

Whiplash: Research and Case Management



Presented by:
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Principle #1:

The three pillars of LOSRIC:

- Accident reconstruction: weak science.
- Body kinematics: strong science.
- Risk Factors: strong science.

- Documentation

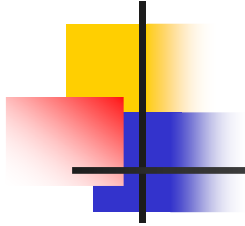


Principle #2:

The threshold of injury is approximately 5 mph delta V.

However, every human being is unique.

The threshold of vehicle damage is 2-3x that of injury potential.



Principle #3:

The use of daily activities to describe the forces experienced in a traffic collision is invalid.



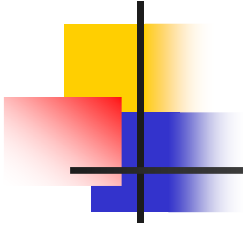
Principle #4:

Property damage is not a reliable indicator of injury potential.



Principle #5:

Minimal vehicle damage cannot be used to determine that a collision was low speed or low impact.



Principle #6:

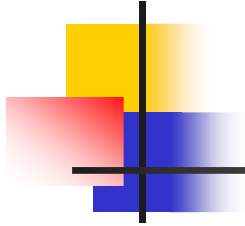
Bumper standards pertain to minimum change in velocity, not maximum.



Principle #7:

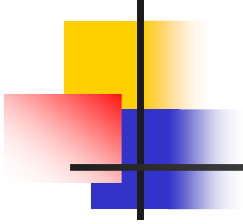
Acceleration of the head is much more important than the acceleration of the vehicle, ΔV , speed, or vehicle damage, when determining injury potential.

Accident reconstruction is a very inexact science.



Principle #8:

Accident reconstruction based on photographs is woefully inadequate.



Principle #9:

Injuries and fatalities occur in collisions with little, or no, property damage.



Principle #10:

It is imperative for the attorneys to set up the Chiropractic physician as the expert.

It is imperative for the attorneys to develop the proper foundation for the soft tissue case!

It is imperative for the DC to document well, treat effectively, and keep costs reasonable.



Principle #11: Paradoxical Relationship

Due to the elastic nature of LOSRIC, the apparent paradox of the inverse relationship between property damage and injury potential is a real one.

Previous attempts to correlate these factors have failed to show a relationship



Low Speed Rear Impact Collision

A review of miscellaneous literature...



French Study: Foret-Bruno et al

- 8000 + crashes and 15,000 occupants
- 27% of occupants in rear-end collisions sustained cervical injuries, compared to 10% and 8% in frontal and side impacts.
- 7% of all crashes = rear end
- Women injured in 42 % and men 21%
- Delta V below 9.3 mph = injury rate 36%
- Delta V above 9.3 mph = only 20%



Thomas et al

- The largest clustering of rear impact crashes is between a delta V of 9.3 and 12.4 mph,
- About 70% occur at a delta V of less than 15.5 mph.



American Studies

- States et al: Reported an injury risk of 38% in consecutive series of 691 rear impacts.
- Kihlberg: 26% of exposed motorists were injured when seat backs did not fail; 19% when failure occurs.



American Studies

Chapline et al:

- Largest category of injury crashes = no damage
- In these 38% of females and 19% of males had symptoms.
- When damage rated as “minor”, these percentages were 54% and 34%.



Japanese Studies

Ono and Kanno: 50% of car crashes result in neck injury, increasing every year.

- 95% of crash injuries are scaled AIS I
- Of these 80% concentrated in the neck
- 95% of these neck injuries are CAD injuries
- ***15-20% of victims have prolonged symptoms***



Australian Study: Dolinis

Two risk factors identified as independent risk factors for injury.

1. A history of prior neck injury (4.5x more likely to be injured)
2. Female gender (2x more likely to be injured than a man)



U.S. Study

- Records from 11 police agencies 1995-1997
- Risk: 45% of females S/S of neck pain
- 28% of males drivers
- 43% of females and 31% males also had **low back pain.**



Overall Risk Estimate

- Based on studies and data, Croft estimates that between 30% and 60% of real world car occupants exposed to LOSRIC of ≥ 2.5 mph delta V sustain some degree of injury ranging from very short lived to disabling.



