REVIEW

Spinal Manipulation for Low-Back Pain

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■ *Purpose:* To review the use, complications, and efficacy of spinal manipulation as a treatment for low-back pain.

■ *Data Identification:* Articles were identified through a MEDLINE search, review of articles' bibliographies, and advice from expert orthopedists and chiropractors.

■ *Study Selection:* All studies reporting use and complications of spinal manipulation and all controlled trials of the efficacy of spinal manipulation were analyzed. Fifty-eight articles, including 25 controlled trials, were retrieved.

■ *Data Analysis:* Data on the use and complications of spinal manipulation were summarized. Controlled trials of efficacy were critically appraised for study quality. Data from nine studies were combined using the confidence profile method of meta-analysis to estimate the effect of spinal manipulation on patients' pain and functional outcomes.

■ *Results of Data Synthesis:* Chiropractors provide most of the manipulative therapy used in the United States for patients with low-back pain. Serious complications of lumbar manipulation, including paraplegia and death, have been reported. Although the occurrence rate of these complications is unknown, it is probably low. For patients with uncomplicated, acute low-back pain, the difference in probability of recovery at 3 weeks favoring treatment with spinal manipulation is 0.17 (for example, increase in recovery from 50% to 67%; 95% probability limits of estimate, 0.07 to 0.28). For patients with low-back pain and sciatic nerve irritation, the difference in probabilities of recovery at 4 weeks is 0.098 (probability limits, − 0.016 to 0.209).

■ *Conclusions:* Spinal manipulation is of short-term benefit in some patients, particularly those with uncomplicated, acute low-back pain. Data are insufficient concerning the efficacy of spinal manipulation for chronic low-back pain.

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Spinal manipulation as a treatment for musculoskeletal complaints has been practiced for centuries. In the last 50 years, the use of spinal manipulation has been equated with the practice of chiropractic, and, in part because of this, the use of spinal manipulation has been labeled an unorthodox treatment by the medical profession (1). Recent research favorable to the chiropractic treatment of patients with low-back pain (2), along with the current emphasis on patient outcomes, has helped stimulate a re-appraisal of the role of spinal manipulation. We reviewed the scientific literature on the use, complications, and efficacy of spinal manipulation for low-back pain. This review should be useful to clinicians who perform spinal manipulation, clinicians who see patients with low-back pain, and researchers interested in spinal manipulation.

Spinal manipulation encompasses many different techniques. In general, these can be broadly categorized as one of two types: nonspecific long-lever manipulations and specific, short-lever, high-velocity spinal adjustments (3). Long-lever manipulations use the femur, shoulder, head, or pelvis to manipulate the spine in a nonspecific manner, whereas short-lever spinal adjustments use a specific contact point on a process of a vertebra to affect a specific vertebral joint. It is this second method that is most closely identified with chiropractic practice, although many chiropractors use long-lever manipulations as well. We examine the use of lumbar spinal manipulation of all types to treat low-back pain.

Methods

We initially searched *Index Medicus* and MEDLINE from 1952 to the present for relevant articles using the MeSH terms chiropractic, manipulation, and backache. We then drew on the bibliographies of these articles. Orthopedists and chiropractors evaluated the bibliography for completeness and suggested additional references, including textbooks. The only unpublished information that was included was a submitted review of complications of manipulation.

Articles were selected for inclusion if they contained data on the use, complications, or efficacy of manipulation for the treatment of outpatients with low-back pain. All articles on use and complications were reviewed. For efficacy, all randomized, controlled trials were analyzed, along with important case series, textbooks, and reviews that were recommended by our consulting orthopedists and chiropractors.

Controlled trials of efficacy were assessed by two investigators for quality using the scoring system of Koes and colleagues (4). This scoring system assigns points for the homogeneity, comparability, and follow-up of the study population; the descriptions of the interventions given; the types of outcomes measures used and how they were assessed; and the data presentation and analysis. The maximum score is 100 (Appendix).

A subset of these trials (one trial from each tertile of quality on the Koes and colleagues' scale) was also assessed for quality using the guidelines of Chalmers and colleagues (5).

