

# Perspectives In Neuroscience



A Quarterly Publication for Continuing Medical Education

Central Illinois Neuroscience Foundation

Date of Original Release: March 2005

## Spinal Manipulation: An Overview

*Stephan J. Troyanovich, D.C.*

*Central Illinois Neuroscience Foundation, Bloomington, IL and Life Chiropractic College—West, Hayward, CA*

This quarterly publication is designed for primary care physicians, neurosurgeons, neurologists, neuroradiologists, and other practitioners. The purpose of this publication is to provide these physicians with current management strategies for dealing with a variety of disorders and conditions in the neurosciences, and to provide up-to-date diagnostic and prognostic information written by specialists in the field. It is estimated that it will take the physician 1 hour to complete the activity. The questions at the end of each lesson are designed to test and evaluate the participants' comprehension of the topic. This CME program is sponsored by the Central Illinois Neuroscience Foundation and funded by grants and donations. This CME activity was planned and produced in accordance with the Illinois State Medical Society's Essential Areas for Continuing Medical Education. The Central Illinois Neuroscience Foundation is accredited by the Illinois State Medical Society to provide continuing medical education for physicians. The Central Illinois Neuroscience Foundation designates this activity for a maximum of 1 hour of category 1 credit towards the American Medical Association's Physician Recognition Award. It is the intent of the Central Illinois Neuroscience Foundation to assure that its educational mission, and Continuing Medical Education activities in particular, are not influenced by the special interests of individuals associated with its program.

### OBJECTIVES

At the conclusion of the activity, the participant should be able to:

1. Define spinal manipulation and discuss its basis for the treatment of soft tissue lesions.
2. Review the efficacy of spinal manipulation for neck pain, back pain, and headache.
3. Compare the risks and benefits of spinal manipulation to other common medical treatments.

### FORWARD

The time devoted to spinal manipulative therapy as part of the curriculum for clinicians in all fields varies from school to school. This issue of Perspectives in Neuroscience offers the opportunity to physicians, nurses, and allied health professionals to learn more about this treatment methodology and its application to the common complaints of neck, back, and headache pain frequently seen in the practitioner's office. ~Ann R. Stroink, MD, Editor & Director of Continuing Medical Education.

### INTRODUCTION

Spinal manipulation is an ancient healing art practiced by a wide variety of cultures. The earliest known recorded reference to spinal manipulation is found in a Chinese document dating approximately 2700 BC.<sup>1</sup>

The term "*spinal manipulation*" has been used to connote anything from the gentle stroking of the paraspinal soft tissues to a "*gross assault*" upon the articulations of an unconscious patient.<sup>2</sup> Medical manipulators Bourdillon, Day and Bookhout state, "*There is still disagreement as to the breadth of the meaning of the word manipulation. In Europe the term is used, in this context, almost solely for procedures involving a high velocity, low amplitude, thrusting movement. In North America it is used in a much wider sense, to include any active or passive movement initiated, assisted or resisted by the operator. This includes treatments sometimes listed as articulation, mobilisation, isometric and isotonic techniques, myofascial, functional or indirect and even craniosacral techniques.*"<sup>3</sup>

### SPECIFIC DESCRIPTIONS

Chiropractic physicians utilize several methods to induce controlled, forced movements of spinal joints in the treatment of neuromusculoskeletal disorders. Using various techniques, the high velocity, short amplitude thrust, referred to above, is the method of manipulation most commonly used by chiropractic physicians. Two specific descriptions have been proposed by chiropractors and physiotherapists: paraphysiologic joint space manipulation and graded mobilization.

#### *Paraphysiologic Joint Space Manipulation*

Chiropractic manipulators Haldeman,<sup>4</sup> Kirkaldy-Willis and Cassidy<sup>5</sup> have described a model of the high velocity, short amplitude thrusting movements used by chiropractors which they refer to as paraphysiologic joint space manipulation. In this model of synovial joint manipulation, three ranges of motion are discussed—the active range of motion, the passive range of motion, and the paraphysiologic range of motion of the involved joint(s).