CAD Related Chronic Pain

- Rear impact injuries carry a worse prognosis than either side or frontal impact injuries.
- On average 30-50% of the patients in these studies had not recovered completely at follow-up—about 10% rating their problem as disabling or severe.



Latest Data

A surprising 45% of the American population with chronic neck pain attributes it to a MVC. (6.2% of population)



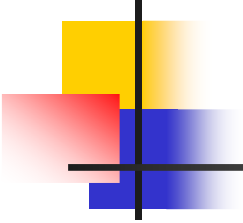
Low Speed Crashes

- Most modern vehicles can withstand crash speeds of up to 8-10 mph, and often higher, without sustaining appreciable damage.
- Resulting delta V = 6-5 to 8 mph.
- **Threshold for soft tissue injury in the neck of a healthy adult male is a delta V of 2.5 to 5 mph.**
- Vehicle can withstand crash velocities nearly 2x the injury threshold.

Nikolai Bogduk, MD, Department of Anatomy and Musculoskeletal Medicine,

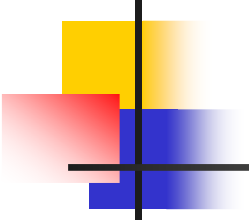
University of Newcastle, Newcastle Bone and Joint Institute, *Point of View*

- “Whiplash-associated disorders have lacked credibility. Opponents in the past have cited lack of evidence of a lesion in patients with symptoms, lack of successful treatment, and lack of a biomechanical link between symptoms and the alleged injury.”



Bogduk (cont'd)

- “The study of Kaneoka et al now fills a critical gap in the story of cervical facet pain. It provides the missing biomechanical link. Theirs is the most significant advance in the biomechanics of whiplash since the pioneering studies of Severy et al in 1955.”

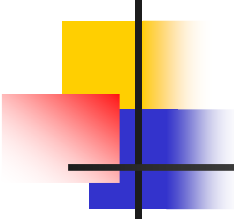


Bogduk (cont'd)

“The critical observation is that in whiplash the lower cervical segments undergo sagittal rotation about an abnormally high instantaneous axis of rotation. As a result, there is no translation; there is only rotation. As the vertebra spins, its anterior elements separate from, while the posterior elements crunch into, the vertebra below.

This mechanism predicts that the resultant lesions should be tears of the anterior annulus and fractures of the zygapophysial joints or contusions of their meniscoids. These are the very lesions seen at postmortem.”

(Clearly, this is an important article. Nikolai Bogduk believes that this is the most important biomechanical research on whiplash in 44 years.)



Pettersson, K; Hildingsson, C; Toolanen, G; Fagerlund, M; Bjornebrink, J
Disc Pathology After Whiplash Injury: A Prospective Magnetic Resonance
Imaging and Clinical Investigation. Spine 1997 Feb. 22 (3) pp. 283-8

- **ABSTRACT:** Study Design: This study was used to evaluate the relationship between magnetic resonance imaging finding and clinical findings after whiplash injury.
- **Objectives:** To identify initial soft-tissue damage after whiplash injury, the development of disc pathology, and the relationship of disc pathology to clinical findings.



Disc Pathology After Whiplash Injury: A Prospective Magnetic Resonance Imaging and Clinical Investigation. Spine 1997 Feb. 22 (3) pp. 283-8

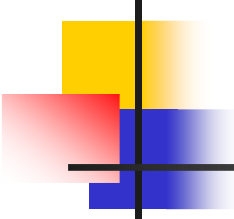
- **Results:** The authors found 13 patients (33%) with disc herniations with medullary (six cases) or dura (seven cases) impingement over the 2-year follow-up period. At the follow-up examination all patients with medullary impingement had persistent or increased symptoms, and three of 27 patients (11%) with no or slight changes on magnetic resonance imaging had persistent symptoms. No ligament injuries were diagnosed.

