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### How does posture affect coupling in the lumbar spine?

Panjabi M, Yamanoto I, Oxland T, Crisco J.  
Spine 1989; 14(a):1002-1011.

There is evidence to suggest that abnormal coupling patterns in the lumbar spine may be an indicator of low-back problems. To quantify the normal coupling patterns, fresh cadaveric human lumbar spine specimens (L1-S1) were used. A pure axial torque or lateral bending moment of 10 N-m (in five equal steps) was applied to the specimen, in five spinal postures, and three-dimensional motions were measured at the five vertebral levels. The results indicated that the coupling patterns changed significantly with the intervertebral level. For example, in neutral posture, the left axial torque produced coupled lateral bending, which varied from  $\sim 2^\circ$  right lateral bending at L1-2, to  $\sim 0^\circ$  at L3-4, and to  $\sim 2.5^\circ$  left lateral bending at L5-S1. Additionally, there was coupled flexion of  $\sim 1^\circ$  to  $2^\circ$  at all levels. Application of left lateral bending moment resulted in  $\sim 1.7^\circ$  of coupled right axial rotation at all levels, except at L1-L2, where it was  $0^\circ$ . Additionally, there was coupled flexion of  $0.7^\circ$  to  $2^\circ$  at all levels. For example, at the L2-3 level, the left axial torque produced coupled right lateral bending that ranged from  $\sim 0.5^\circ$  at full extension to  $\sim 2.5^\circ$  at full flexion. There was also accompanying coupled flexion of  $\sim 0.4^\circ$  to  $1.7^\circ$ . Application of left lateral bending moment at the L2-3 level produced axial rotation of  $\sim 2.5^\circ$ , which did not vary with the posture, while the other coupled motion varied from  $\sim 1.7^\circ$  flexion at full extension to  $\sim 0.8^\circ$  extension at full flexion posture.

### Intradural herniation of a lumbar intervertebral disc

Jenkins L, Bowman M, Cotter H, Gildenberg P.  
J Spinal Dis 1989; 2(3):196-200.

Intradural disc herniation of an intervertebral disc is a rare occurrence. The clinical presentation varies in severity and a high level of suspicion is necessary to determine the diagnosis. This is a case report of an intradural disc herniation in a young male. A review of the literature identifying the pathophysiologic mechanisms of intradural disc herniation, diagnostic imaging techniques, and treatment is presented.

### The role of chiropractic pre-employment examinations in occupational health and safety

Freedman A, Cork B. J Aust Chiro Assoc 1989; 19:87-91.

The introduction of WorkCare in 1985 by the Victorian government was aimed at reducing the cost of work-related accidents, whilst also improving the welfare of Victorian workers. WorkCare, implemented under the Accident Compensation Act and the Occupational Health and Safety Act, has the three objectives of providing services in three specific areas, namely prevention, rehabilitation and compensation. The average cost of \$4,600 per back claim represented a \$150 million cost to WorkCare, and manual handling claims accounted for approximately 42% of total claims received by the Accident Compensation

Commission (ACC) between September 1985 and March 1987. During 1986 back injuries accounted for 30% of the total compensation payment by the State Electricity Commission, Victoria. The multidisciplinary practice of occupational health and safety in Australia has lagged far behind that of the major industrial countries, and the authors suggest that the reduction of back injuries caused primarily by manual handling problems requires a multi-faceted approach, a component of which is the application of chiropractic pre-employment examinations.

### Chiropractic examination procedures: a reliability and consistency study

Lobeuf C, Gardner V, Carter A, Scott T.  
J Aust Chiro Assoc 1989; 19:101-4.

Intra-session inter-examiner agreement and inter-session intra-examiner agreement (consistency) was analysed in chronic LBP patients relating to certain chiropractic tests: pain on spinous palpation, interspinous palpation, spinous percussion, sign of the raising thumb, resiliency on extension and motion palpation. The ability of examiners to agree on the presence/absence of positive findings in these subjects was generally good. Some tests had significantly better results at the fifth than at the first visit. Only motion palpation had significantly better intra-examiner agreement when compared with the first visit inter-examiner agreement values. There was also a high rate of agreement per segment, with the majority of consensus being on negative findings.

### Prediction of low-back trouble frequency in a working population

Burton A, Tillotson K, Troup J. Spine 1989; 14(9):939-46.

