Electrophysiologic Basis for Evaluation & Treatment of patients with Spine Pain: The Cervical Spine

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The Painful Neck Syndrome: Can we do better?
- Cervical radiculopathy: Neck & Arm Pain
- Cervical radiculopathy & neck pain are the computer-age syndrome & the MVA common disorder.
- The anatomic & biomechanical nature of cervical spine encourage mobility at the expense of stability & strength (lumbar)
- The position of the neck between the head & arms-torso complex subject it to confounding torques.

Causes of cervical radiculopathy
- Discogenic
- Degenerative
- Traumatic
- Others.

Physical Examination
- Inspection: Observe gait (spastic gait with SCI), posture for evidence of mal-alignment; head posture/tilt
- ROM.
- Neurological exam: sequential examination by nerve root (motor, sensory & reflexes)
- Motor (MMT): 0-5.

C5 & C6 nerve roots
- **C5**: Motor: deltoid, biceps.
- Reflexes: biceps.
- Sensation: lateral upper arm.
- **C6 nerve root**: Motor: biceps & wrist extensors
- Reflexes: Brachioradialis
- Sensation: lateral forearm, thumb & index.

C7 & C8
- **C7**: Motor: triceps, wrist flex., fingers ext.
- Reflexes: Triceps
- Sensation: middle digit.
- **C8 root**: Motor: hand intrinsic, finger flexors
- Reflexes: None.
- Sensation: medial forearm, ring & little fingers.
Mechanical Theory in Cervical radiculopathy
- Mechanical dysfunction at the disc, facets, or soft tissue (ligamentous...etc) will cause compression to the neural element causing radiculopathy.
- Evaluation & treatment should be focused on the mechanical forces laid on the neural elements & how to decompress it.
- McKenzie et. al. (centralization & periph.)

Evaluation methods for Neck Pain
- Visual analog scale: subjective.
- Neck ROM & manual muscle strength: not correlated to symptoms.
- EMG power frequency spectrum analysis: not clinical.
- Imaging: anatomical & not functional.

Neck Pain: Current Treatments
- McKenzie method.
- Cervical manipulation & tractions.
- Myofascial release.
- Craniosacral therapy.
- Rest & medication.
- Surgeries (laminectomies, discectomies, spinal fusion......etc.)

Treatment of neck pain: Critique
- All methods are not based on objective/numerical evaluation of the compressive forces on the compromised nerve roots.
- Therefore, these treatments are based on trial & error. It may work or may not.
- Also these treatment deals with the patient’s symptoms & do not treat the cause of the problem.

Testing Methods for Neck Pain
- Needle EMG: invasive, painful, indirect.
- F-waves: questionable, not reliable, painful
- Somatosensory evoked potentials: Non-specific, time consuming, indirect.
- H-reflex: variable, used latency parameter only.
- There is a need for objective numerical, specific & sensitive method for evaluation of cervical radiculopathy.

Electrophysiologic Testing: Critique
- All tests carried out from lying positions where the compressive forces are nil. The same for imaging studies. (testing in lying position does not give the correct answer)
- Conventional electrophysiologic testing, in static posture, does not relate to the pathology occurring in the daily dynamic postures.
- Testing results also requires complex interpretation.
Nerve root testing procedures

- The H-reflex. (sensory-motor)
- The F-wave: good for plexopathies & not radiculopathies.
- Somatosensory evoked potential: latency measurements & cannot be used for on-line monitoring.
- The FCR/H-reflex is a segmental test for C7 root (the most common injury site).

What is the H-Reflex?

- Hoffman reflex.
- The electric picture of the mechanical tendon stretch reflex (ATR, PTR, deep tendon reflex for upper & lower extremities).
  - Pathway: Ia sensory afferents → one synapse → motoneurons → muscle fibers.

Use of the H-Amplitude & not the latency in On-line monitoring

- The reflex amplitude reflects the composite number axons conducting the signal (e.g., number of lanes on the highway). Trickling of the traffic past the injury (accident) would be based on the number of lanes blocked by the accident (small or large).

Procedure For Evaluation of Neck Pain

- Testing FCR/H-reflex during lying position (R & L).
- Testing FCR/H-reflex during sitting position (R & L).
- Identify the compromised/symptomatic limb & H-reflex.
- Test the compromised H-reflex during maintained end range of RSB, LSB, RRT, LRT, FB, BB, Protraction (prot.) & retraction (ret.) as well as combined postures.

Kinesiologic H-Reflex of the cervical spine

- Testing the changes in FCR/H-reflex amplitude in response to postural neck modification in 3 axes (total of 20 directions).
- It reflects the compression/decompression effects on the spinal nerve roots during various postures.
- It is evaluative in nature & may have bearing on treatment strategies.