- **Conclusion:** Although disc pathology seems to be one contributing factor in the development of chronic symptoms after whiplash injury, it may be unnecessary to examine these patients in the acute phase with magnetic resonance imaging; correlating initial symptoms and signs to magnetic resonance imaging findings is difficult because of the relatively high proportion of false-positive results. Magnetic resonance imaging is indicated later in the course of treatment in patients with persistent arm pain, neurologic deficits, or clinical signs of nerve root compression to diagnose disc herniations requiring surgery.



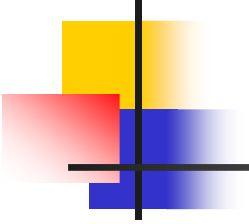
Lord, in Spine: State of the Art Reviews: Cervical Flexion-Extension/Whiplash Injuries, Hanley and Belfus, Sept. 1993, p. 362

- “In studies in which experimental animals or cadavers have been subjected to whiplash motion, injuries to the cervical zygapophyseal joints are among the most common and most consistent lesion produced. The lesions include tears of the joint capsules, intraarticular hemorrhage and impaction fractures.”
- “Postmortem studies of victims of MVAs reveal that zygapophyseal joint injuries are common, being present in 86% of necks examined. The lesions include capsular tears, ruptures of meniscoids, intraarticular hemorrhage, and small fractures.”



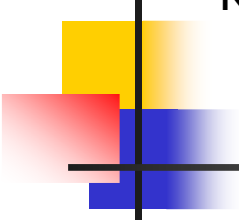
Woodward, Cook, et al. (1996). “Chiropractic Treatment of Chronic Whiplash.” *Injury* 27 (9): 643-5

- *“The accumulated literature suggests that 43% of patients will suffer long-term symptoms following ‘whiplash’ injury. If patients are still symptomatic after 3 months then there is almost a 90% chance that they will remain so. No conventional treatment has proven to be effective in these established chronic cases.”*
- *“The results of this retrospective study would suggest that benefits can occur in over 90% of patients undergoing chiropractic treatment for chronic ‘whiplash’ injury.”*
- Following the chiropractic treatment, 93% of the patients had improved.



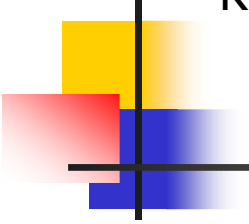
A Symptomatic Classification of Whiplash Injury and the Implications for Treatment. Khan, Cook, Gargan, and Bannister, University Department of Orthopaedic Surgery, Bristol, UK. The Journal of Orthopaedic Medicine 21[1]1999.

- Objective: To determine which patients with chronic whiplash will benefit from chiropractic treatment.
- 93 patients, 68 female.
- Conclusion: Whiplash injuries are common. Chiropractic is the only proven effective treatment in chronic cases. Our study enables patients to be classified at initial assessment in order to target those patients who will benefit from such treatment.
- 57% make full recovery.
- Resolution of symptoms will have occurred within 2 years of injury.
- 8% will remain disabled by their symptoms.



Khan, Cook, Gargan, and Bannister, University Department of Orthopaedic Surgery, Bristol, UK. The Journal of Orthopaedic Medicine 21[1]1999.
(cont'd)

- Non-responders do exist. Defining characteristics include: full range of motion in association with neck pain, bizarre symptoms, female sex and ongoing litigation.
- McNab, found that symptoms persist in 45% of patients two years after settlement of litigation.
- Watkinson et al, found significantly higher frequency of degenerative changes on radiological examination of patients who have sustained soft tissue injuries than in a controlled population, place more emphasis on the organic basis of symptoms.



Khan, Cook, Gargan, and Bannister, University Department of Orthopaedic Surgery, Bristol, UK. The Journal of Orthopaedic Medicine 21[1]1999.
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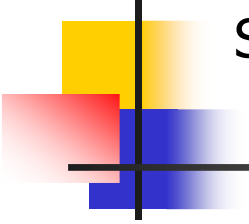
Whilst other studies have suggested that neurological signs (Group 2) have a poorer prognosis, this was not the case amongst our patients. Indeed, such patients showed the greatest improvement in disability grade.

