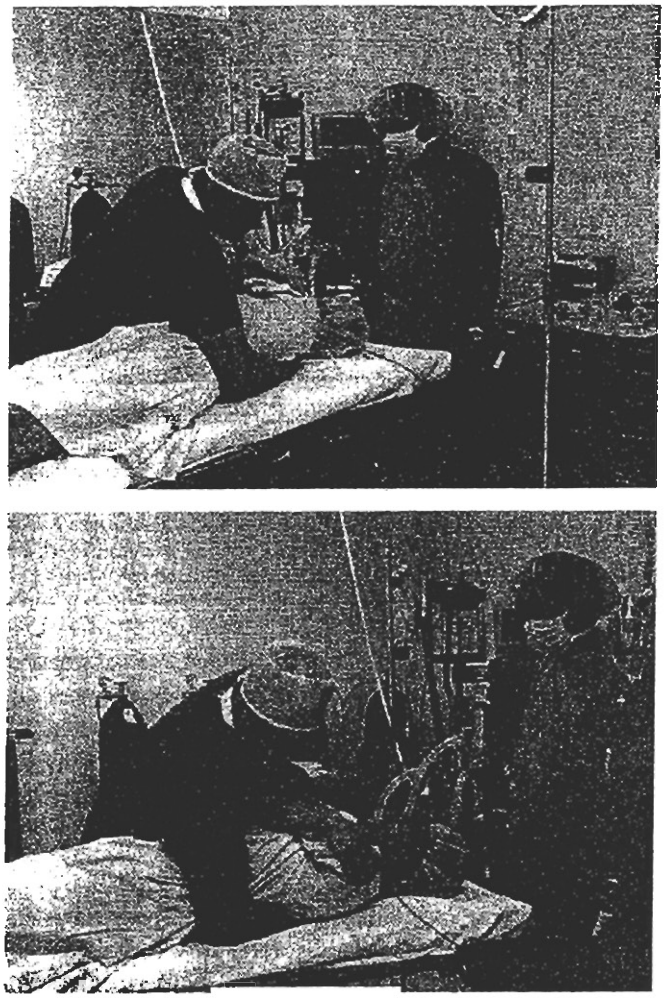

Fig. 3. (Top) The clinician positions his hand under the patient's thoracic spine to act as a fulerum. (Bottom) The patient is returned to a supine position with arms crossed over the chest and the clinician applies a quick anterior to posterior thrust using a contact with his left hand (lower photograph).

of physical therapy modalities. Transition from passive stretches and modalities to active exercise and muscle strengthening is stressed during the course of rehabilitation.

Reported complications

In theory, complications could occur as the result of the anesthesia or the manipulative force. Complications reported in the literature as being associated with MUA include cauda equina syndrome [41,42], paralysis [42], vertebral pedicle fracture [41] and dens fracture with C1–C2 dislocation [43]. These complications, however, were reported in the early orthopedic literature that were surveys not specific to MUA and assessing techniques employing long lever manipulation. Table 3 lists adverse reactions reported by the authors of studies specifically investigating MUA. Use of long-lever techniques applied under general anesthesia resulted in few complications reported in the case series. Riches [1] and Chrisman et al. [6] reported exacerbation of symptoms in 1 of 75 and 5 of 39 patients, respectively. The five patients with exacerbated symptoms in Chrisman et al.'s study reported in 1964 consisted of patients with immediate complaints of increased lumbosacral pain and muscle tightness, although improvement in leg pain was noted. These patients were then treated with plaster body jackets. A table appearing in Chrisman et al.'s article appears to indicate that three of these five patients were rated as good or excellent 6 to 8 weeks after manipulation with one patient classified as an immediate failure and one classified as a delayed failure [6]. Krumhansl and Nowacek [31] reported two cases of intractable respiratory distress of 171 patients, which resolved after a return to the operative suite. They also documented "pain paralysis" in an additional two patients who experi-