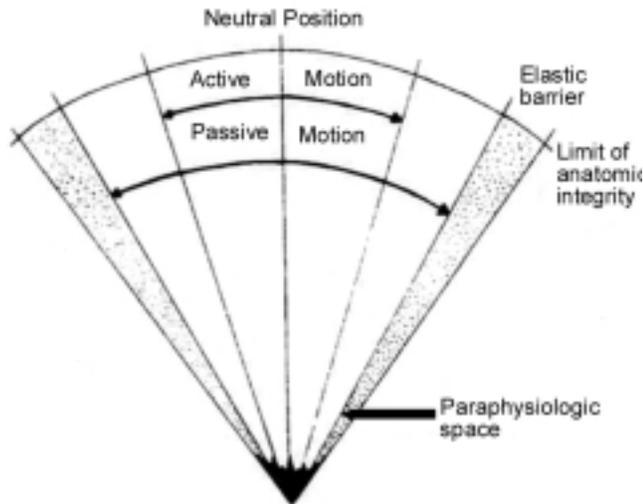
The active range of motion is defined as that range in which the muscles acting over the joint can produce movement. The passive range of motion is that additional range through which the joints can be moved by an external force acting on the joints.

For example, using the intrinsic muscles of your forearm and hand, flex and extend your right index finger maximally. This action induces the maximum active range of motion of your right first metacarpophalangeal joint. Next, gently force your right index finger further into extension using your left hand. The additional extension induces the additional passive range of



central illinois  
**NEUROSCIENCE**  
**FOUNDATION**

(800) 997-CINF



**Figure 1:** A graphic representation of the active, passive, and paraphysiologic ranges of motion of a synovial joint.

motion allowed by the right first metacarpophalangeal joint, tendons and ligaments.

The paraphysiological range of motion is the small amount of additional movement that may be passively forced beyond the maximal passive range of motion, but just short of the limits of the anatomical integrity of the joint (i.e. just before the joint would become dislocated).

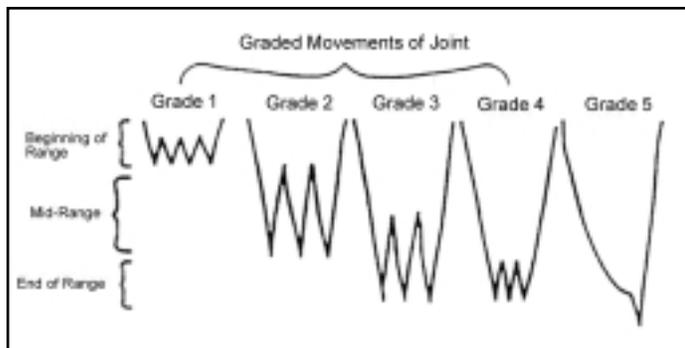
Kirkaldy-Willis and Cassidy state: "At the end of the passive range of motion an elastic barrier of resistance is encountered. This barrier has a spring-like end-feel which is the result of a negative subatmospheric intra-articular pressure. This negative pressure is a stabilizing factor in the coaptation of the articular surfaces. If the separation of the articular surfaces is forced beyond this elastic barrier, the joint surfaces suddenly move apart with a cracking noise. This additional separation can only be achieved after cracking the joint. This has been labeled the paraphysiological range of motion. This constitutes a manipulation."<sup>5</sup>

Graphic representations of these three ranges of motion are presented in Figure 1.

### Graded Mobilizations

Another model of *controlled*, forced, passive movements of synovial joints is presented by Saunders.<sup>6</sup> Saunders, a medical physiotherapist, discusses the idea of graded mobilizations of synovial joints ranging from gentle movements performed within the beginning of the range of motion to forced, controlled movements that take the joint to the limit of anatomical integrity (Figure 2). The movements are graded as follows:

- Grade 1—gentle movements of small amplitude done at the beginning



**Figure 2:** Graphic representations of graded mobilizations of a synovial joint.

of the available range of motion of the joint

- Grade 2—gentle movements of large amplitude done into the available midrange of motion of the joint
- Grade 3—moderate movements of large amplitude done through the available range of motion of the joint and extending into any restriction of movement
- Grade 4—oscillating movements of small amplitude done at the end of the available range of the motion of the joint and into any restriction of movement
- Grade 5—high velocity, short amplitude thrusting movements performed up to the anatomic limits of the joint

As described, a Grade 5 mobilization is equivalent to paraphysiological joint space manipulation.