This study was performed to estimate the discriminatory power of multiple combinations of risk indicators for the occurrence and recurrence of low-back trouble (LBT) in workers. Two categories of LBT provided groups for discrimination: 1) the presence or absence of LBT history, and 2) three patterns of recurrence characterized by the number of episodes (isolated, periodic, chronic). The risk indicators comprised data reflecting occupational and leisure demands on the back, measures of lumbar sagittal mobility, and anamnestic features of the first episode. Discriminant analysis was the statistical procedure used. The results showed that it was possible to find linear combinations of the discriminating variables that successfully allocated around two-thirds of the sample to the correct group. The presence of a history of LBT was predicted by the combined effect of increasing age and adult sports participation, but only in females did a heavier job contribute to such prediction. A reduction in risk was associated with lumbar flexibility and sports participation at school. Chronic LBT was more accurately identified than the two other groups; increasing age, a long initial spell, and an onset early in life were associated with increased likelihood of chronicity, while a report of symptoms being relieved by sitting reduced this risk. It is concluded that the occurrence and recurrence of LBT are related in combinations of risk indicators, and that it is imperative to consider the interactive effect of a multiplicity of factors in epidemiologic studies.



### The effects of compensation on recovery from low-back injury

Greenough C, Fraser R. *Spine* 1989; 14(9):947-55.

The influence of compensation on recovery from low-back pain was assessed in retrospective controlled cohort study. One hundred fifty compensable and 150 noncompensable back injury patients were invited for review between 1 and 5 years from presentation. A 91.3% follow-up was achieved, and there was no difference in the median age, follow-up, and initial injury score between the two groups. The incidence of reported pain, disability, psychological disturbance, unemployment, and length of time off work was greater in the compensation group ( $P < 0.001$ ). Settlement of the claim did not result in any reduction in morbidity, even up to 5 years later. These results demonstrate that the payment of compensation delays recovery from low-back injury.

### Isolated spinous process deviation – a pitfall in the interpretation of AP radiographs of the lumbar spine

Schaik J, Verbiest H, Schaik J. *Spine* 1989; 14(9):970-6.

A new type of spinous process deviation is described. This variant may cause confusion in the interpretation of anteroposterior (AP) radiographs of the lumbar spine. In the literature, two types of lumbar spinous process deviation (SPD) have been described: 1) SPD due to rotation of the entire vertebra (as in rotatory scoliosis and degenerative arthritis), and 2) SPD as a consequence of developmental asymmetries of the neural arch. The present study demonstrates that spinous process deviation in the AP radiograph is not a reliable diagnostic guide. The authors' quantitative morphologic analysis of computed tomographic (CT) sections of over 200 lower lumbar vertebrae *in vivo* revealed a third type of SPD, namely isolated deviation of the spinous process, ie, deviation without any associated rotation or asymmetry of the vertebral body or arch. Since the oval shadow cast by the spinous process in AP radiographs is caused by its tip, rather than its base (as was demonstrated by *in vitro* tests), it is concluded that the position of the spinous process shadow in AP radiographs cannot be used as a reliable landmark to differentiate between the three types of SPD. This is only possible by means of a CT examination.

### The value of computerized tomography in determining lumbar facet joint orientation

Gunzburg R, Sandhu A, Fraser R. *J Spinal Dis* 1989; 2(3):170-5.

The reliability of assessing facet joint obliquity from standard CT scans in the lumbar spine was studied. There was no significant difference in repeated measurements by one single examiner, nor in measurements made by different examiners. Measurements of facet joint obliquity from CT scans made on different occasions was not significantly different either. This reproducibility occurred despite the fact that adjacent CT scans from one joint extremity to the other showed variation in obliquity of about 11%.

### Inter-examiner reliability of motion palpation of the lumbar spine: a review of quantitative literature

Keating J. *Am J Chiro Med* 1989; 3:107-110.

In the past decade at least seven quantitative studies of the inter-examiner reliability of motion palpation of the lumbar spine have been reported in the refereed literature. In this survey several characteristics of these seven papers were noted, including type of motion palpation, qualifications and experience of examiners, characteristics of subjects, levels of the lumbar spine which were examined, units of measurements, types of inferential statistic, and the appropriateness of conclusions. On the basis of this review, no strong claims for the objectivity of lumbar motion palpation are justified at this time. Although several measurement strategies deserve replication, the current literature generally demonstrates marginal-to-no reliability, limited numbers of examiners, and over-reliance on asymptomatic students as palpatory subjects.