Statistical combinations of the results of controlled trials of efficacy were done using the confidence profile method of Eddy and Hasselblad (6, 7). The hierarchical Bayesian model employed by this method uses a likelihood function for each study and combines these likelihood functions using a hierarchical random effects model. The model uses an essentially noninformative prior probability with gamma (1/2, 1/2). The result is a joint probability distribution, for the parameters of interest. From this combined distribution, it is possible to calculate the probability that the true value of the effect lies within any specified interval. The 95% probability limits (also called 95% credible set), then, are the values of the parameter that are between 2.5% and 97.5% of the distribution. This is similar to, but not directly analogous to, a 95% confidence interval from classical statistics.

For comparison, we also combined studies using a straight Bayesian model, the method of Peto, and the method of DerSimonian and Laird. The Q statistic, a standard variance weighted formula that follows a chi-square distribution, was used to test for heterogeneity of results. The FAST•PRO meta-analysis software (8) was used for all calculations.

Results

In the United States, chiropractors provide most of the manipulative therapy for which reimbursement is sought. In our analysis of data from the RAND Health Insurance Experiment, chiropractors delivered 94% of the manipulative therapy. We will infer information about the use of spinal manipulation from the limited literature on the use of chiropractic services. Unfortunately, these studies, which are regional, lack adequate sampling schemes, or have possibly outdated databases, do not allow generalization with confidence to current practice. Still, some statements can be made.

The rate of use of chiropractic services is approximately 50 visits per 100 person-years. Chiropractic services are used by about 5% of the total population per year (9, 10). This care is delivered by about 45 000 chiropractors at a cost of approximately $2.4 billion in 1988 (11). Between 32% and 45% of these visits are for low-back pain (10, 12-15). Spinal manipulation accounts for between 61% and 92% of all services for which reimbursement is sought (10, 12-15). The patients average between 5 and 18 visits per episode (9, 10, 12-15). Chiropractic care is most frequently used by persons who are white, middle-aged, and employed (9, 10, 12, 14). It is also used more commonly by persons with a high school education compared with persons with either more or less education (10). A sevenfold differences in the use rate of chiropractic services by geographically defined populations has been observed (10), but causes of these variations in use remain unknown.

Complications

No systematic report of the frequency of complications from spinal manipulative therapy has been published. No complications were reported in the clinical trials of manipulation, which in total comprised more than 1500 patients treated with manipulation. All else that is known comes from case reports (16-24), and there is concern that these represent only a fraction of the total number of complications. A review of the world's literature by Ladermann (21) showed 135 case reports of serious complications, including 18 deaths, due to manipulation. These case reports were published primarily from 1950 to 1980. Most of the complications of manipulation in this series can be attributed to one or more of the following: cervical manipulation, misdiagnosis, presence of coagulation dyscrasias, presence of herniated nucleus pulposus, and improper technique.

Table 1. Quality Scores of Controlled Trials of Manipulation for Low-Back Pain*

Study (Reference)	Methods Criteria																	Total Score 100
	A 2	B 5	C 4	D 3	E 4	F 12	G 10	H 5	I 5	J 5	K 5	L 5	M 10	N 10	O 5	P 5	Q 5	
Ongley et al. (44)	2	4	4	0	4	0	10	5	5	0	0	5	4	4	5	5	5	62
Hadler et al. (35)	2	3	0	0	4	0	10	5	0	0	5	3	6	6	3	5	5	56
McDonald et al. (36)	2	5	0	3	4	0	10	5	0	0	5	0	6	0	3	5	5	53
Meade et al. (2)	1	6	4	0	0	12	0	5	0	0	5	0	8	0	5	0	5	51
Bergquist-Ullman (37)	2	1	2	0	4	6	10	5	0	5	5	2	2	0	5	0	0	49
Waagen et al. (47)	1	2	5	0	0	0	5	5	5	0	5	5	4	4	3	0	5	49
Waterworth et al. (38)	2	5	0	3	4	0	5	5	5	0	5	0	6	0	3	5	0	48
Gibson et al. (48)	1	3	0	3	4	0	0	5	0	5	5	0	8	0	3	5	5	47
Mathews et al. (39)	1	4	2	3	0	6	10	5	0	0	0	0	4	0	5	0	5	45
Glover et al. (52)	1	2	4	3	4	0	5	5	0	5	0	0	2	0	3	5	5	44
Hoehler et al. (53)	1	2	0	0	0	0	5	5	0	5	0	5	6	6	3	0	5	43
Doran et al. (54)	1	0	0	0	2	12	0	5	0	0	0	3	4	2	3	5	5	42
Coxhead et al. (50)	1	0	0	0	4	12	0	5	0	0	0	0	6	0	3	5	5	41
Sims-Williams (55)	1	1	0	0	4	0	5	5	0	5	0	3	6	2	3	0	5	40
Farrell et al. (40)	2	3	0	3	4	0	0	5	0	0	0	0	6	0	3	5	5	36
Godfrey et al. (41)	2	2	0	0	2	0	10	5	0	0	0	0	8	4	3	0	0	36
Zylbergold et al. (56)	1	2	0	3	4	0	0	5	0	0	0	0	6	0	3	5	5	34
Bronfort (58)	1	2	0	0	2	0	5	5	0	0	5	0	4	0	5	0	5	34
Rasmussen (42)	2	0	0	3	4	0	0	5	0	0	0	0	6	0	3	5	5	33
Nwuga (49)	2	3	0	0	0	0	10	5	0	0	0	0	2	2	3	0	5	32
Evans (45)	1	0	0	0	2	0	5	5	0	0	0	0	8	2	3	0	5	31
Cowyer et al. (43)	2	3	0	0	2	6	0	5	0	0	0	0	2	0	3	0	5	28
Edwards (51)	1	0	0	3	4	0	0	5	0	0	0	0	6	0	3	5	5	27
Kinalski et al. (57)	0	0	0	0	4	6	0	0	5	0	0	0	4	0	0	0	5	24
Arkuszewski (46)	0	1	0	0	2	0	0	5	0	0	0	0	4	0	5	0	5	22