Group 1: Neck pain, restricted ROM, no neurological deficit.

Group 2: Neurological symptoms, neck pain, restricted motion.

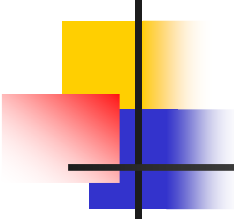
Group 3: Severe neck pain, full ROM, no neurological symptoms.

Results: Organic pain causes psychological stress, not the result of it!



Vert Mooney, MD, Spine, 12(8), 1987 754-759, Presedential address of the International Society for the Study of the Lumbar Spine. May 29-June 2, 1986 Dallas, TX.

- “Physical activity seems to be a source of increase of endorphins”, which greatly reduce the perception and neurotransmission of painful stimuli.
- In adulthood, mucopolysaccharide production is switched to chondroitin sulfate B and keratosulfate production, both of which bind less water which adversely affects primarily the nucleus.
- “Mechanical activity has a great deal to do with the exchange of water and oxygen concentration in the disc.”
- “The fluid content of the disc can be changed by mechanical activity, and the fluid content is largely bound to the proteoglycans, especially of the nucleus.”



Vert Mooney, MD, Spine, 12(8), 1987 754-759, Presedential address of the International Society for the Study of the Lumbar Spine. May 29-June 2, 1986 Dallas, TX. (cont'd)

- “In summary, what is the answer to the question of where is the pain coming from in the chronic low-back pain patient? I believe its source, ultimately, is in the disc. Basic studies and clinical experience suggest that mechanical therapy is the most rational approach to relief of this painful condition.”
- “Prolonged rest and passive physical therapy modalities no longer have a place in the treatment of the chronic problem.”

Chronic Cervical Zygapophysial Joint Pain After Whiplash: A Placebo-Controlled Prevalence Study.

Derby MD, Spine 1996;21:1744,1745 (August 1, 1999)

- “This study reveals a single symptomatic segment in 26 of 31 patients completing the study in which the C2-3 joint is the most common cause of upper cervical pain referral and headache and the C5-6 joint is the most common source of lower cervical axial pain and referred arm pain.”
- “Although muscle pain and tissue hyperalgesia may be an integral part of chronic cervical pain after whiplash injuries, such pain may be better explained as a secondary reflex reaction to injury of segmental supporting structures.”



Acute Injuries to Cervical Joints. An Autopsy study of Neck Sprain.
Taylor, Twomey, Spine 1993, July;18(9):1115-22

A comparative study of cervical spines from 16 subjects who died of major trauma and 16 control subjects who died of natural causes, showed clefts in the cartilage plates of the intervertebral discs in 15 of 16 spines from the trauma victims.

It is suggested that disc “rim lesions” could cause the pain experienced by patients with neck sprain.



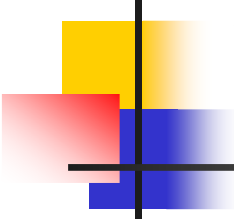
Acute Injuries to Cervical Joints. An Autopsy study of Neck Sprain.
Taylor, Twomey, Spine 1993, July;18(9):1115-22 (cont'd)

“Neck sprain without fracture poses a difficult diagnostic problem because soft-tissue injuries are not usually demonstrable by using standard radiography. This adds to a patient’s distress, because there is no objective display of an injury to account for the pain. Such patients are often regarded as having a psychosomatic illness with little organic basis.”

“A substantial proportion of neck sprains remain symptomatic for more than 2 years with little or no evidence of organic disease.”

“There is good evidence that disc splits (rim lesions) near the endplate persist for 6-18 months or more without healing and their presence is associated with early disc degeneration.”

“The clefts are only visible on extension films and the pain distribution suggests that the discs involved may be responsible for the symptoms.”