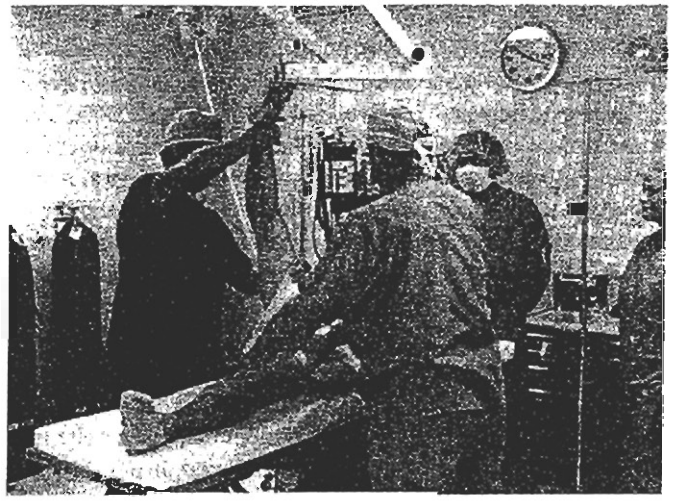

Fig. 4. A straight leg raise stretch is applied by the clinician while the first assistant stabilizes the contralateral leg. All mobilization and manipulation are applied with an awareness of the preprocedure range of motion of the fully conscious patient. Maneuvers are typically performed bilaterally.

Fig. 5. Manipulation of the lumbar spine and sacroiliac joint is accomplished by placing the patient in a side-lying posture. The first assistant (left) helps to stabilize the patient while the clinician contacts specific sacral and/or lumbar segments to deliver the adjustive thrust. The clinician is positioned to ensure patient safety. The thrust is delivered only through the hand that is contacting the patient's spine.

enced transitory inability to move their lower extremities because of severe pain in the sacroiliac joint for a period of 1 week or less. Neither patient demonstrated sensory or neurological damage, and both recovered completely within 10 days [31]. Wilson and Ilfeld [2] indicated a slight increase in the size of defect demonstrated by myelography (interpreted as being the result of herniation of the intervertabral disc) after manipulation in 1 of 18 patients. We have been unable to find any report of complications using more modern osteopathic and chiropractic techniques or as a result of the use of anesthesia. Overall, the authors of the 17 MUA articles from 1930 to the present reviewed in this article report adverse reactions or complications in a total of 11 (0.7%) of 1,525 patients.

Manipulation under joint anesthesia/analgesia

Definition

Manipulation under joint anesthesia/analgesia (MUJA) is the combination of fluoroscopically guided intra-articular injections of anesthetic and corticosteroid agents and subsequent manipulations of the injected joints [25,44].

Reported indications

MUJA combines manipulation therapy with fluoroscopically guided intra-articular injections of anesthetic and corticosteroid agents. Dreyfuss et al. [25] suggest the use of MUJA for patients with recalcitrant spinal synovial joint–mediated pain. These authors think that the anesthetic component of MUJA provides the following potential clinical benefits: 1) a single anesthetic block of the zygapophyseal joint or sacroiliac joint and its capsule that would block the pain-mediated nerve supply may tentatively confirm or deny the working diagnosis of z-joint– or sacroiliac joint–mediated pain, and 2) the anesthetic block provides a brief window of opportunity for spinal manipulation therapy delivery while the patient is relaxed and in a relatively pain free state. The use of corticosteroids with MUJA has been proposed as a means of providing two additional benefits: 1) the corticosteroid agent alone may provide long-lasting therapeutic effect by reducing inflammation, and 2) the corticosteroid may extend the window of opportunity for spinal manipulation therapy beyond the anesthetic effects [25].

Literature review

There are no controlled clinical trials or large case series describing the outcome using these techniques (Table 2). Dreyfuss et al. [25] present four cases where the MUJA procedure was performed. These patients are described as having lumbar zygapophyseal joint– and/or sacroiliac joint–mediated pain diagnosed by fluoroscopically guided, contrast-enhanced, intra-articular anesthetic injections. Before undergoing MUJA, each of the four patients had an extensive treatment history, including care provided by family doctors, physiatrists, physical therapists, chiropractors and/or neurologists. Improvement in pain appears to be the main outcome measure with each patient experiencing 80% to 100% improvement, which was sustained for a follow-up period of 4 to 6 months.