## WHY DO CHIROPRACTORS MANIPULATE JOINTS?

Prolonged rest and/or immobilization have been shown to cause a variety of adverse biomechanical and biochemical changes in injured joint tissues. In regards to these adverse effects, medical orthopedist Cyriax states, "when non-bacterial inflammation attacks the soft tissues, that move, treatment by rest has been found to result in chronic disability later, although the symptoms may temporarily diminish. Hence, during the past century, treatment by rest has given way to therapeutic movement in many soft tissue lesions. Movement may be applied in various ways: the three main categories are, 1) active and resistive exercises; 2) passive, especially forced movement; and 3) deep massage."<sup>7</sup>

Chiropractic physicians have always advocated therapeutic movement as a means to limit the adverse effects of joint immobilization and to promote health. The most common conditions treated by chiropractic physicians are low back pain, neck pain, extremity pain, and headache.<sup>8</sup> Research has been accumulating over the past two decades that confirms the clinical effectiveness of chiropractic manipulation for these conditions.

For example, a clinical practice guideline published by the Agency for Health Care Policy and Research (AHCPR), a division of the U.S. Department of Health and Human Services, states, that for acute low back problems in adults: "Relief of discomfort can be accomplished most safely with nonprescription medication and/or spinal manipulation."<sup>9</sup> The AHCPR recommendations were made after an exhaustive review of over 350 scientific articles on the subject of low back pain including 37 **randomized controlled trials** of spinal manipulation for low back pain. The randomized controlled trials demonstrated the safety and efficacy of spinal manipulation in the treatment of acute low back pain in comparison to other methods of care. It is important to note here that acute low back pain was defined by the AHCPR to be, "...back and back related leg pain of less than three months duration."<sup>9</sup>

Patients suffering with back pain make up approximately two-thirds of chiropractic practice. The remaining one-third of patients who treat with chiropractic physicians almost entirely suffer with neck pain and headache. The treatment of neck pain and headache by spinal manipulation has also received much attention in the scientific literature.

An article published in the medical journal *Spine* reviewed the effectiveness of spinal manipulation for the treatment of neck pain and headaches.<sup>10</sup> The article summarized the findings of multiple clinical trials of chiropractic manipulation as compared to different medications, physical therapy, cold packs, acupuncture, etc. In general, chiropractic manipulation of the neck was found to be superior in terms of reducing tension headache frequency, intensity, and improving functional status of patients when compared to other standard medical treatments. With respect to chiropractic manipulation of the neck for the treatment of migraine headache, which is thought to have a cervical etiology in some cases, the article states, "Chiropractic patients reported greater reductions in frequency

and intensity of attacks after 2 months and statistically significantly less pain intensity compared with the other groups. Chiropractic patients were more likely to have had no recent attacks after 20 months." Chiropractic manipulation for neck pain was also found to be safe and effective as demonstrated by at least four prospective randomized controlled trials.

## IS SPINAL MANIPULATION A SAFE PROCEDURE?

A commonly held opinion by critics of spinal manipulative therapy is the notion that the procedure is unsafe, seriously injuring or killing hundreds of people each year. Much of the misinformation that continues to exist regarding the safety of spinal manipulative therapy stems from a well orchestrated campaign by opponents of the profession.