### A prospective, randomized, double-blind evaluation of trigger-point injection therapy for low-back pain

Garvey T, Marks M, Wiesel S. *Spine* 1989; 14(9):962-4.

The efficacy of trigger-point injection therapy in treatment of low-back strain was evaluated in a prospective, randomized, double-blind study. The patient population consisted of 63 individuals with low-back strain. Patients with this diagnosis had nonradiating low-back pain, normal neurologic examination, absence of tension signs, and lumbosacral roentgenograms interpreted as being within normal limits. They were treated conservatively for 4 weeks before entering the study. Injection therapy was of four different types: lidocaine, lidocaine combined with a steroid, acupuncture, and vapocoolant spray with acupressure. Results indicated that therapy without injected medication (63% improvement rate) was at least as effective as therapy with drug injection (42% improvement rate, at a  $P$  value of 0.09). Trigger-point therapy seems to be a useful adjunct in treatment of low-back strain. The injected substance apparently is not the critical factor, since direct mechanical stimulus to the trigger-point seems to give symptomatic relief equal to that of treatment with various types of injected medication.

### Equilibrium dysfunction in scoliosis – cause or effect?

Beirne J, Goldberg C, Dowling F, Fogarty E. *J Spinal Dis* 1989; 2(3):184-9.

To determine whether equilibrium dysfunction is the cause or effect of idiopathic scoliosis, patients with idiopathic scoliosis, congenital scoliosis, and comparable controls were tested, using clinical postural tests and electronystagmographic recording of spontaneous and positional nystagmus, smooth visual pursuit, and rotation-induced nystagmus. The scoliosis patients were stratified as progressive or nonprogressive. Dysfunctional responses occurred in the idiopathic progressive and congenital progressive groups, and in two idiopathic nonpro-



gressive patients whose curves subsequently deteriorated. These results suggest that equilibrium dysfunction is characteristic of patients with progressive curves, regardless of etiology, implying that it is secondary to the curve rather than a primary event. Seven patients with progressive curves undergoing surgical correction and stabilization were tested preoperatively and 6 months postoperatively. No change in the responses occurred, suggesting the dysfunction persists at least 6 months following arrest of progression.

### Disc herniations of the cervical spine

Ben Eliyahu D. *Am J Chiro Med* 1989; 3:93-100.

Cervical spine pain with radiating pain down the upper extremity is not an uncommon finding in clinical practice. One of the less recognized sources of neck pain and radiculopathy is disc herniation. Cervical disc herniations can be due to acute trauma or spontaneous occurrence as a sequela to discogenic spondylosis. Anatomic diagnosis can be made by enhanced CAT Scan or MRI Scanning in conjunction with the clinical findings. Physicians should have a high index of suspicion for cervical disc herniations in patients with cervical and radicular pain that is resistant to conservative treatment. A case study and literature review of 34 cases of cervical disc herniation is presented; related anatomy, biomechanics, etiology, diagnosis and treatment are reviewed.

### Rationale for the management of flexion-distraction injuries of the thoracolumbar spine based on a new classification

Gertzbein S, Court-Brown C. *J Spinal Dis* 1989; 2(3):176-183.

A new classification of flexion-distraction injuries of the spine is described based on the bony and soft tissue injuries to the posterior complex and the anterior column. In addition, the classification includes the status of the vertebral body, that is, the association of a wedge-compression fracture or a burst injury. The soft tissue component provides a rationale for surgical intervention. Most injuries were treated by compression instrumentation, but it is recommended that those injuries associated with a burst component require distraction instrumentation.

### The role of spinal flexion and extension in changing nerve root compression in disc herniations

Schnebel B, Watkins R, Dillin W. *Spine* 1989; 14(8):835-7.

Changes in nerve root compression forces with spinal motion were measured on six freshly frozen adult cadaver spine specimens. A model was devised to represent a herniated disc at the L4-5 level. This was done using an anterior approach placing a compression-measuring device through the disc at the L4-5 level and against the L5 root. An accelerometer was used to monitor the range of motion of the spine. Because the compression device was held in a static position, the only variable was the tautness of the nerve root across the tip of the device.