Protocol

Fluoroscopically guided joint injections of anesthetic and/or corticosteroid agents are recommended by the proponents of these procedures to ensure specificity of delivery. A radio-opaque contrast agent is used to confirm needle placement and delivery of injected material into the joint or into the tissues surrounding the pain-mediated nerve supply. Anesthetic agents, such as lignocaine (1.5cc of 2% solution) with or without corticosteroids (eg, 0.5 cc celestone soluspan), are injected directly into the joint. Manipulation is applied only if the injection establishes a diagnosis of predominant joint-mediated pain. Michaelsen and Dreyfuss [44] state that a reduction in pain limited to 50% indicates additional pain generators other than the joints injected. Reduction in 90% to 100% of pain after the injection of anesthetic agent is considered a strong indication that the injected sites are the anatomic structures responsible for the patient's pain.

Manipulative procedures commonly used with this procedure may be short-lever, high-velocity, low-amplitude manual techniques or less forceful spinal joint mobilization therapy. Six to eight sessions of spinal manipulation therapy are commonly recommended within the first 10 to 12 days after the intra-articular injections of anesthetic and corticosteroid. This is then followed by the introduction of such active therapies as muscle stretching exercises, aerobic and general conditioning and strengthening exercises, which presumably were not well tolerated before the injection.

Reported complications

This technique is relatively new and there are no reported complications. Theoretically the complications associated with manipulation or with the intra-articular injection of anesthetic should be considered. Dreyfuss et al. [25] reported no complications with MUJA occurring in their four patients, but there are no large case series to determine rate of complications.

Manipulation under epidural anesthesia

Definition

The use of an epidural segmental anesthetic often with simultaneous epidural steroid injection (ESI) followed by spinal manipulation therapy has been referred to as manipulation under epidural anesthesia (MUEA) [24].

Reported indications

Ben-David and Raboy [20] suggest several benefits of MUEA relative to MUA: MUEA is a less costly alternative to MUA, patients may be more receptive to the use of local anesthetic rather than general anesthesia and the use of steroid injections during the procedure may reduce inflammation secondary to the manual treatment and inhibit reformation of fibrosis and adhesions. Clinical indications proposed for MUEA include chronic mechanical low back pain [20,21], lumbosciatic pain [18,26] and recalcitrant lumbar radiculopathy [24].

Table 3
Reported complications of manipulation under anesthesia by study

Author(s) Date	Reported complications	Complication rate* complications: patients (%)
Riches EW 1930	One patient of 75 reported worse back pain as a result of manipulation. Upon examination, she displayed diffuse tenderness of entire back, but good flexibility despite radiological evidence of osteoarthritic lipping of the lumbar vertebral bodies.	1:75 (1.3)
Wilson JN and Ilfeld FW 1952	One of 13 patients with myelographic evidence of herniated intervertebral disc showed a slight increase in the defect immediately after manipulation with anesthesia or analgesia. This patient also noted increased pain in his back and leg, which subsided in 2 days.	1:13 (7.7)
Siehl D and Bradford W 1952	No reported complications in a series of 100 low back manipulations under general anesthesia involving 87 different patients.	0:87 (0)
Mensor MC 1955	No aggravation of symptoms by manipulation for the 205 patients in this study. No occurrence of motor weakness, paralysis or complication of the bladder or rectal sphincter.	0:205 (0)
Siehl D 1963	No reported complications in a series of 723 cases of manipulation under anesthesia performed on 666 separate patients (including the 87 patients contained in Siehl and Bradford's 1952 report).	0:666 (0)
Chrisman DO et al. 1964	Five of 39 patients complained of increased lumbosacral pain and muscle tightness immediately after manipulation under anesthesia.	5:39 (13)
Siehl D et al. 1971	No reported complications in 21 patients receiving manipulation under anesthesia.	0:21 (0)
Morey LW 1973	No reported complications in 119 patients undergoing manipulation under anesthesia, 93 receiving lumbar spine manipulation and 26 receiving manipulation of the cervical spine.	0:119 (0)
Krumhausl BR and Nowacek CJ 1986	Four patients of 171 receiving manipulation of the lumbar and/or cervical spine under anesthesia experienced complications. Two lumbar spine patients were returned to the operative suite because of intractable respiratory distress, which was resolved with Valium. Two patients experienced severe pain in the sacroiliac joints, which prevented leg movement for 3 to 7 days. Both patients recovered completely within 10 days.	4:171 (2.3)
Francis R 1989	Case report with full resolution of symptoms and 12-month follow-up. Author states similar results in over 20 MUAs performed but offers no details.	0:1
Mennell J 1990	No reported complications in this study of 100 consecutive cases with pain arising from cervical spine. Thirty-two patients received MUA of the cervical spine.	0:32 (0)
Greenman PE 1992	Case report with full resolution of presenting symptoms (painful stiffness of cervical spine, intractable nausea) lasting for at least the following 18 months.	0:1
Alexander GK 1993	Case report of MUA for low back pain with satisfactory results.	0:1
Hughes, BL 1993	Case report of MUA series for patient with restricted cervical spine motion, pain and paresthesia after a motorcycle accident. Resolution of symptoms reported.	0:1
Davis CG et al. 1993	Two case reports of MUA for chronic, severe low back pain and sciatica that failed to respond to numerous surgeries. Marked improvement in pain and function with decreased dependence on medication use was reported for both patients.	0:2
West DT et al. 1999	No complications reported in a case series of 177 patients receiving MUA.	0:177 (0)
Herzog J 1999	Case report of MUA for patient with cervical disc herniation, cervical radiculopathy and cervicogenic headache. Patient reported 95% improvement in overall condition.	0:1
Total patients*		11:1,525 (0.7)