In 1963, adversaries of the profession established a plan to eliminate Chiropractic as a competitor in the healthcare marketplace.<sup>11,12</sup> As part of their illegal campaign, the text, *At Your Own Risk: The Case Against Chiropractic*, a book written by journalist Ralph Lee Smith, to over 1000 of the nations largest libraries.<sup>11</sup> In his text, Smith portrayed the chiropractic profession in an extremely unfavorable light and further implied that chiropractic manipulative therapy was an unsafe treatment method often resulting in serious injury.<sup>13</sup>

In 1987 the federal court system found Chiropractic's opponents guilty of violating federal antitrust laws and was forced to pay damages and abandon its overt attacks against the profession of chiropractic.<sup>11,12</sup> Unfortunately, myths, legends, and lies do not often die an easy death, and residual effects continue to linger. Perhaps one of the greatest injustices of these unlawful tactics is that today, patients continue to be discouraged from seeking spinal manipulative therapy due, in part, to the misinformation pedaled as "truth" in the early 1960s.

But, what is the truth? Is spinal manipulative therapy performed by chiropractic physicians or others (osteopaths, physical therapists) safe? Reports of stroke secondary to spinal manipulative therapy have been reported in the medical literature. If spinal manipulation is capable of causing stroke, what is the mechanism of injury? What is the incidence of stroke secondary to cervical spinal manipulation? Who is the high

risk patient? How does cervical spinal manipulation compare in terms of safety to standard medical treatments? Because this is a topic of great interest in some healthcare circles, the remainder of this article will focus on these topics.

### Clinical Anatomy and Biomechanics

The vertebral arteries are paired vessels that track cranially through the transverse foramina of the transverse processes of cervical vertebrae 1 through 6. The vertebral arteries then pass posteriorly and medially around the lateral masses of the Atlas vertebra, ascend through the foramen magnum of the occiput, and then converge to form the basilar artery (Figure 3).

Fifty percent of axial rotation allowed by the cervical spine occurs between C1 and C2.<sup>14</sup> Full axial rotation of the head may result in up to 50 degrees of rotation of C1 on C2. When this occurs, the vertebral arteries that course through the transverse foramina of C1 and C2 undergo deformation to accommodate this movement (Figure 4). This physiologic motion is generally

well tolerated and blood flow to the posterior fossa is maintained due to the bilateral supply offered by intact vertebral arteries. However, in rare cases when certain pathologic processes are present, such as fibromuscular dysplasia,<sup>15</sup> or when one vertebral artery is abnormally narrow,<sup>16</sup> maximum axial rotation of the head and neck may result in compromise of circulation to the territories supplied by the vertebral arteries. This reduction in blood flow may occur as a result of injury to the vessel (vertebral artery dissection) with full rotation, or it may result simply due to intermittent occlusion caused by the movement.

Of note is that axial rotation has been shown to be the motion that has the greatest potential for this phenomenon to occur. Blood flow compromise of the magnitude described above has not been demonstrated with other movements of the head and neck such as flexion, extension, or side-bending.<sup>17</sup> This is important information that the practitioner can employ to reduce risk when devising manipulative treatment strategies for injured or ill patients seeking care.

### Incidence

The exact incidence of vertebralbasilar stroke secondary to cervical spinal manipulation is not known. Data based estimates in the literature suggest it is a rare event ranging from 1 stroke in 2 million cervical manipulations to 1 stroke in 500,000 manipulations.<sup>18</sup> The most commonly cited incidence is 1 stroke per 1 million cervical manipulations. For patients with conditions amenable to cervical spine manipulation, the average course of treatment is ten sessions per year. This would result in an annual incidence rate of about 1 vertebralbasilar stroke per 100,000 patients per year.

Vick et al.<sup>19</sup> performed a retrospective review of the English language medical literature over a 68-yr period from 1926 to 1993. They discovered a total of 128 articles from fifteen different countries that reported injuries as a result of spinal manipulation. From these sources a total of 185 specific serious complications were reported from manipulation of the cervical, thoracic, or lumbar spine. The breakdown of the type and number of injuries reported as a result of this review is as follows: cerebrovascular accident-123, disc herniation-23, bone fracture/dislocation-14, neural encroachment-12, general increase in pain-6, complication of undiagnosed tumor-3, cardiac arrest-1, tracheal rupture-1, abdominal aorta rupture-1, unreported injury-1.