By simultaneously monitoring motion and force delivered at the tip of the compression meter placed at the nerve root, we were able to quantitate nerve root tension forces across the tip of the measuring device in relation to spinal motion. The force was measured with controls as well as in flexion and extension. In addition, the force was measured as traction was applied to the L5 root. The amount of compressive force and tension in the nerve root increased with flexion of the spine and decreased with extension of the spine. In conclusion, flexion of the lumbar spine increased the compressive force on the L5 root and extension decreased the compressive force on the L5 root.

### Thermography in the diagnosis of sympathetic maintained pain

Ben Eliyahu D. *Am J Chiro Med* 1989; 2:55-60.

Sympathetic maintained pain is a condition often overlooked as an etiology of chronic pain. Accurate diagnosis can be made with the use of thermography, which shows regional nonspecific patterns of hypothermia or decreased thermal emission in the affected extremity. When persistent pain, burning, or numbness does not resolve, sympathetic hyperdysfunction should be suspected. Sympathetic maintained pain is thought to be an early stage of reflex sympathetic dystrophy and a certain percentage of cases progress to end stage reflex sympathetic dystrophy. With early diagnosis and recognition, proper treatment can be implemented. Thermography has shown to be an excellent diagnosis tool for early diagnosis of sympathetic dysfunction. Presented here is a case report of a patient with sympathetic maintained pain following a minor injury.

### Abdominal aortic aneurysm

Boline P, Anderson A. *Am J Chiro Med* 1989; 3:114-6.

A case is reported of a patient with an abdominal aortic aneurysm. The patient was referred for a second opinion consultation and presented with shoulder and had neck and low-back pain. The report demonstrates that a patient can have more than one pathological process involved in his/her symptomatology and the need for chiropractors to do a thorough history and physical examination. Additional diagnostic imaging is discussed. A brief review of the anatomy and pathophysiology of abdominal aortic aneurysm is given.

### Anomalous lumbosacral articulations and low-back pain: evaluation and treatment

Jönsson B, Strömqvist B, Egund N. *Spine* 1989; 14(8):831-4.

Eleven patients ranging from 13 to 76 years in age with low-back pain and asymmetric sacro-transverse joints were studied. Preoperatively, scintimetry was performed in eight of the patients, in all cases with normal results. Ten of the 11 patients had their sacrotransverse joint anesthetized in fluoroscopy. Nine of these experienced pain reduction or alleviation. Resection of the transverse process was performed in all



cases. At follow-up, at 6 to 42 months postoperatively, seven patients reported total alleviation of pain, and two, significant improvement. Two patients had unchanged symptoms; one patient was 76 years of age, had associated degenerative changes of the spine, and had no effect of local anesthetics in his joint, and the other was a 13-year-old male competitive swimmer. The authors conclude that, in patients with anomalous unilateral lumbosacral articulations and low-back pain, in whom local anesthesia into the joint gives pain alleviation, resection of the transverse process may be a worthwhile procedure.

### Back injuries in college athletes

Keene J, Albert M, Springer S, Drammond D, Clancy W.  
J Spinal Dis 1989; 2(3):190-5.

Frequency and types of back injuries sustained by intercollegiate athletes were determined by examining medical records of 4,790 athletes that competed in 17 varsity sports over a 10-year period. These athletes sustained 333 back injuries, an injury rate 7 per 100 participants. Injury rates were significantly higher in football and gymnastics, and 80% of the injuries occurred in practice, 6% in competition, and 14% during preseason conditioning. Muscle strains occurred with much greater frequency than other types of injuries, and acute back injuries were much more prevalent (59%) than overuse injuries (12%) or injuries associated with pre-existing conditions (29%).

### Spinal sagittal configuration and mobility related to low-back pain in the female gymnast

Ohlen G, Wrenmark T, Spangfort E. Spine 1989; 14(8):847-50.

The purpose of this study was to correlate low-back complaints in 64 female gymnasts (mean age, 12 years) to spinal sagittal configuration and mobility as measured by two noninvasive methods. Measurements by Debrunner's kyphometer and Myrin's inclinometer were highly correlated. Average thoracic kyphosis was 32°, lumbar lordosis 35°. The mean range of sagittal motion was 57° in the thoracic spine and 113° in the lumbar spine. On average, 1° of the total sagittal lumbar mobility was lost for every 1° of increased lordosis. Low-back pain (LBP) was reported by 20% of the girls, and these girls had a significant larger lordosis (41°) than girls with no history of LBP (35°).