*Total represents unique patients taking into account the duplication of the 87 patients appearing in Siehl and Bradford's 1952 study and follow-up study by Siehl in 1963.

MUA = manipulation under anesthesia.

Literature review

Several case reports and case series describe the use of MUEA with or without ESI for the treatment of recalcitrant lumbar radiculopathy [24], severe low back pain with degenerative changes [20], chronic mechanical low back pain [21] and chronic lumbosciatic syndrome [18,26] (Table 2).

We were able to find two case reports of MUEA with ESI [20,24] documenting the use of this combination therapy. Aspegen et al. [24] reported the use of MUEA with ESI for the treatment of one case of L5 intervertebral disc syndrome with peridural scar formation and one case of L4 intervertebral disc syndrome with radiculopathy. Both patients received conventional care (oral medications, physical therapy, spinal manipulation therapy) before undergoing MUEA with ESI. Improvement was reported clinically and on VAS, Oswestry Disability Index and pain drawings.

Ben-David and Raboy [20] provide a further three cases of MUEA with ESI. After failure of manipulation therapy alone in two patients and of ESI alone in the third patient, all three patients reported dramatic immediate improvement when both treatments were administered together. The effect was transient, but the authors report that subsequent response to clinical management with manipulation therapy appeared enhanced.

Three case series discuss the use of ESI and local anesthesia with manipulation for chronic mechanical low back pain [21] and chronic lumbosciatic syndrome [18,26]. Nelson et al. [21] performed a retrospective analysis on 10 of 17 cases of patients with chronic low back pain experiencing suboptimal (less than 50% improvement) response to conventional care. The main outcome measure used was an "improvement scale" consisting of a line marked in 10% increments from 0% (no improvement) to 100%. On average, the patients reported a 25% improvement with manipulation combined with ESI over and above any improvement reported after conventional care. Warr et al. [26] followed 500 patients who had not responded to conservative care. Manipulation with ESI resulted in a success rate of 63% (success defined as complete or near complete relief of all symptoms, lack of recurrence within the follow-up period and no requirement of further treatment) with patients reporting immediate favorable results extending for at least 6 months. The remaining 37% of patients experienced temporary relief that was attributed to the effects of the steroid injection. Brown [18] reported 62 cases of patients experiencing low back pain after trauma. Twenty-one patients had a prior history of surgery, and all patients had undergone long periods of conservative therapy, including bed rest, traction, physical therapy and back supports, which achieved transient relief of pain. Manipulation after pressure caudal anesthesia was administered in all patients, with 20 patients also receiving steroid injections. The authors report excellent results in 53% of patients, good results in 31% and no appreciable benefit in 16% (excellent results defined as complete and persistent relief of sciatic root pain for a minimum of 3 months, good results defined as either transitory elimination or striking reduction of persistent root pain after each procedure).