Regarding these injuries, Vick et al. state, "Of the estimated several hundred million manipulative treatments performed each year, only 185 reports of injury were found in the published literature during the past 68 years. Comparing these figures with the incidence of adverse effects (including death) associated with many pharmaceutical agents, manipulative treatment remains an extremely safe, therapeutic modality when performed by a knowledgeable and skilled practitioner."<sup>19</sup>

The 123 reported cerebrovascular accidents may lead one to conclude that manipulation of the cervical spine is a particularly risky procedure. However, when compared to other healthcare interventions for the same conditions, cervical spine manipulation is a safe and efficacious treatment option.

In a 1996 article authored by Dabbs and Lauretti<sup>18</sup> compared the risks of serious complications or death for patients receiving a course of manipulative treatment or nonsteroidal anti-inflammatory drugs for the treatment of neck pain. As a result of their review of the scientific literature on the subject the authors stated, "... the best available data suggests that the risk of serious neurovascular complication from cervi-



Figure 4: The vertebral arteries are deformed (stretched and compressed) with axial rotation of the head. Maximal axial rotation is depicted in the illustration above.

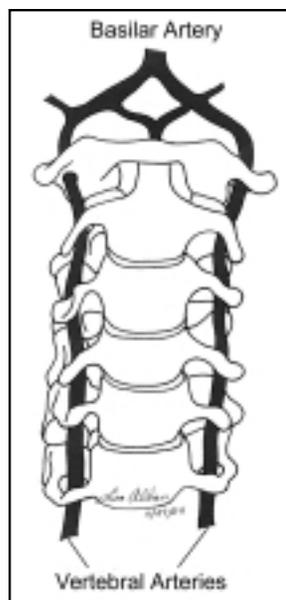


Figure 3: The vertebral arteries are paired vessels that track cranially through the transverse foramina of the transverse processes of C6 through C1.

cal manipulation is approximately one incident per 100,000 patients receiving a course of treatment per yr, or 0.001%. The estimated risk of death from cervical manipulation is one death per 400,000 patients receiving a course of treatment per yr, or .00025%. The risk of serious gastrointestinal complication requiring hospitalization because of NSAID use for similar conditions (i.e., a diagnosis of osteoarthritis [OA]) is 0.4% per year. The risk of death from hemorrhage or ulcer perforation attributable to NSAID use for OA is 0.04%. **Therefore, based on the best available evidence, we calculate the risk of serious complications or death is 100-400 times greater for the use of NSAIDs than for the use of cervical manipulation in the treatment of similar conditions.**<sup>18</sup> (emphasis added).

Similarly, an article published in the medical journal *Spine* compared the risks for cervical spine manipulations, use of NSAIDs, and cervical spine surgery.<sup>20</sup> Hurwitz et al.<sup>20</sup> report an average risk of vertebrobasilar accident, major impairment or death as 7.5 per 10,000,000 manipulations. They further report an average incidence rate of serious gastrointestinal event (bleeding, perforation, or other adverse event resulting in hospitalization or death) from the use of NSAIDs as 1 per 1000 subjects. And finally, they report an average incidence rate of neurologic complication or death from cervical spine surgeries as 11.25 per 1000.

### Onset, Signs & Symptoms

Terrett<sup>21</sup> performed an excellent review of 177 cases of vertebrobasilar stroke following cervical spine manipulation that appeared in the English, French, German, Scandinavian, and Chinese health care literature between the years of 1934 and 1994. He found that the onset of signs and symptoms of stroke following spinal manipulative therapy (SMT) occurred during the procedure or within moments or minutes of the procedure in almost 70% of the cases. Approximately 10% experienced the onset of signs and symptoms within one hour, about another 15% within 24 hours, and the remainder beyond 24 hours of the procedure.

Interestingly, in those cases where the type of cervical spine manipulation is described, axial rotation of the head and neck occurred in 95%.

The cardinal symptoms of stroke following cervical spine manipulation are light headedness, vertigo, or dizziness. This may also be accompanied by loss of consciousness, diplopia, dysarthria, dysphagia, ataxia of gait, nausea (with or without vomiting), numbness in the face and/or body, and nystagmus.