### Normal range of motion of the cervical spine

Lind B, Sihlbom H, Nordwall A, Malchau H.  
Arch Phys Med Rehab 1989; 70(a):692-5.

To evaluate the normal range of the cervical spine, 70 healthy subjects were studied using radiography and clinical examination. An equal number of men and women were studied; age ranged from 12 to 79 years. Radiographs were taken in the lateral projection during maximal flexion and extension. In the frontal projection, radiographs were taken bending to the left and right. The radiographs were analyzed on a digitizing tablet linked to a computer, using preset points to indicate the

motion between the vertebrae. The intraobserver error of measurement was  $\pm 1.8\%$ . The range of axial rotation was measured with the aid of a compass placed on the subject's head. The intraobserver error of measurement with this technique was  $\pm 6\%$ . The largest intersegmental flexion-extension motion occurred between C4/C5 and C5/C6. A linear decrease of motion in all directions, except in flexion, was found with age. There was no statistically significant difference in motion for men and women. The reliability of methods is discussed.

### Reproducibility of physical signs in low-back pain

McCombe P, Fairbank J, Cockersole B, Pynsent P.  
Spine 1989; 14(a):908-18.

The reproducibility between observers of physical signs in patients with low-back pain was investigated. Fifty patients were examined by two surgeons and another sample of 33 patients was examined by a surgeon and a physiotherapist. Continuous data on five signs were analyzed by Pearson's correlation coefficient, and binary data on 54 signs were analyzed by Kappa agreement coefficient. Reliable signs consisted of measurements of lordosis and flexion range, determination of pain on flexion and lateral bend, nearly all measurements associated with the straight leg raising test, determination of pain location in the thigh and legs, and determination of sensory changes in the legs. Signs of root tension showed better agreement when qualified with a description of where the pain was experienced. Bony tenderness was more reliable than soft tissue tenderness.

### Relation between surgeons' practice volumes and geographic variation in the rate of carotid endarterectomy

Leape L, Park R, Solomon D, Chassin M, Koseoff J, Brook R.  
N Engl J Med 1989; 321:653-7.

We examined the relation between the number of operative procedures carried out by individual surgeons and the variation in the rate of carotid endarterectomy among Medicare beneficiaries in areas of high, average, and low use of the procedure in 1981. Rates ranged from 48 per 100,000 in the low-use area to 178 per 100,000 in the high-use area.

Two variables accounted for most of the differences in the rates: the number of surgeons performing the procedure and the number of endarterectomies performed by surgeons with high practice volumes. Twice as many surgeons in the high-use area and 25 percent more in the average-use area performed carotid endarterectomy as compared with those in the low-use area. If the average number of cases per surgeon had been the same, the differences in the number of surgeons would have accounted for 36 percent and 15 percent, respectively, of the differences in use.

Surgeons who performed 15 or more carotid endarterectomies during the year accounted for most of the variation in the rates. These high-volume surgeons represented 15 percent and 17 percent of the surgeons in the areas of high and average use, respectively, as compared with 4 percent of those in the low-use area. They accounted for 60 and 77



percent, respectively, of the additional endarterectomies. Three fourths of the surgeons performing carotid endarterectomies carried out fewer than 10, and 24 percent did only 1.

We conclude that most of the geographic variation in the rate of carotid endarterectomy is caused by a few surgeons in high-use areas who perform large numbers of operations.

### Ultrasonographic Evidence of hip synovitis in patients with rheumatoid arthritis

Koski J. *Scand J Rheum* 1989; 18:127-131.

One hundred non-operated hip joints in 50 adult patients with active rheumatoid polyarthritis were examined by ultrasonography as well as by clinical methods and X-ray. In 15 hip joints in 11 patients, ultrasonography indicated intra-articular effusion (a distance between the joint capsule and bone of more than 7 mm in 14 and a difference between the two sides of more than 1.5 mm for one hip). There were no subjective symptoms associated with five of these hip joints, the X-ray findings were normal for 11 hips, and careful clinical examination showed normal findings for one hip joint. The routine clinical examination used in the hospital had revealed pathological findings in only two of these hip joints. It is concluded that ultrasonography may reveal intra-articular effusion or synovitis in clinically and radiologically apparently normal hip joints of patients with active rheumatoid arthritis. The increase in pain and restricted motion was statistically significant in the hips for which ultrasonography indicated intra-articular effusion. Hips that appear pathological in ultrasonography are thus synovitic, and do not fall within the range of normal variation for healthy hip joints.

