Avicenna was the greatest ancient doctor (980-1033)
He wrote the “Canon of Medicine” -- the most famous book in the history of medicine
It was the main medical textbook for East and West for 600 years

Current Presentation Overview

1. Pathophysiology of Musculoskeletal Pain
2. Evidence based treatment modalities supported by pathophysiology of pain
3. Practical application of Pain Neurophysiology and Spinal Biomechanics in conjunction with current interventional Pain Management procedures
Evidence Based Treatment For Back Pain

Bogduk, N., Clinical Update for Chronic Back Pain, 2004:

- Only proven treatment: facet nerve diagnostic blocks follow by radiofrequency denervation
- Good evidence: botox injections, ligament injections, massage
- There is no evidence of long-term efficacy for drug therapy with analgesics, NSAID's, muscle relaxants or antidepressants for treatment of chronic low back pain

Consider these facts, presentation concentrates on:
1. Pathophysiology of nerve, neuromuscular junction, muscles, and ligaments
2. Application of radiofrequency, chemodenervation, ligament injections, and massage in pain management

Major Sources Of Back Pain: Target-Specific Approach

- Disc – about 40% of patients
- Facet Joints – 20% – 40% of patients
- Sacroiliac Joint – about 20%

The musculoskeletal system consists of the richly innervated bones, joints, ligaments, muscles, nerves and blood vessels that interconnect within spinal column. All of these tissues can be affected by degenerative process and can be a source of pain.
A New Concept Of Degenerative Disease

- The hypothesis has the following sequential steps:
- Single trauma or cumulative microtrauma causes subfailure injuries of the ligaments and embedded mechanoreceptors
- The injured mechanoreceptors generate corrupted signals, which cause muscle discoordination - spasm/shortening and lead to joints instability
- Muscle dysfunction also can cause tendinitis or tenosynovitis
- This results in abnormal stresses and accelerated degeneration of joints

Base For Successful Pain Management

Understanding of Degenerative Process
- Ligaments aging/injury
- Muscle discoordination
- Muscle spasm/shortening
- Joint/disc dysfunction
- Osteoarthritis/discopathy

Understanding of Pain
- Gate Theory
- Neurogenic Inflammation
- Neuromatrix Theory
- Peripheral Sensitization
- Central Sensitization
Gate Theory

TENS & Intraosseous Blood Pressure
Blood Supply of Bone

- Vascular connection between bone marrow, cortex, periosteum and attached muscle

Ligament & Tendon Attachments

- There is considerable evidence to suggest that ligaments function as neural sensors to facilitate supportive reflex contractions of muscles.
- According to the recent hypotheses of chronic back pain, injury to ligaments lead to muscle discoordination, disrupts the neural apparatus as well as the structural support.
- Muscle attachments are richly innervated, metabolically active area with a blood supply from the bone, it may be the "weakest link" and most reactive site in the musculoskeletal system.
Injection Into The Attachments

Cross-sectional plan of blood supply of bone cortex & attached muscle

Local anesthetic injections into the attachments

- Attachments – richly innervated & this area is a bottleneck of muscle blood supply
- Injections - stabilize nerve endings & dilate blood vessels
- Prolotherapy?

Effect Of Injections Into The Attachments

- Injections into tender ligament and tendon attachments achieved complete relief of pain that was sustained at 12 months in 20% of patients, and more than 50% relief of pain in just under half of all patients (Bogduk, 2004)
Tissue Injury

Autosensitization

Activation of nociceptive pathways is subject to activity-dependent plasticity, which manifests as a progressive increase in the response of the system to repeated stimuli (Wolf, 2000)

Pain Transition to the Chronic State Modulation & Modification of Pain System

- **Peripheral sensitization**: sensitization of nociceptors and peripheral hyperalgesia
- **Trigger points formation** due to local vicious cycle: SP, CGRP produces edema and leads to BK release and nociceptors sensitization.
- **Chronic muscle lesions** (myositis) associated with a higher density of the nociceptors.
- **Central sensitization**: expansion of population of dorsal horn neurons related to affected area.
- **Strong nociceptive input** to the spinal cord leads to cell death predominantly in inhibitory interneurons.
**Neural Plasticity Of CNS**

- **Neural plasticity**: the capacity of neurons to change their function, chemical profile, or structure.

- Protracted nociceptive inputs induce plastic, either functional or structural, alterations in the nociceptive pathways.

- These plastic changes lead to crosstalk among the neural networks, including circuits related to motor, autonomic, or psychological functions.

- These plastic changes, once established, persist even after the original pain sources disappear. (Kumazawa T., et al., 1998)

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**Neuromatrix Theory of Pain**

- The Neuromatrix is genetically determined neural network in the brain.

- Pain is a multidimensional experience produced by characteristic “Neurosignature” patterns of nerve impulses generated by Neuromatrix.