* Refer to the Appendix for definitions of the letters, A through Q.

Table 2. Summary of Studies of Manipulation for Acute Low-Back Pain

Author (Reference)	Quality Score	Manipulative Treatment	Comparison Treatment	Sample Size	Result
Hadler et al. (35)	56	Single long-lever manipulation	Mobilization (as sham manipulation)	54	Statistical benefit of manipulation in improvement on functional status index in patients with pain of 2 to 4 weeks
McDonald et al. (36)	53	Osteopathic manipulation with back exercises and instructions	Back exercises and instructions alone	95	Borderline statistical benefit of manipulation in improvement on functional status index in patients with pain of 2 to 4 weeks
Bergquist-Ullman (37)	49	"Combined physiotherapy" including manipulation	Group 1, "back school"; Group 2, diathermy	217	Manipulation statistically better than diathermy, no better than "back school" in relief of symptoms
Waterworth et al. (38)	48	Manipulation and physical therapy	Group 1, Diflunisal; Group 2, back exercises, ultrasound, heat	112	No statistical benefit
Mathews et al. (39)	45	Manipulation	Heat	291	Overall no benefit; statistical benefit of manipulation in recovery for subgroup of patients with limited straight-leg raising
Farrell et al. (40)	36	Maitland manipulation and mobilization	Back exercises and instructions	48	Statistical benefit of manipulation in pain relief after first treatment
Godfrey et al. (41)	36	Rotational manipulation, physiotherapy	Physiotherapy alone	81	No statistical benefit
Rasmussen (42)	33	Rotational manipulation	Diathermy	24	Statistical benefit of manipulation in non-blinded assessment of pain at 2 weeks
Cowyer et al. (43)	28	Cyriax manipulation	Bed rest, lumbar pillow, analgesics	136	Statistical benefit of manipulation in relief of pain at 1 week; benefit was gone at 6 weeks

Cervical manipulation had a greater number of complications, of a more serious nature, than did lumbar manipulation. Chiropractors rarely treat patients who have low-back pain with cervical manipulation as a specific treatment for this type of pain. Our review does not cover cervical manipulation.

Misdiagnosis of the patient's condition accounted for 26 of the 135 complications in the report by Ladermann. Most of these cases involved the unrecognized presence of tumors or metastatic disease. The main complication was delay in diagnosis and treatment. The most serious complication of the manipulation of patients with coagulation dyscrasias was paraplegia from meningeal hematoma.