### The role of thermography in the evaluation of lumbosacral radiculopathy

So Y, Aminoff M, Olney R. *Neurology* 1989; 39:1154-8.

We studied 27 normal subjects and 30 patients with low-back pain to evaluate the diagnostic accuracy of thermography in the diagnosis of lumbosacral radiculopathy. Thermographic abnormality was defined as the presence of either interside temperature difference exceeding 3 standard deviations from the normal mean, or an abnormal heat pattern overlying the lumbosacral spine. In patients with clinically unequivocal radiculopathy, thermography and electrophysiologic study were similar in diagnostic sensitivity, and the 2 methods agreed on the presence or absence of abnormality in 71% of cases. However, the thermographic findings had limited localizing value. Relative limb warming was often seen in patients with acute denervation on EMG, and limb cooling in those with more chronic lesions, but the side of the root lesion could not be identified confidently by thermography alone. Moreover, thermographic abnormalities appeared not to follow a dermatomal distribution and failed to identify the clinical or electrophysiologic level of radiculopathy in most cases. Thus, the thermographic findings are non-specific, of little diagnostic value, and of uncertain prognostic relevance.

### Computed tomography of lumbar apophyseal joint lipoma: report of three cases

Dietemann J, Bonneville J, Runge M, Jeung N, Weintraub A, Wackenheim A. *Neuroradiol* 1989; 31:60-62.

The authors report three cases of lumbar apophyseal joint lipoma located at the L4/L5 or L5/S1 level. CT scan makes the diagnosis easily possible; indeed erosive changes with enlargement of the upper portion of the lumbar articular joint and anterior displacement of the top of the superior facet are associated with intra-articular fatty densities. Clinical symptoms are rarely encountered and may be related to narrowing of the upper portion of the intervertebral foramen.

### Extraforaminal lumbar disc herniations: CT demonstration of Sharpey's fibers avulsion

Bonneville J, Runge M, Cattin F, Potelon P, Tang Y. *Neuroradiol* 1989; 31:71-74.

Forty-seven extraforaminal lumbar disc herniations (EFLDH) accounting for 7% of all lumbar disc herniations encountered during the same period of time were reviewed. L3-4 or L4-5 disc was involved in 89% of the cases giving rise to a L3 or L4 nerve root compression. An abnormal motion of lateral bending with rotation of the trunk was found retrospectively in 60% of the patients. In 53% of all EFLDH a bony avulsion of the vertebral endplate facing the herniation was demonstrated at the site of attachment of Sharpey's fibers. This study suggests that this previously undescribed bony changes witnesses a special injury of the spine responsible for most EFLDH.

### Cord/spine motion in experimental spinal cord injury

Maiman D, Coats J, Myklebust J. *J Spinal Dis* 1989; 2(1):14-49.

We examined cord motion and cord-spine coupling associated with the axial tension and dorsal impact models of spinal cord injury. In 20 cats, distraction forces up to 15 kg were applied. Five microliters of radiopaque agent was injected into the central cord at C4-C7 (14 cats) and T6-L1 (6 cats) at 2-mm intervals. In 20 cats, 300 g/cm impacts were delivered after injection of contrast at 2-mm intervals from the impact point. Trials were conducted under fluoroscopy. At 5-kg distraction, vertebral motion averaged 2.12 mm and cord motion averaged 1.03 mm (coupling ratio = .49). At 10-kg coupling increased to .75. Between 10 and 15-kg distraction, the amount of increase in cord length slowed, as did the ratio (.59). Differences in length between load groups were significant at most levels, and motion corresponded with histologic injury reported previously. In the thoracolumbar region, minimal spine motion and no cord motion occurred. Spine motion was not seen with dorsal impact although cord motion at 2 mm from impact averaged 1.3 mm/300 g/cm, which decreased away from the impact point. The spinal cord has limited elasticity, which may be related to injury. Because spine and cord motion occur in clinical injury, experimental models need to incorporate this element.