- Neurosignature patterns may be triggered by sensory inputs, but they may also be generated independently of them.
Convergence of Nerve Impulses in Spinal Cord

- DRG Branching Neurons
- Lissauer Tract – intersegmental connections

Convergence of Nerve Impulses in CNS

Interconnections in Neuromatrix:
- Reticular formation: Spinothalamic & Trigemino-thalamic tracts
- Thalamus: spinothalamic, spinoreticular & trigemino-thalamic tracts
Vicious Cycles Of Pain

- Trigger Point Formation
- Peripheral Sensitization
- Pain
- Muscle Spasm
  - Sympathetic Stim.

- Injury
- Microtrauma
- Inflammation

- Muscle Dysfunction
- Joints Instability
- Joints, Disc Degeneration
- Neurogenic Inflammation
- Dorsal Root Reflex
- Central Sensitization
Patient Preparation

- Currently recommended pre procedural sedation

Ligamentous Sprain Treatment

1. The pain of ankle and wrist sprains can be relieved in most cases by 1-2 treatments with injection of local anesthetic.

2. Best results are obtained if all of the tender spots are injected as soon as possible (less than 12 hr) following injury.

3. The joint should be pain free following injection, which should permit normal use of the joint at once, including walking.
Peripheral & Central Desensitization

Peripheral:
MP nerve block f/b denervation

Central:
Decrease DRR by anesthetic injection into the attachment f/b PT modalities

Cross-sectional plan of blood supply of bone cortex and attached muscle

Spinal Biomechanics

Transitional Zones
- Occ – cervical
- C4 - C5
- C6 - T2
- T4 - T5
- T10 – L2
- L4 – S1
Functional Connections Of Transitional Zones

Spinal Meniscoid
1. Joint capsul
2. Meniscoid

Fusion & Functional Blockade Effect On Spinal Function

- Immobilization of spinal segments influences the remaining mobile segments by increasing the load and motion not only at the immediately adjacent segment but also at the distal segments. *(Nagata H et al., Spine, 1993)*

- Unfused segments have to work more frequently toward the extremes of their functional ranges of motion after fusion. *(Chow DH et al., Spine, 1996)*
Regional Coupling Patterns

Spinal Segmental Evaluation – Mobility Test For Functional Blockade

- Lateral springing pressure on spinal processes
Spinal Segmental Evaluation – Palpation, Friction Pressure, Pinch-Roll Test

- Facet joints and muscle
- Cutaneous branches
- Interspinal ligament

Spinal Injury

- Spinal microtrauma causes microfractures of the endplate with intraosseous pressure increase in the vertebral bodies and spinous processes
- During ligament strains the supraspinous ligament undergoes the maximum load and increase in length, followed by the interspinous ligament
- Facet joints & capsular ligaments are injured during whiplash injuries
Spinal Degeneration

- Injury or cumulative microtrauma causes subfailure of the ligaments (spinal ligaments, disc annulus and facet capsules), facet joints instability, and can lead to meniscoids entrapment
- Ligament mechanoreceptors generate corrupted signals, which lead to paraspinal muscle spasm/shortening
- This results in excessive loading and accelerated degeneration of disc and facet joints

Spinal Functional Treatment

- Spine should be viewed as a one organ with highly developed neuromuscular control system. Each region of spine functionally connected and compensated by another
- Goal of treatment: unload functionally affected region of spine to decrease it overuse and peripheral sensitization

Treatment Steps:
1. Detect hypomobile spinal segments with shortened muscles in transitional regions by manual segmental testing
2. Spinal Segmental Desensitization: pre-injection paraspinal nerve blocks follow by N&I of shortened paraspinal muscles
Spinal Segmental Desensitization

Treatment of Muscle Shortening and Enthesopathy
- Needling & Infiltration taut muscle bands with local anesthetic

Summary Of Neurophysiology of Pain
- Peripheral sensitization – nociceptors density/activity increased
- Central sensitization – thalamic projection neurons increased, inhibitory neurons decreased
- Dorsal Root Reflex – neurogenic inflammation
- Sympathetic activation by pain - tissue ischemia
- Intraosseous blood pressure increase
- Muscle spasm/shortening
Application of Neurophysiology to Pain Management

1. Decrease the size of painful area:
   a). Decrease peripheral sensitization – nerve/MP blocks/ablation, passive modalities PT
   b). Decrease central sensitization – decrease neurogenic inflammation, decrease DRR

2. Target-specific treatment:
   a). Diagnostic controlled nerve blocks
   b) Neuro-ablative procedures: radiofrequency

Sequential Steps In Management Of Musculoskeletal Pain

CONCLUSION

We do have a responsibility to direct a patient’s care towards functional restoration rather than purely medicinal palliation.