Protocol

Manipulation under epidural anesthesia with ESI usually involves a fluoroscopically guided epidural analgesia and steroid injection (typically, lidocaine and methylprednisone) followed within 15 to 30 minutes by the manual procedures outlined in the above MUA section. Lumbar stretching followed by spinal manipulation is the most common approach. Unlike MUA, the patient is able to cooperate during the procedure. It is therefore not considered imperative that an assistant be available to aid in positioning the patient during the manipulation, as is the case of MUA. Postprocedure treatments typically consist of stretching, standard manipulation therapy and therapeutic modalities as indicated.

Reported complications

Warr et al. [26] report no serious complications in 500 patients receiving manipulation with epidural injections, although thecal puncture occurred in 7 cases. The procedure was abandoned, and the epidural injections were performed successfully 1 week later in each of these cases. The case series by Brown [18], where manipulation was applied after pressure caudal anesthesia, describes four patients in which a mild transitory (lasting a few seconds) tetanic convulsive episode developed after 30 to 40 cc of saline had been injected. None of the episodes were recognized by the patients or produced sequelae. In each case discontinuation of injection allowed for completion of the manipulation.

Manipulation with proliferant or steroid injection

Definition

Other medicine-assisted manipulation therapies discussed in the literature include manipulation combined with cortisone injections into paraspinal tissues and proliferant injections. Blomberg et al. [23] discussed the use of cortisone injections into the paracoccygeal structures and into the insertion of the piriformis muscle on the greater trochanter as an essential component of a pragmatic approach to low back pain, which also includes the use of manipulation, specific mobilization, muscle stretching, home exercises and traction. The regimen proposed by Ongley et al. [22] consists of injection of a proliferant solution into sacroiliac and paraspinal ligaments considered to be of value when used in conjunction with manipulation, local anesthesia and repeated flexion exercises.

Reported indications

Both of these regimens were proposed as new approaches to the treatment of low back pain, and both use injections as one component of manual therapy protocols that involve mobilization and manipulation. Neither of these authors have been very specific in their indications with the populations studied consisting of acute and subacute subjects with low back pain [23] or patients with chronic low back pain [22].

Literature review

Blomberg et al. [23,45,46] studied manual therapy with steroid injections in a multicenter trial (Table 2). Fifty-three patients with acute or subacute low back pain receiving conventional treatment were compared with 48 patients receiving experimental treatment, which included manual therapy and cortisone injections. Results revealed a reduction in objective findings of low back pain on physical examination, decreased pain, decreased drug consumption, decrease in sick leave and disability rating and an increase in quality of life.

Ongley et al. [22] randomized 81 patients with chronic low back pain into two treatment groups. One group of 40 received manipulation and injections of local anesthesia (dilute lignocaine) and a proliferant solution containing dextrose-glycerine-phenol. The control group of 41 patients re-

ceived treatment with less extensive use of initial local anesthesia and manipulation and the substitution of saline for the proliferant solution. Using modified versions of the Roland-Morris disability index, Waddell's chronic disability index and a visual analog scale to measure outcomes, the authors reported greater improvement in disability and pain scores for the experimental group at follow-ups of 1, 3 and 6 months. In the experimental group, 35 of 40 patients (88%) reported greater than 50% improvement in disability scores as compared with 16 of 41 patients (39%) in the control group. Mean disability scores at 6 months were 3.41 (of a possible 33 with 33 representing most disability) in the experimental group and 8.29 in the control group ($p<.001$). Differences in pain scores (measured using a visual analogue scale with a maximum of 7.5) at 6 months were also statistically significant ($p<.001$) between the experimental group (VAS=1.5) and the control group (VAS=3.08)