The Optimum Spinal Posture in cervical spine

- The cervical spine/head posture that causes maximum recovery of the compromised FCR/H-reflex.
- It indicates maximum decompression of the compromised nerve root.
- It reflects optimum condition for neural conduction via the nerve root & vertebral foramina.
- It is usually associated with reduced radicular symptoms.
THE UNWANTED SPINAL POSTURE (USP)
- The posture causing maximum further suppression of the compromised H-reflex.
- It indicates maximum compression in the nerve root.
- It creates the worst condition for neural conduction via the nerve root & the vertebral foraminae.
- It is usually associated with aggravation of the radicular symptoms.

THE PREFERRED SPINAL POSTURE (PSP)
- The posture causing limited recovery of the compromised H-reflex.
- It indicates limited decompression of the compromised nerve root.
- It creates good condition for neural conduction via nerve roots & foraminae.
- It is usually associated with limited reduction in the radicular symptoms.

THE COMPROMISING SPINAL POSTURE (CSP)
- The spinal postures causing further reduction in the compromised H-reflex.
- It indicates further compression of the compromised nerve roots.
- It creates bad condition for neural conduction in the nerve roots & foraminae.
- It is usually associated with aggravated radicular symptoms.

Treatment Strategies
- Sleep in the OSP (use pillows & supports)
- Exercises must be carried out in the OSP using both hands as a guide.
- Avoid the USP (absolutely)
- Exercises may be carried out in the PSP.
- Don’t exercise in the CSP.
- Avoid the USP & CSP in ADL.
- Don’t use a collar for support.

Flexor Carpi Radialis H-reflex (FCR/H-reflex)
- Electrical stimulation of the median nerve, at the cubital fossa, behind the biceps tendon using subthreshold stimuli to muscle action potential.
- Recording: surface electrodes on the FCR motor point in the forearm with gain of 200-500 uv/div. It can be facilitated by mild muscle contraction.
Research studies providing the evidence for Sabbahi’s Technique on cervical spine

- To monitor the changes in FCR H-reflex parameters, in normal subjects, during modified head posture.

- Methods: Subjects:
  - N= 22 age: 30-50y.
  - Record FCR H-reflex during maintained end range of head FB, BB, Rot. (R&L), SB (R&L), retraction & protraction.
Cervical spine studies/ normal subjects: Results/ conclusions

- All head postures, except flexion, cause facilitation of FCR H-reflex. No changes in the latency parameter.
- These results indicate that H-reflex changes may be caused by spinal root compression/decompression phenomena.
- Neck Flexion produced most compression on cervical nerve roots.

Experimental studies on the Neck: Patients

- Patients: Chronic cervical radiculopathy
  - N= 16   6 male   10 female
  - Age: 33-61 y.
  - Symptoms: neck & arm pain/symptoms; +ve clinical, EMG & MRI reports
  - History for > 6 wks.
  - Limited improvement from conventional therapy.
  - No previous history of cervical spine surgeries.

Experimental studies: Methods

- FCR H-reflex tested in sitting position in neutral posture & in the OSP; 4 traces.
- The intensity of radicular symptoms was evaluated using VAS, before & after 15 min. of exercise in the OSP (5 sec. on, 5 sec. off)
- Paired t-test & spearman’s correlation were used for statistical analysis.

Experimental Neck Studies: Results

- The H-reflex was significantly larger in amplitude & shorter in latency in OSP.
- Significant reduction in the intensity of radicular symptoms after exercise in OSP.
- Weak association between the H-reflex & the intensity of radicular symptoms.
Experimental Neck Studies - Conclusions of patient’s studies

- Exercises in OSP improved neural conduction in the compromised nerve root & reduced the intensity of radicular symptoms.
- Postural exercises charted based on H-reflex measurement is a valid evaluation & treatment technique in patients with cervical radiculopathy.

Disability Changes after treatment of patients with cervical radiculopathy

- Objectives: To evaluate the disability status of patients with cervical radiculopathy after treatment in OSP:
  - Patients: N=14 Age: 33-60 y.
  - Confirmed C7 radiculopathy (clinical, EMG & MRI)
  - Recorded FCR H-reflex, Identify OSP

Neck Disability study - cont.

- Exercise in OSP 15 min., 3x/day for 2 days.
- Disability was measured using Neck Disability Index (NDI) before & after exercises program.