The development of the cauda equina syndrome is the serious complication of lumbar spinal manipulation that most concerns medical physicians. Haldeman and Rubinstein reported the development of the cauda equina syndrome in 29 patients with the presenting symptom of sciatica treated with lumbar manipulation. (Haldeman S, Rubinstein S. Personal communication.) Sixteen of these patients were manipulated under narcosis or ether anesthesia, which is not a commonly used manipulative technique today. Estimating the frequency with which the cauda equina syndrome occurs in patients undergoing lumbar spinal manipulation is difficult because of uncertainty in both the number of cases that have occurred and the number of lumbar manipulations that have been delivered. Haldeman's review revealed four cases of the cauda equina syndrome that occurred in the United States since 1967. Using data from our community-based study of the use of chiropractic services (10) to provide a rough estimate of the number of lumbar manipulations delivered in the United States during the same period, we estimate the rate of occurrence of the cauda equina syndrome as a complication of lumbar spinal manipulation to be on the order of less than one case per 100 million manipulations. Even if the number of cases of the cauda equina syndrome is underestimated by tenfold, the complication rate is still low.

These data suggest that the risk of lumbar spinal manipulation is small and that it may vary by the clinical condition with which the patient presents. No firm conclusions about the precise level of the complication rate may be drawn, however, because there are few available data. Systematic reports of the rate of complications of spinal manipulation are needed to help estimate better the risk of this procedure.

Efficacy

The efficacy of spinal manipulation for low-back pain must be assessed by the degree of benefit compared with risk patients receive from it. Because no survival benefit has ever been shown or claimed, this assessment is necessarily based on relief of pain, time to relief of pain, improvement in functional status, days lost from work, or similar outcomes. Physiologic variables, such as flexibility and number of degrees of straight leg raising, have been used as outcome measures, but these measures and functional status correlate poorly (25).

For this analysis to be useful for clinicians, the efficacy of spinal manipulation must be examined in terms of the different clinical syndromes with which patients with low-back pain present. As part of our assessment of spinal manipulation, we convened a panel of back-pain specialists, including chiropractors, orthopedists, primary care physicians, and a neurologist, to decide what the clinically meaningful variables are for patients with low-back pain for whom a clinician may want to consider manipulation (26). This panel of experts defined acute low-back pain as pain of less than 3 weeks in duration; subacute low-back pain as pain of between 3 and 13 weeks in duration; and chronic low-back pain as pain of longer than 13 weeks. Sciatic nerve root irritation was defined as typical radicular pain (shooting pain in the posterior thigh or calf) and a straight leg raising sign in the leg with the pain. We will examine the efficacy of spinal manipulation for patients with the clinical syndromes described by these definitions.

Our literature search on efficacy yielded 29 controlled trials of manipulation for low-back pain. We excluded four of these. Two articles used hospitalized patients as their study group (27, 28), whereas our focus is on outpatients; one article (29) presented data that were also reported in more detail in another article already included in our analysis; and one article (30) presented data in insufficient detail to evaluate the conclusions (for example, no sample size was given). The remaining 25 articles form the basis for our analysis of efficacy.

Study Quality

Table 1 shows the studies arranged by descending quality score. The studies range in quality score on the Koes and colleagues' scale from a low of 22 to a high of 62, out of a possible 100 points. For reference, a recent study of high quality that examined the effect of facet joint injection for back pain (31) scored a 78 using the same criteria. A landmark controlled trial reported in 1981 on the use of quadrantectomy for breast cancer (32), which has greatly affected clinical practice, scored a 64. The studies of Arkuszweski (48) and Hadler and colleagues (35), which scored 22 and 56 on the Koes and colleagues scale, respectively, received quality scores of 14 and 55.5, respectively, out of a possible 85, when re-evaluated using the method of Chalmers.

Acute and Subacute Low-Back Pain

Most patients with acute low-back pain without sciatic nerve irritation recover without any specific treatment within a few weeks (33, 34). The nine studies listed in Table 2 tested the effect of manipulation against various other conservative treatments for patients who predominantly had this kind of low-back pain syndrome. The quality scores of the studies ranged from 28 to 56. The two studies with the highest quality scores (35, 36) both showed a statistically beneficial effect of manipulation in patients whose back pain had been present for 2 to 4 weeks. These studies used different composite indices of health status as their outcome measure. The indices used in these studies assessed several different aspects of outcome. The remaining seven studies assessed a single aspect of outcome or assessed several aspects independently. Because the two highest quality studies did not report results independently for the components of their indices, we could not include them in our meta-analysis. We did not, however, neglect these studies. As discussed below, we compared their results with the results of our meta-analysis.