### Demographics

Strokes of all kinds occur at an annual incidence rate of about 200 per 100,000 individuals. The incidence rises steeply with advancing age and is slightly more common in men than in women.<sup>22</sup> In contrast to the demographic profile associated with ischemic strokes, individuals suffering from stroke secondary to cervical artery dissections are more frequently women less than 45 years of age. The reported annual incidence rate of vertebral artery dissections is 1 to 1.5 per 100,000.<sup>23-25</sup>

Perhaps not coincidentally, the overall demographics of patients suffering vertebral artery dissections with stroke match those of the patient who may suffer a vertebrobasilar stroke secondary to cervical manipulative therapy.<sup>21</sup> That is to say, the typical patient suffering a stroke secondary to cervical spine manipulation tends to be a female between the ages of 26 and 45—they very same high risk individual for vertebral artery dissections in general. It should also be noted that the occurrence rates described above are essentially identical for both groups.

### Practitioners

Terrett<sup>21</sup> also reports on the type of practitioner with whom the 177 cases of stroke secondary to cervical spine manipulation were treated. His results are summarized in Table 1. As noted in the table, eleven cases were performed by lay manipulators and in twenty-two cases, the type of practitioner is unknown. Of the remaining 144, a chiropractic physician is implicated in 99, a medical physician in 25, an osteopathic physician in 13, and a physiotherapist in 7.

The Rand corporation published a report on spinal manipulation in 1991.<sup>26</sup> Rand reports that 90-95% of all spinal manipulative therapy

performed in the United States is carried out by chiropractic physicians with the remaining 5-10% predominantly performed by physiotherapists and osteopathic physicians. If all practitioners are equal in their skill and safety, then 90-95% of all strokes precipitated by cervical spine manipulation should be attributable to chiropractic physicians. However, Terrett's data on the type of practitioner inducing a stroke in a patient indicates that, at worst, only 68% of the reported strokes were precipitated by a chiropractic physician. This implies that cervical spine manipulation applied by chiropractic physicians may be safer than that applied by the other manipulative practitioners.

That cervical spine manipulation applied by chiropractic physicians may be safer than that applied by other practitioners could be due to the fact that the biomechanics of cervical spine motion and vertebral artery dissections is a subject that receives a great deal of attention in chiropractic training. In order to reduce risk, many chiropractic physicians simply

Practitioner	Number of cases of stroke	Percentage of total cases
Chiropractic Physician	99	56%
Medical Physician	25	14%
Osteopathic Physician	13	7.3%
Physiotherapist	7	4.0%
Other lay manipulator	11	6.2%
Unknown	22	12%

**Table 1.** Breakdown of type of practitioner for 177 cases of stroke following cervical spine manipulation. Data from Terrett<sup>21</sup> reported over a 60 year period. The Rand Corporation reports that 90-95% of all spinal manipulative therapy performed in the U.S. is carried out by chiropractic physicians.<sup>26</sup>

choose NOT to perform manipulations that induce maximum axial rotation of the head and neck due to the fact that such motion places the patient at the highest risk for a stroke to occur.

## CONCLUSION

Spinal manipulation is an ancient healing art that has found popular acceptance among the healthcare consuming public. Over 50 prospective randomized trials demonstrate the clinical effectiveness of spinal manipulative therapy for headache, neck pain, and back pain. Although risks for adverse events exist in the application of spinal manipulative therapy, the risks are lower than for common medical treatments such as the prescription of NSAIDs. There is evidence that suggests that spinal manipulation as applied by chiropractic physicians may be safer than that applied by other practitioners of manual therapy. In light of these facts, spinal manipulation as provided by chiropractic physicians should be the choice of treatment for many patients suffering with mechanical neck and back pain and headache of cervical origin.