Protocol

The protocol described by Blomberg et al. [23,45,46] combined manipulation, mobilization, muscle stretching, home exercises, autotraction and cortisone injections. All patients received manipulation with thrust techniques or specific mobilization of the low back and sacroiliac joints. Autotraction was part of the protocol for a small subset of patients. Patients were treated with these manual therapies for 1 to 2 weeks before the procedure. Patients nonresponsive to treatment were further assessed through per rectum palpation of paracoccygeal structures or palpation of the piriformis insertion on the greater trochanter. Steroid injections (triamcinolone) and injection of local anesthetics were administered at these sites. Follow-up care by physicians and therapists were provided for patients who experienced recurrence of pain with the average number of visits being 3.5 and 2.8 times, respectively.

Ongley et al. [22] provide a detailed description of their 6-week treatment protocol that combines a single administration of long-lever manipulation of the lumbar and sacroiliac areas with injection of local anesthetic and proliferant solution. On the first visit, all patients received 10 mg diazepam intravenously for relaxation and amnesia. Through a single insertion point at the L5 spinous process, a rigid needle was used to inject a maximum of 10 ml of 0.5% lignocaine at the tip of the L4 and L5 spinous processes and associated ligaments; the attachment of the ligamentum flavum along the borders of the L4 and L5 laminae; apophyseal joint capsules at L4–L5 and L5–S1; the attachment of the iliolumbar ligament on the transverse processes of L4 and L5; the attachment of the iliolumbar ligament and dorsolumbar fascia to the iliac crest; the attachments of short and long fibers of the posterior sacroiliac ligaments and the sacral and iliac attachments of the interosseous sacroiliac ligaments. An injection of 50 mg triamcinolone in 10 ml 0.5% lignocaine (proliferant solution) was administered into the origin of the gluteus medius. These injections were followed by manipulation of the lumbar and sacroiliac areas with an assistant immobilizing the patient's thorax and the therapist using the thigh as a lever to apply rotary and flexion forces. Injection of the proliferant solution was repeated on a second visit, and flexion exercises were introduced, which consisted of repeated active forward flexion of the lumbar region in a standing or seated position. These first two visits were followed by repeated weekly injections of proliferant solution for the duration of 6 weeks and continued flexion exercises.

Reported complications

Ongley et al. [22] reported patient complaints of pain and stiffness for 12 to 24 hours after each injection for both groups of patients. Two patients in the experimental group and one patient in the control group experienced increased menstrual flow. Two patients in the experimental group had postmenopausal spotting 4 weeks after the start of treatment, and one patient in the control group withdrew after the injection on day 2 because of a severe headache and cough.

Contraindications for medicine-assisted spinal manipulation

As with any procedure, suggested contraindications are categorized as absolute and relative and are generally based on common sense. Any contraindication to spinal manipulation therapy without the use of adjuvant medication should be considered a contraindication to medicine-assisted spinal manipulation. In addition, any medical condition that precludes the use of analgesia, anesthesia or injection of corticosteroids and/or proliferant solution would prevent the use of these combination therapies.

Suggested absolute contraindications include any form of primary or secondary malignant process involving the spinal cord or vertebral structures. Joint hypermobility or instability, acute inflammatory conditions, bone/joint infection, acute bone fracture in the area to be treated, progressive neurological deficits and the presence of large aortic aneurysms represent absolute contraindications [15,33–35]. Relative contraindications include osteoporosis, herniated nucleus pulposus, prior spinal surgery to treatment area and other relative contraindications of spinal manipulation therapy [17,33,34]. These conditions may warrant a more careful administration or modification of the manipulation technique.

Additional risks are introduced by the use of an anesthetic agent. Anesthesia and sedation reduce the patient's ability to provide immediate feedback of experienced pain or to guard against overzealous administration of manual techniques. Patient–clinician communication is preserved throughout procedures using local anesthetics, as with the MUJA and MUEA protocols. Of special concern when combining anesthesia or conscious sedation with a procedure involving numerous potential changes of patient positioning during mobilization and manipulation maneuvers is vigilant monitoring and preservation of the patient's airway.