The remaining seven studies (37-43) used recovery from back pain as their outcome measure (Table 3). Although these measures were not identically defined,

Table 3. Outcome Measures Combined in Meta-Analysis of Acute Low-Back Pain Studies

Author (Reference)	Outcome Measure	When Assessed	Number of Patients Recovered	
			Manipulated Group	Comparison Group
Coyer et al. (43)	"Well" (relief of symptoms)	3 wk	58 of 76	36 of 60
Bergquist-Ullman (37)	Return to work	3 wk	30 of 61	25 of 56
Farrell et al. (40)	"Symptom-free," very low pain score, can do all functional activity without difficulty, and objective lumbar movements are without pain	3 wk	22 of 24	15 of 24
Godfrey et al. (41)	1- to 5-point scale of "general symptomatology" dichotomized by the original authors into "marked improvement" or not	Mean, 2 wk	14 of 39	7 of 33
Rasmussen (42)	"Fully restored," no pain, normal function, no sign of disease, fit to work	2 wk	11 of 12	3 of 12
Mathews et al. (39)	6-point pain scale divided into "recovered" and "not recovered"	2 wk	116 of 152	73 of 108
Waterworth et al. (38)	"Excellent overall improvement" by patient self-report	12 d	23 of 38	15 of 36

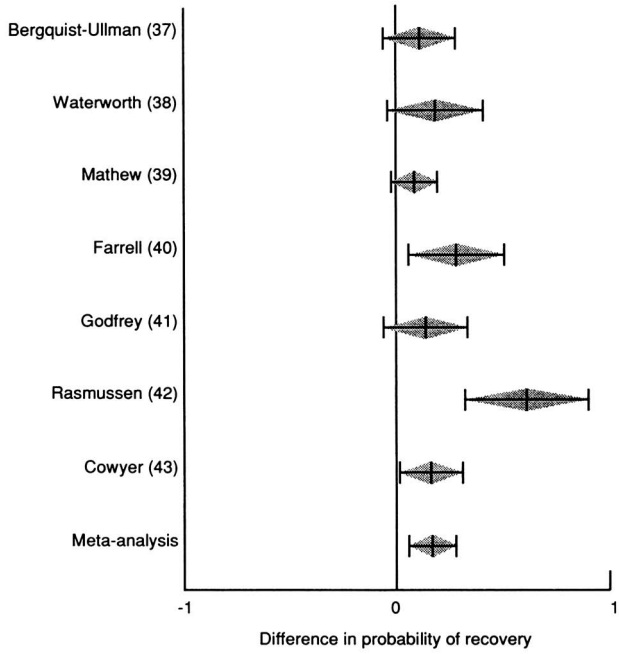

Figure 1. Difference in probability of recovery in seven trials of manipulation. A difference in probability of greater than zero represents a beneficial effect of manipulation. For individual studies, the 95% confidence intervals are shown, and for the meta-analysis, the 95% probability limits are shown.

we combined them using the previously described hierarchical Bayesian model. Figure 1 shows the difference in probability of recovery from back pain (with 95% CIs) for each of the seven studies. The result of the hierarchical combination is that manipulation increased the probability of recovery at 2 or 3 weeks after the start of treatment by 0.17 (95% probability limits, 0.07 to 0.28).

We investigated the sensitivity of our result to the method of combining studies and to the method of selecting studies for meta-analysis. Combining these seven studies using other meta-analytic models gave the following results: a straight Bayesian model, difference in probabilities of 0.15 (95% CI, 0.09 to 0.22); the method of DerSimonian and Laird, difference in probabilities of 0.15 (CI, 0.06 to 0.23); the method of Peto, odds ratio of 2.0 (CI, 1.48 to 2.77).

We examined the effect of manipulation by analyzing different sets of studies (Table 4). The studies of highest quality and second highest quality both showed a statistically significant beneficial effect of manipulation on functional outcomes for patients with low-back pain of between 2 and 4 weeks duration. Our meta-analysis of the remaining seven studies showed a statistically significant effect of manipulation for recovery from low-back pain. If we analyzed the three studies of highest quality (37-39) (those that received quality scores over 40) from among these seven studies using the hierarchical Bayesian model, the difference in probabilities of recovery is 0.11 (95% probability limits, 0.00 to 0.22).

To investigate the potential sensitivity of this analysis to change by the addition of a new study, we calculated the net benefit of manipulation when the above seven studies were combined with potential new studies of varying sample size that showed no benefit (for example, control group and manipulated group had equal probability of recovery at 3 weeks). It would require 250 patients in each arm of the intervention of a new study to decrease the combined benefit of manipulation by just over half.