Acute Injuries to Cervical Joints. An Autopsy study of Neck Sprain.
Taylor, Twomey, Spine 1993, July;18(9):1115-22 (cont'd)

Conclusion:

- “Clinical studies show that rim lesions and traumatic herniations are demonstrable in survivors of motor vehicle trauma, in the absence of vertebral fractures. Such lesions would cause acute pain at the time of the injury and would be likely to progress to early disc degeneration, with extension of the clefts and vascularization within the clefts.”
- “The disc may degenerate because the clefts separate the center of the disc from its source of nutrition in the vessels of the vertebral marrow and the outer annulus. These degenerative changes would also be likely to contribute to chronic pain and dysfunction of the cervical spine.”



Vehicle Damage vs. Injury Potential Article

Is there a valid correlation between
vehicle damage and the probability of
injury?

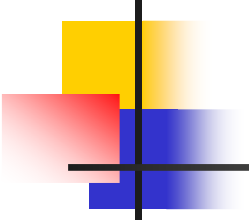
Answer: NO!!



Callier, 1981

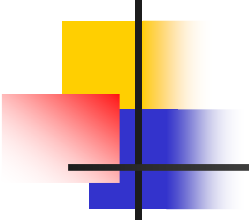
“A collision, when the offending car moves at a rate as slow as seven (7) mph can cause severe tissue damage and injury.

Taken from Croft seminars:
(Module 4, Section two-Cervical Spine References)



McNab, 1982

3.7 to 5 mph rear-end impact, which subjects the cervical spine to as much as 4.5 G-forces, constitutes the threshold for mild cervical strain injury.



McNab, 1982

“The amount of damage sustained by the car bears little relationship to the force applied.”

The Spine, Saudners, 1982, p. 648



Ameis 1986: Canadian Family Physician,
September, 1986

“Each accident must be analyzed in its own right. Auto speed and damage are not reliable parameters.”

Cervical Whiplash: Considerations in the Rehabilitation of Cervical Myofascial Injury.



Hirsh, et al 1988

In an 8-mph rear-end collision, a 2 G-force of acceleration of the vehicle may result in a 5G-force acceleration of the occiput and head.

“The amount of damage to the automobile may bear little relationship to the forces applied to the cervical spine and to the injury sustained by the cervical spine.”

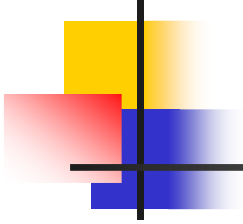
Whiplash Syndrome, Orthopedic Clinics of North America, October 1988. p. 791.



Navin, Macnab, et al. 1989

“The experimental results indicate that some vehicles can withstand a reasonably high speed impact without significant structural damage. The resulting occupant motions..... dangerous acceleration up to speeds greater than that of the vehicle.”

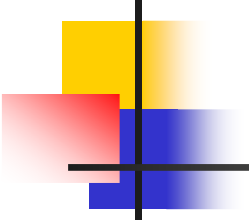
An Investigation into Vehicle and Occupant Response Subjected to Low-Speed Rear Impacts.



Emori, 1990

“...neck extension becomes almost 60 degrees which is a potential danger limit of whiplash, at collision speed as low as 2.5 km/h.”

SAE, Feb, 1990, p.108.



McConnell, et al 1993

The crash tests study concluded that Delta Vs of 5 mph was the probable threshold for cervical injury.



Smith, J. 1993

“The absence or presence of vehicle damage is not a reliable indicator of injury potential in rear impacts. Based upon the principle of conservation of energy, any energy which does not go into damaging the vehicle must be converted into kinetic energy, the source of injuries.”

“The Physics, Biomechanics, and Statistics of Automobile Rear Impact Collisions.”

Trial Talk: 10-14.



Smith, J. 1993 (cont'd)

“Since kinetic energy is the source of injury to vehicle occupants, it is obvious that the bumper standards have the effect of reducing vehicle damage while increasing the probability of personal injury in rear end impacts.”



Ono, et al 1997

At impact speeds of 2.5, 3.7, and 5 mph C5-6 compressive loading and bending movement was found along with sudden extension causing compression in the facet joint, rather than gliding. There was more injurious compression in the facet joints during extension even before the head hits/strikes that seat's head restraint.