Discussion

Review of the literature on medication-assisted spinal manipulation leaves one in the same state of confusion and skepticism aroused by similar reviews of many other treatment protocols for spinal pain, including many surgical and injection techniques. There is ample enthusiasm by proponents, reasonable theory to support the consideration of the technique, a number of case series with very few controlled clinical trials and claims that a substantial portion of patients receiving the treatment report improvement of their symptoms and are satisfied with their care. In addition, as with surgical procedures, there is a proliferation of new methods of combining medication with manipulation that makes future studies more difficult and serves to confuse patients and clinicians trying to get beyond the personal experiences and techniques advocated by a single provider or small group of providers.

The suggestion that combining commonly applied treatment approaches may be more beneficial than a single approach appears intuitively reasonable. The difficulty with this thinking is that many of the treatments used as components of these combination procedures have yet to be established as valuable treatment modalities in their own right for the conditions being treated. The use of spinal manipulation in patients with uncomplicated low back and neck pain is growing [47] and most reviews of randomized trials of spinal manipulation suggest that current research supports the role of manipulation [11,48,49]. The problem arises when medication-assisted manipulation is recommended for very specific conditions, such as disc herniation, facet syndrome, ligamentous laxity, and so forth. Very few controlled trials on the effectiveness of manipulation have selected patients with these specific diagnoses. Similarly, the controlled clinical trials that investigate the injection of local anesthetics, epidural injections and sclerosing agents are either scarce or inconclusive. For example, a recent systematic review of conservative treatments for acute and chronic nonspecific low back pain included an assessment of epidural injections [49]. One randomized controlled trial investigating the use of ESIs for acute low back pain was found, indicating limited evidence for the effectiveness of ESIs for acute low back pain with nerve root pain and radicular neurologic deficit. Six randomized controlled trials identified in van Tulder et al.'s systematic review [49] suggested moderate evidence supporting the short-term effectiveness of ESIs as compared with placebo for chronic low back pain but no evidence regarding increased effectiveness of ESIs over injections of local anesthetic or muscle relaxant.

The use of manipulation under sedation or anesthesia suggests that there is a dose response to manipulation. This assumes that if mobility associated with manipulation is beneficial, then greater mobility anticipated from manipulation and mobilization during muscle relaxation should be more beneficial. This basic hypothesis has yet to be studied. It has also yet to be shown that medicine-assisted manipulation techniques are any more effective than manipulation by itself.

Although medicine-assisted spinal manipulation therapies have a relatively long history of clinical use and have been reported in the literature for over 70 years, evidence for the effectiveness of these protocols remains largely anecdotal. Lack of strong clinical trials has not diminished the growing utilization of these procedures. Although we have not been able to find reliable data on utilization, there is an obvious greater interest in these therapies. Currently, one surgical center in California claims that approximately 50 MUA procedures are being performed there every month. Rigorous studies evaluating patient selection, risks and benefits of these therapeutic approaches are needed. The long history of this treatment approach and the encouraging case series are reason enough to spend resources to conduct controlled clinical trials or at least comparative cohort studies. Without such studies, it is not possible to reach any definitive conclusion as to the benefits or risks of these procedures.

Until we have greater understanding of the procedure and a substantial body of research on which to base any discussion of medication-assisted manipulation, clinicians and payers will have to base opinions on their personal requirements and insist on research for any procedure offered patients with spinal pain. If a clinician recommends or offers, and a payer reimburses, surgery, injections, epidurals and certain physical therapy approaches to patients without requiring substantial proof of effectiveness and safety, then it would be difficult to deny the use of medication-assisted manipulation or fail to reimburse for it. If on the other hand a clinician or payer rejects all surgery that does not have a body of controlled clinical trials supporting its use and refuses to offer patients or pay for most injection and physical therapy procedures that have limited or no research support, then it would be reasonable to reject medication-assisted manipulation until such research is carried out and published. It would seem unreasonable, however, to hold medication-assisted manipulation to a higher standard of scientific rigor than that required of other treatment approaches. Clearly, it is more desirable to offer and pay for treatment with an established body of research support and clear understanding of its indications, contraindications and risks. The hope is that this will be forthcoming in the near future for the various forms of medication-assisted manipulation.

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