These studies show that the benefit of manipulation when compared with nonmanipulative conservative therapy is an improvement of between 0.11 and 0.17 in the probability of recovery from back pain, when measured at 2 or 3 weeks from the start of treatment. Clinically, a 0.17 difference in probability means that if the underlying rate of recovery from low-back pain of this type at 2 or 3 weeks is 50% (which is the overall recovery rate of all of the control groups in the above studies), then 67% of patients treated with manipulation will recover in the same period (a 34% improvement in recovery).

When measured, all nine studies showed that any difference between the manipulated and control group is gone within a few weeks to months, consistent with the natural history of the untreated disease. Considering that both of the highest quality studies showed a beneficial effect and that our meta-analysis of the other seven studies also showed a beneficial effect, we conclude that spinal manipulation hastens recovery from acute uncomplicated low-back pain, but its long-term effect, either in preventing the development of chronic low-back pain or in preventing recurrences of acute low-back pain, is unknown.

Chronic Low-Back Pain

Table 5 shows the five studies that examined the use of spinal manipulation for patients with predominantly chronic low-back pain. They received quality scores from 22 to 62. Because the study of highest quality (44) included a soft-tissue injection of "proliferant" to the manipulated group, the contribution of manipulation alone to the beneficial effect seen in this study is impossible to discern. The study by Evans and associates (45), which received a quality score of 31 and showed a benefit for manipulation, used a crossover design with patients acting as their own controls and is not comparable to the other studies. Of the remaining three studies, that of Arkuszweski (46), which received the lowest quality score, is not comparable to the other two because in Arkuszweski's study, 84% of the patients had sciatic nerve irritation, whereas this patient group was specifically excluded from the other two studies. Of the other two studies, both received comparable quality scores; both used change on a visual analog scale as an outcome measure; one showed a benefit (47) and one did not (48). Thus, on the basis of these studies, the data are insufficient to support or refute the efficacy of spinal manipulation for patients with chronic low-back pain.

Low-Back Pain with Sciatic Nerve Root Irritation

Table 6 presents the three studies that examined the use of spinal manipulation for patients with low-back pain and sciatic nerve root irritation. All three received

relatively low quality scores, ranging from 28 to 41. The study by Nwuga (49) used outcome measures of uncertain importance (total number of minutes receiving manipulation or diathermy until pain relief, degrees of flexion, rotation, and straight leg-raising compared to baseline within groups), making his demonstrated benefit of manipulation compared with diathermy of questionable clinical significance in terms of improved functional patient outcomes. The other two trials were combined on the outcome measures, "patient better" (measured at 4 weeks) from the Coxhead and colleagues' study (50) and "good or satisfactory result" (measured after up to 14 treatments) from the Edwards (51) study, using the hierarchical Bayesian model. The difference in probabilities of this improvement was 0.098 favoring manipulation (95% probability limits, − 0.016 to 0.209). We conclude from this result, when considered in the context of the poor quality of these two studies and the possibility of a greater frequency of serious complications in this patient group, that it is premature to recommend manipulation for these patients without further well-designed and well-conducted efficacy studies.

Other Studies

Many randomized controlled trials of spinal manipulation either included persons with both acute and chronic back pain in their patient group or failed to define their patient group. We identified nine such studies, ranging in quality score from 24 to 51. The highest quality study (2) was not a study of manipulation per se but rather a study of "chiropractic care" compared with "medical care" for patients with a variety of low-back pain syndromes; it showed a small but statistically significant long-term benefit in favor of chiropractic care. It is impossible to estimate the relative contribution that spinal manipulation alone made to the overall beneficial effect seen. Of the remaining eight studies, four showed a statistical benefit for manipulation (52-55), three showed no benefit (51, 56, 57), and one reached no conclusion (58). We could not include any of these studies in our analysis because of the heterogeneous or undefined nature of the patients they studied.

Other Clinical Syndromes

Spinal manipulation has not been shown to reduce a herniated nucleus pulposus physically. In fact, two studies (59, 60) showed no difference myelographically in disc protrusion before and after manipulation. Many patients reported an improvement in symptoms despite the apparent absence of change in their disc protrusion. In the study by Chrisman and coworkers (60), most patients who had chronic pain had an "excellent" or "good" improvement in pain relief (35 of 39); however, 10 of these patients had recurrences requiring surgery.