Table 3. Spearman's correlation coefficient between H-reflex (amplitude and latency) and NDI scores before and after 2 days of 15 min exercising in the OSP

<table>
<thead>
<tr>
<th></th>
<th>NDI</th>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>H-reflex amplitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural head position</td>
<td>-0.64*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>OSP</td>
<td>-</td>
<td>-</td>
<td></td>
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<tr>
<td>H-reflex latency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural head position</td>
<td>0.55*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>OSP</td>
<td>-</td>
<td>0.38</td>
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* P < 0.05

Table 2. NDI scores before and after 2 days of 15 min exercising in the OSP

<table>
<thead>
<tr>
<th></th>
<th>NDI</th>
<th>Before</th>
<th>After</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Head position</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Natural</td>
<td>0.45 ± 0.35</td>
<td>0.39 ± 0.35</td>
<td>0.004</td>
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<tr>
<td>OSP</td>
<td>18.34 ± 2.36</td>
<td>17.66 ± 3.02</td>
<td>0.011</td>
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<tr>
<td>Table 3.</td>
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<tr>
<td>Head position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>16.29 ± 5.99</td>
<td>7.07 ± 4.68</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>
Disability was reduced in cervical radiculopathy after exercise in OSP

Results: Disability scores was reduced from 16.29 to 7.07 after 2 days exercises in OSP.

Conclusions: Exercises in OSP will decrease the disability in patients with cervical radiculopathy via neural decompression & resolving radicular & spinal symptoms.

Neck Retractions promote cervical root decompression & reduce radicular Pain

- Subjects: 10 normal subjects  Age: 22-32y
- Patients: N= 13                      Age: 25-45y
- Procedure: Reading for 20 min. followed by 20 repetitive neck retractions.
- Measured Parameters: FCR H/reflex & intensity of neck & radicular pain before & after intervention.
- Analyses: Repeated measure ANOVA

Neck Retractions increased H-Amplitude & reduced Neck Pain

- RESULTS: H-reflex was decreased in amplitude after reading & increased after neck retractions, in both groups. The change was more pronounced & statistically significant in patients with radiculopathy.
- No changes in H-latency.
- This was associated with significant increase in neck pain after reading & reduction after neck retractions.

Neck Retractions study: Conclusions

- Neck retraction is a preferred posture for treating patients with neck pain. It decompresses cervical nerve root, mostly of lower cervical level, & reduce neck & radicular pain.
- We recommend including neck retractions in exercise program for treatment of cervical radiculopathy (especially for lower cervical levels).

Immediate Effects of Treatment with OSP in Neck Pain

- Our experience on > 500 patients (without spine surgeries)
- Our experience on > 200 patients with cervical spine surgeries.
- Usually numbness is eliminated 1st. This is followed by radicular pain & then weakness.
- The tenderness spot at the medial border of the scapula showed reduced pain intensity in OSP.
- The reduced radicular symptoms is more pronounced in the OSP.
Clinical Observations on Patients with Neck Pain Treated by OSP

- The radicular symptoms are aggravated in the USP, even if it is retraction.
- Mild changes in the OSP may aggravate symptoms.
- The changes in radicular symptoms follow the centralization/peripheralization concept.
- The reduced radicular symptoms was maintained.
- You can save patients spine surgeries.

The use of Mobilization techniques in the OSP of the neck.

- Use of short burst mobilization in the direction of the OSP accelerate the treatment results. Start with unloading (lying), progress to loading (sitting).
- Application of ice pack during mobilization would decrease the soft tissue pain resulting from mobilization.

OSP: Single or Double axes

- Most of the OSP, in the neck was double axes.
- Neck retraction was a common preferred posture (mostly for C8 level) but less effective than the OSP for treatment of neck pain due to other spinal levels.

Gradation of Treatment protocol in neck pain

1st: OSP may be applied during lying position (unloaded) in advanced conditions.
2nd: OSP may be applied during sitting position as a second gradual step (loading).
3rd: OSP may be applied while wearing a weighted helmet, in later stages of the program.

Home Program for Neck Patients

- Sleep in the OSP for about 30 min. at bedtime.
- Avoid sleeping in the USP (absolutely).
- Exercise in the OSP 5x/day (10 min. each)
- You may exercise in retraction posture???
- Avoid exercise in the CSP.
- Don’t drive unless it is necessary; use a lumbar roll for posture’s alignment.

Treatment of Neck Pain with OSP: Conclusions

- Electrophysiologic-based techniques for evaluation & treatment of patients with cervical radiculopathy has been proposed, tested & validated.
- The new technique adds objectivity in the measurement & guidance in the treatment based on neural compression/decompression concept.
- It does not depend on patient’s self report.
Bibliography


Thank You