## REFERENCES

- Breasted JH. The Edwin Smith surgical papyrus. Vol. I. Chicago: Univ. of Chicago Press. 1930.
- Mennel JM. History of the development of medical manipulative concepts: medical terminology. In: The research status of spinal manipulative therapy. Washington, DC: U.S. Dept. of Health, Education, and Welfare. NINCDS Monograph No. 15. 1976.
- Bourdillon JE, Day EA, Bookhout MR. Spinal Manipulation. Oxford: Butterworth-Heinemann Ltd. 1992.
- Haldeman S. Modern developments in the principles and practice of chiropractic. New York: Churchill Livingstone 1980.
- Kirkaldy-Willis WH, Cassidy JD. Spinal manipulation the treatment of low back pain. *Can Fam Physician* 1985; 31:535-40.
- Suanders HD. Evaluation, treatment and prevention of musculoskeletal disorders. Minneapolis: Viking 1988.
- Cyriax J. Orthopaedic medicine, diagnosis of soft tissue lesions (Vol D). London: Bailliere Tindall 1982.
- Hurwitz EL, Coulter ID, Adams AH, Genovese BJ, Shekelle PG. Use of chiropractic services from 1985 through 1991 in the United States and Canada. *Am J Public Health* 1998; 88:771-6.



**CME ACCREDITATION**

The Central Illinois Neuroscience Foundation is accredited by the Illinois State Medical Society to provide continuing medical education for physicians.

**CME CREDIT DESIGNATION**

The Central Illinois Neuroscience Foundation designates this educational activity for a maximum of 1.0 hour in category 1 credit towards the AMA Physicians Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

**TO RECEIVE CME CREDIT**

To receive CME credit for this activity, the participant must correctly answer 70% of the Continuing Medical Education Questions. Please return a copy of this page via mail or fax with the requested information and completed answers by May 1, 2005 to: Central Illinois Neuroscience Foundation, 1015 South Mercer Avenue, Bloomington, IL 61701; Fax: (309) 663-2344. Your answers will be graded by the author and the corrected form will be returned with your CME certificate.

**Continuing Medical Education Questions**

1. Spinal manipulation is a term that has been used to describe a wide variety of manual treatment methods from gentle massage to forceful manipulation under anesthesia.  
 True  False
2. The parapsychologic joint space manipulation and a Grade V mobilization are equivalent procedures.  
 True  False
3. Although rest or immobilization initially relieves pain in acute soft tissue injuries of the spine, it has been shown to increase disability in the long run.  
 True  False
4. Over 50 prospective randomized trials have demonstrated effectiveness of spinal manipulative therapy in the treatment of back pain, neck pain, and cervicogenic headache.  
 True  False
5. Stroke secondary to cervical spinal manipulation occurs at an annual incidence rate estimated at about 1 per 100,000 people taking a course of treatment per year.  
 True  False
6. Vertebral artery dissections occur in the general population at about the same annual incidence rate as that of vertebrobasilar stroke secondary to cervical spinal manipulation.  
 True  False
7. Serious complications resulting in hospitalization or death occurs 100 to 400 times more frequently from taking NSAIDs than from receiving a spinal manipulation of the cervical spine.  
 True  False
8. The cardinal symptom of stroke following cervical spine manipulation is vertigo/dizziness/light headedness but may also be accompanied by other symptoms.  
 True  False
9. Although rare, strokes secondary to cervical spine manipulation occur more commonly in females than males, which is also true of vertebral artery dissections in general.  
 True  False
10. The number one strategy that can be employed to reduce the risk of stroke secondary to cervical spine manipulation is simply not to perform a manipulation of the neck in maximum axial rotation.  
 True  False

Winter 2005

*Perspectives In Neuroscience*

\_\_\_\_\_  
Last Name

\_\_\_\_\_  
First Name

\_\_\_\_\_  
Specialty

\_\_\_\_\_  
Address

\_\_\_\_\_  
City/State/Zip

\_\_\_\_\_  
Telephone

\_\_\_\_\_  
ME Number

Actual Time Spent Completing this Activity \_\_\_\_\_

Please state any topics that you would like to see discussed in future issues of **Perspectives in Neuroscience** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Educational Activity Assessment**