The Quebec Task Force (61), which dealt with the usefulness of a variety of conservative modalities as treatments for low-back pain, classified "mobilization/manipulation" as "contraindicated on the basis of scientific evidence" for lumbar spinal disorders with confirmed or presumed radicular compression. They cited no data to support this statement.

Central spinal stenosis has not been subjected to a controlled trial of manipulative therapy. Kirkaldy-Willis and Cassidy (62) feel it responds substantially less well to manipulation than other indications; they reported 2 of 11 patients were "symptom-free" and an additional 2 had only "mild intermittent pain" after manipulation. These 11 patients were "a small, select group of patients with central spinal stenosis who were unfit for surgery." Cox (63) feels as well that central spinal stenosis or medial disc protrusion responds poorly to manipulation.

There are no controlled trials of manipulation in patients with chronic low-back pain who had previously had a laminectomy. Two case series, however, report somewhat conflicting results. In the series by Potter (64), previous laminectomy did not alter the response of patients with chronic low-back pain to manipulation, with or without neurologic findings. Kirkaldy-Willis and Cassidy (62), however, reported a 72% response rate in patients without previous laminectomy and a 64% response rate in patients with previous laminectomy in patients with chronic back pain of all kinds.

No controlled trials exist to determine the prognostic influence of spondylolisthesis in response to manipulation for back pain. Mierau and colleagues (65) reported that the response of patients with chronic low-back pain with and without spondylolisthesis is equivalent. There is no evidence that spinal manipulation can reduce a spondylolisthesis.

How Many Manipulations Are Necessary?

Joint fixation is defined as an abnormal movement of a joint (excluding hypermobility) and is usually detected

Table 4. Results of Synthesis of Studies for Efficacy of Spinal Manipulation for Acute Low-Back Pain without Sciatic Nerve Irritation

Source of Data (Reference)	Measure of Effect
Study with highest quality score (35)	For patients with low-back pain of between 2 and 4 weeks duration, manipulated patients achieved a 50% reduction in pain score more rapidly than those who received mobilization ($P < 0.03$).
Study with second highest quality score (36)	For patients with low-back pain of between 2 and 4 weeks duration, manipulated patients had 46% improvement on a disability index at 1 week compared with 17% improvement for controls ($P < 0.04$).
Meta-analysis of seven combined studies	Manipulated patients had a 0.17 improvement in the probability of recovery at 3 weeks (95% probability limits, 0.07 to 0.28).
Meta-analysis of subgroup of three combined studies with highest quality scores	Manipulated patients had a 0.11 improvement in the probability of recovery at 3 weeks (95% probability limits, 0.0 to 0.22).

Table 5. Summary of Studies of Manipulation for Chronic Low-Back Pain

Author (Reference)	Quality Score	Manipulative Treatment	Comparison Treatment	Sample Size	Result
Ongley et al. (44)	62	Rotational manipulation and soft-tissue injection of "proliferant" and back exercises	Sham manipulation, soft-tissue saline injection, and back exercises	81	Manipulated group had statistically better functional outcomes
Waagen et al. (47)	49	Chiropractic adjustments	Sham adjustments	19	Statistical benefit on pain score of manipulation at 2 weeks
Gibson et al. (48)	47	Osteopathic manipulation	Diathermy	109	No statistical benefit
Evans et al. (45)	31	Rotational manipulation and codeine	Codeine alone	32	Statistical benefit of manipulation in pain score; crossover design
Arkuszweski (46)	22	Manipulation and mobilization with aspirin, diazepam, and massage	Aspirin, diazepam, and massage	100	Statistical benefit of manipulation in pain relief and return to work; nonblinded assessment

by palpation (26). A lack of agreement exists among nonchiropractic clinicians that this is a clinically definable entity. It is many chiropractors' clinical experience that patients with evidence of joint fixation and a recent episode of back pain are at higher risk for relapse than those without evidence of joint fixation. Because of this, many chiropractors believe that these patients should undergo manipulation to relieve the undesirable joint restriction, believing that this brings a more durable improvement in symptoms. This series of beliefs, however, has not been subjected to rigorous study.

The scientific literature is not helpful in deciding the appropriate frequency or duration of spinal manipulative care. The literature reports controlled trials or case series with between 1 and 19 sessions of manipulation lasting from a single day to 2 months. It is unclear how many, if any, manipulations are necessary or whether they should end before or after the patient has become pain-free.