Brault, et al 1998

Recent crash testing produced injuries in 29% and 38% in 2.5 and 5 mph, respectively in Delta Vs, low speed rear impact collisions.

Significant Facts



- There is no relevant science that equates injury potential to vehicle damage.
- No accident reconstructionist can predict an individual's INJURY THRESHOLD.
- The presence of an injury is best determined by the examining physician and is based on the CORRELATION between history, examination, x-ray and other diagnostic tests.
- No MD, DC, DO or other medical professional was ever educated to consult an accident reconstructionist to determine the presence or absence of injury.

Significant Facts



- Strong research exists correlating RISK FACTORS and injury potential.
- Strong research exists demonstrating that chronic pain is often the result of Low Speed Rear Impact Collisions (LOSRIC).
- The “6-8 week natural healing time” is a myth that should forever be abandoned.
- “No Crash-No Cash” is a concept that should be forever abandoned.



Review of Risk Factors

Acute Risk Factors: 18

Late or “Chronic” Risk Factors:
20



Sneeze Article

“The “G” forces of an ordinary sneeze is greater than that experienced in a LOSRIC, yet people sneeze everyday and don’t get hurt. How do you explain that?”



Sneeze Analogy

Allen; Iain Weir-Jones; P Eng, et al. (1994).

***“Acceleration perturbations of daily living; A comparison to “whiplash”*”. Spine: 1994
19(11): 1285-92.**

- 8 healthy volunteers
- subjected them to daily activities, none of which caused any hint of injury.



Allen Paper-ADL

1. Looking to the left,
2. Unexpected startle by discharge of a starter pistol behind the subject,
3. Standing up suddenly from a kitchen chair,
4. Passively dropping the head backwards as if falling asleep from a seated position,
5. Routine sitting into a kitchen chair from standing,
6. Sneeze from sniffing pepper into nostrils,
7. A simulated cough,
8. An unexpected bump against the left shoulder as would occur in a crowd,
9. An anticipated hardy slap on the back greeting,
10. Kicked hard from behind while sitting in a wheeled office chair,
11. Hopping off a 20 cm (8 inch) step and land on both feet,
12. Plopping backwards into a low-backed office chair.



Response to Allen Paper

1. Artifact movement
2. No two persons are alike, and no two crashes are alike.
3. The forces applied to the body are not the same for different individuals who appear to perform similarly.
4. This study was limited in the number of volunteers. The full spectrum of the population, with a presumed wide variance in physical and psychological profiles, was not tested.



Response to Allen Paper

5. The authors did not consider the influence of “awareness factor” during their two highest peak average measured accelerations of 10.1 G (plop in chair) and 8.1 G (hop off step).
6. The authors did not take into account other well researched risk factors associated with LOSRIC, and compare them to common activities like a sneeze.
7. The applied forces in a LOSRIC are external. The force generated during a sneeze is internal.



Response to Allen Paper

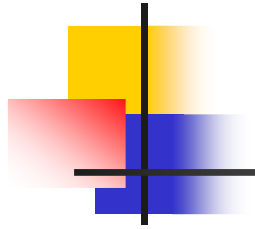
8. **A short list of risk factors important to consider in LOSRICs that were not considered by the authors include:**

- ✓ Poor head geometry (1, 2)
- ✓ Rear impact versus frontal impact collision (3, 4, 5, 6)
- ✓ Front versus rear seat position (7)
- ✓ Out of position occupant (8, 9)
- ✓ Height, mass, or age of patient (10, 11, 12, 13)
- ✓ Injury threshold of patient (14)
- ✓ Position of head rest (15)
- ✓ Mass of bullet vehicle versus mass of target vehicle (16)
- ✓ Non-failure of seat back and influence of head rest (17)
- ✓ Pre-existing conditions (18)



Litigation Neurosis: Is it real?

See article



The Neurological Basis for Chronic Pain

Two important studies...