1. Did this issue meet the stated learning objectives?  
 Yes  No
2. On a scale of 1 to 5, with 5 being the highest, how do you rank the quality of this educational activity?  
 5  4  3  2  1
3. Did you perceive any evidence of bias for or against any commercial products? If yes, please explain.  
 Yes  No
4. On a scale of 1 to 5, with 5 being the highest, how do you rank the effectiveness of this activity, as it pertains to your practice?  
 5  4  3  2  1
5. On a scale of 1 to 5, with 5 being the highest, please rank the degree to which this activity changed your attitude about this topic.  
 5  4  3  2  1
6. Will this activity change the way you practice medicine?  
 Yes  No

9. Bigos S, Bowyer O, Braen G, et al. Acute low back problems in adults. Clinical practice guideline no. 14. AHCPR Publication No. 95-0624. Rockville, MD: Agency for Health Policy and research, Public Health Service, U.S. Department of Health and Human Services. December 1994.
10. Hurwitz EL, Aker PD, Adams AH, Meeker WC, Shekelle PG. Manipulation and mobilization of the cervical spine: A systematic review of the literature. Spine 1996; 21:1746-60.
11. Wolinsky H, Brune T. The serpent on the staff. New York: GP Putnam's Sons 1994.
12. Wardwell WI. Chiropractic: History and evolution of a new profession. St. Louis: Mosby Year Book 1992.
13. Smith RL. At your own risk: The case against chiropractic. New York: Pocket Books 1969.
14. Panjabi M, White A. Clinical biomechanics of the spine. Philadelphia: JB Lippincott Co. 1990.
15. Begelman SM, Olin JW. Fibromuscular dysplasia. Current Opinion in Rheumatology 2000; 12:41-7.
16. Stopford JSB. The arteries of the pons and medulla oblongata. J Anat 1916; 50:131-64.
17. Toole JF, Tucker SH. Influence of head position upon cerebral circulation: Studies on blood flow in cadavers. 1960; 2:616-23.
18. Dabbs V, Lauretti WJ. Risk assessment of cervical manipulation vs. NSAIDs for the treatment of neck pain. J Manip Physiol Ther 1995; 18:530-6.
19. Vick DA, McKay C, Zengerle CR. The safety of manipulative treatment: review of the literature from 1925 to 1993. JAOA 1996; 96:113-5.
20. Hurwitz EL, Aker PD, Adams AH, Meeker WC, Shekelle PG. Manipulation and mobilization of the cervical spine: A systematic review of the literature. Spine 1996; 21:1746-60.
21. Terrett AGJ. Vertebrobasilar stroke after spinal manipulation therapy. In: Lawrence DJ, ed. Advances in chiropractic, Vol 4. St. Louis: Mosby-Year Book, Inc. 1997:373-415.
22. Clayman CB. The American Medical Association home medical encyclopedia. New York: Random House 1989:947-8.
23. Bassetti C, Carruzzo A, Sturzenegger M, Tuncdogan E. Recurrence of cervical artery dissection: a prospective study of 81 patients. Stroke 1996; 27:1804-7.
24. Leys D, Moulin TII, Stojkovic T, Bergey S, Chavor D. Follow-up of patients with history of cervical artery dissection. Cerebrovasc Dis 1995; 5:43-9.
25. Schievink WI, Mokri B, O'Fallon WM. Recurrent spontaneous cervical artery dissection. N Engl J Med 1994; 330:393-7.
26. Shekelle PG, Adams AH, Chassin MR, et al. The appropriateness of spinal manipulation for low-back pain: project overview and literature review. Santa Monica, CA: Rand 1991.

# Mission Statement

*The Central Illinois Neuroscience Foundation was organized to enhance neuro healthcare through education and research.*

**This Continuing Medical Education publication was sponsored and funded by the Central Illinois Neuroscience Foundation through grants and donations.**

EDITOR: Ann R. Stroink, M.D., Director of CME

ASSISTANT EDITOR: Jennifer Johns

GRAPHIC DESIGNER: Diane Uhls

GUEST EDITOR: Joseph M. Casto, Ph.D.



central illinois  
**NEUROSCIENCE**  
**FOUNDATION**

1015 S. Mercer • Bloomington, IL 61701

Non-Profit Org.  
U.S. Postage  
PAID  
Normal, Illinois  
Permit No. 44