Future Research

Several of the studies of efficacy in this review compared patients receiving combined therapies that included spinal manipulation with control patients receiving other therapies (37-40, 42, 43, 48-51). Treatments provided with spinal manipulation included back exercises, ergonomic instructions, mobilization, and medications. In these studies, the component of the combined therapy most responsible for the therapeutic benefit is unknown. Several studies, however, compared patients receiving manipulation with those receiving a sham manipulation (35, 47, 53) or combined therapies where the only difference is the addition of manipulation (36, 41, 45, 47). From this analysis, we conclude that there may be several beneficial components of therapy for patients with low-back pain and that spinal manipulation, in some patient groups, is one of these components. The extent to which other treatments contribute to the efficacy of spinal manipulation is unknown and should be studied further.

To help define better those patients for whom spinal manipulation may be of benefit, as well as the magnitude and cost of that benefit, goals of future research should include rigorous randomized, controlled trials of patients with clinically homogeneous low-back pain syndromes, who receive well-defined interventions and control treatments and who are assessed for response with valid measures of functional outcomes. Research is needed to establish the efficacy of manipulation for patients with chronic low-back pain and sciatic nerve root irritation and low-back pain; the rate of complications of manipulation; the number of manipulations needed to

Table 6. Summary of Studies of Manipulation for Sciatic Nerve Root Irritation

Author (Reference)	Quality Score	Manipulative Treatment	Comparison Treatment	Sample Size	Result
Coxhead et al. (50)	41	Maitland manipulation	Group 1, back exercises; Group 2, traction; Group 3, corset	322	Borderline statistical benefit of manipulation for pain relief at 4 weeks
Nwuga (49)	32	Rotational manipulation	Exercises and heat	51	Statistical benefit of manipulation in some, not all, spinal mobility variables; no functional outcomes measured
Edwards (Group IV) (51)	27	Maitland manipulation	Heat, massage, and exercises	46	Borderline statistical benefit of manipulation in relief of pain and resumption of normal activities

achieve the maximum response; and the cost-effectiveness of manipulation compared with other forms of conservative care.

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Appendix

Criteria for assessing the methods of studies of efficacy of spinal manipulation (from Koes and colleagues) (4).

A Description of inclusion and exclusion criteria (1 point). Restriction to a homogeneous study population (1 point).
B Comparability for duration of complaints, value of outcome measures, age, recurrences, and radiating complaints (1 point each).
C Randomization procedure described (2 points). Randomization procedure that excludes bias (for example, sealed envelopes) (2 points).
D Information about which group from which patients withdrew and reason for withdrawal (3 points).
E Loss to follow-up: all randomized patients minus the number of patients at main point of measurement of the main outcome measure, divided by all randomized patients, multiplied by 100 (maximum, 4 points).
F Smallest group immediately after randomization (> 50 subjects in smallest group, 6 points; > 100 subjects in smallest group, 6 additional points).
G Manipulative treatment explicitly described (5 points). All reference treatments explicitly described (5 points).
H Comparison with an established treatment (5 points).
I Other physical treatments or medical interventions avoided in the design of the study (except analgesics; advice on posture; or use at home of heat, rest, or a routine exercise scheme) (5 points).
J Comparison with placebo (5 points).
K Citation of qualified education or experience, or both, of the manipulative therapist (5 points).
L Placebo-controlled study: attempt at blinding (3 points), blinding evaluated and fully successful (2 points). Pragmatic study: patients fully naive (3 points) or time restriction (no manipulative treatment for at least 1 year) (2 points); naiveness evaluated and fully successful (2 points).
M Measured and reported use of pain, global measurement of improvement, functional status (activities of daily living), spinal mobility, use of drugs and medical services (2 points each).
N Each blinded measurement mentioned under point M earns 2 points.
O Outcome of measures assessed during or just after treatment (3 points). Outcome of measures assessed 6 months or longer (2 points).
P When loss to follow-up is less than 10%: analyses on all randomized patients for main outcome measures and on the most important points of measurement minus missing values, regardless of noncompliance and co-interventions (5 points). When loss to follow-up is greater than 10%: intention-to-treat as well as an alternative analysis that accounts for missing values (5 points).
Q For main outcome measures and at main times of measurement: In the case of (semi-) continuous variable, presentation of the mean or median with standard error or centiles (5 points).

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