Spine 2004; 29(2):182-188 Characterization of Acute Whiplash-Associated Disorders. Sterling, PhD, et al.

Conclusions.

Acute whiplash subjects with higher levels of pain and disability were distinguished by sensory hypersensitivity to a variety of stimuli, suggestive of central nervous system sensitization occurring soon after injury.

These responses occurred independently of psychological distress. These findings may be important for the differential diagnosis of acute whiplash injury and could be one reason why those with higher initial pain and disability demonstrate a poorer outcome.

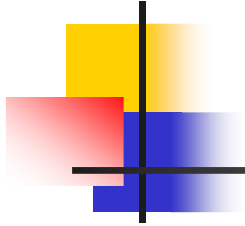


Evidence for spinal cord hypersensitivity in chronic pain after whiplash injury and in fibromyalgia. Banic B, et al. Pain; 2004 Jan;107(1-2) p7 - 15

Patients with chronic pain after whiplash injury and fibromyalgia patients display exaggerated pain after sensory stimulation. Because evident tissue damage is usually lacking, this exaggerated pain perception could be explained by hyperexcitability of the central nervous system.

We provide evidence for spinal cord hyperexcitability in patients with chronic pain after whiplash injury and in fibromyalgia patients. This can cause exaggerated pain following low intensity nociceptive or innocuous peripheral stimulation. **Spinal hypersensitivity may explain, at least in part, pain in the absence of detectable tissue damage.**

Lecture Summary



- The biomechanics of a motor vehicle accident (whiplash) may cause injury to the disc and facet joints; therefore these structures are the most probable source for irritation causing chronic whiplash pain.
- An appreciable amount of chronic pain afferents synapse in the limbic cortex, causing an abnormal psychological profile. The abnormal profile can only be helped by successful treatment of the chronic spinal pain.
- The best treatment for the disc and facet soft-tissue injuries are early, persistent, controlled motion of the injured tissues.



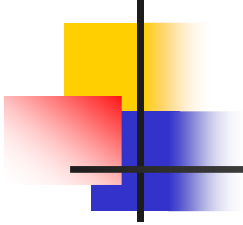
Lecture Summary

(cont'd)

- Self directed controlled motion of injured extremity joints is possible because the muscles that cross those joints are primarily under the control of the voluntary motor cortex.
- Self directed controlled motion of injured spinal joints is NOT possible because the muscles that move the individual segments are not under the primary control of the voluntary motor cortex, but rather controlled primarily through the vestibular spinal tracts (descending medial longitudinal fasciculus), which is non-voluntary.
- Injury to the spinal discs and facet joints causes a non-voluntary contraction of the non-voluntary segmental movers (primarily the multifidus) at the level of injury and for several segments above and below the level of injury.

Lecture Summary

(cont' d)



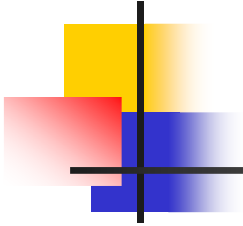
This non-voluntary contraction locks the motor unit into a certain parameter of position and reduced movement.

This reduction of movement:

- Opens the pain gait.
- Impairs the “disc pump” which:
 - Accelerates disc degeneration
 - Makes the disc more acidic which increases the firing of disc nociceptors.
- Alters the quality of the synovial fluid which:
 - Reduces its nutrient value, which accelerates posterior joint arthrosis and pain.

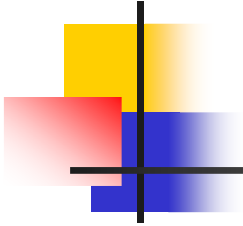
Lecture Summary

(cont' d)



Chiropractic Adjustments:

- Segmentally fire high threshold mechanoreceptors that di-synaptically inhibit tone in the segmental movers, which improves segmental spinal motion and position.
- This controlled movement allows the injured tissues to heal better and quicker.
- This controlled movement improves the fluid exchanges of the disc and synovial fluid, which reduces pain and joint degeneration.
- This controlled movement initiates a neurological sequence of events that causes pain inhibition (closes the pain gate).



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