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The Management of Cervicogenic Pain and Headaches After Concussion

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Bailey Denno, PT, DPT
Objectives

- Define concussion and post-concussive syndrome, cervicogenic headache and pain.
- Identify at least three red flags that may be associated with post-concussion symptoms.
- Describe how to assess athletes for readiness for return to play.
- Identify pathophysiology and anatomy of cervical and neural components involved in post-concussion syndrome.
- Describe at least three components of performing and applying clearance testing of the cervical spine prior to manual treatment (SCATT, Vertebral Artery, Flexion Rotation Test, etc).
- Identify at least three manual and therapeutic exercise techniques appropriate specific to post-concussion syndrome.
- Describe at least three patient techniques observed by video/photos and be complete goal setting based on case study.

Definitions

- Sports Concussion Definition
  
  Sport related concussion is a traumatic brain injury induced by biomechanical forces. Several common features that may be utilized in clinically defining the nature of a concussive head injury include:
  
Definitions

- Sports Concussion Definition
  - SRC may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head.
  
  - SRC typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, signs and symptoms evolve over a number of minutes to hours.


- SRC may result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.

- SRC results in a range of clinical signs and symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive features typically follows a sequential course. However, in some cases symptoms may be prolonged.
Sports Concussion Recovery

- Majority (80-90%) resolve in 7-14 day period
- May take longer in children and adolescents


Definitions DSM-IV

- Post-Concussion Syndrome
  - Cognitive deficits in attention or memory
  - And at least three or more symptoms including: headache, dizziness, fatigue, irritability, apathy, personality change, or sleep or affective disturbance
Definitions (WHO ICD-10)

- Post-Concussion Syndrome
  - Presence of 3 or more of the following symptoms including: headache, dizziness, fatigue, irritability, insomnia, and concentration or memory difficulty
  - Controversy in the literature regarding the cause, nature and treatment of PCS

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Post-concussion Syndrome

- Post-Concussion Syndrome in Athlete
  - Up to 15% of concussions can be associated with persistent symptoms
  - Diagnosis should be considered with symptoms lasting > 3 weeks
  - The Berlin expert consensus is that use of the term ‘persistent symptoms’ following SRC should reflect failure of normal clinical recovery—that is, symptoms that persist beyond expected time frames (ie, >10–14 days in adults and >4 weeks in children).
Post-concussion Syndrome

- Post-Concussion Syndrome in Athlete

  - The strongest and most consistent predictor of slower recovery from SRC is the severity of a person’s initial symptoms in the first day, or initial few days, after injury.

  - Low level of symptoms in the first day after injury is a favorable prognostic indicator.

Symptoms Associated with PCS

<table>
<thead>
<tr>
<th>Cognitive</th>
<th>Somatic</th>
<th>Sleep</th>
<th>Affective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confusion</td>
<td>Headache</td>
<td>Drowsiness</td>
<td>Emotional</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>Fatigue</td>
<td>Sleeping less</td>
<td>Irritability</td>
</tr>
<tr>
<td>Disorientation</td>
<td>Nausea/vomiting</td>
<td>Sleeping more</td>
<td></td>
</tr>
<tr>
<td>Feeling “in a fog”</td>
<td>Visual disturbance</td>
<td>Difficulty falling asleep</td>
<td></td>
</tr>
<tr>
<td>Vacant stare</td>
<td>Phonophobia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inability to focus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed verbal and motor responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slurred speech</td>
<td></td>
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</tbody>
</table>
Concussion and Cognition

Effect of sustaining multiple concussions
- For athletes multiple concussions seems to be a significant risk factor
- Cognitive-attentions memory impairment
- Mental fatigue and irritability
- Depression; social withdrawal
- Insomnia
- Physical fatigue
- Balance disturbance
- Sensitivity to light

Sports Concussion Recovery

- Strongest predictor of slower recovery = severity of a person’s initial symptoms on the first day or initial few days after
Post-concussion Syndrome

- Evidence for cognitive rest

<table>
<thead>
<tr>
<th>Complete Cognitive Activity Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0; Complete cognitive rest</td>
<td>No reading, homework, text messaging, video games, online activity, crossword puzzles, or similar activities. The most stimulating activities at this level would be watching TV, watching movies, or listening to music.</td>
</tr>
<tr>
<td>1; Minimal cognitive activity</td>
<td>No reading, homework, crossword puzzles or similar activities. Less than 5 text messages per day, less than 20 min per day combined of online activity and video games.</td>
</tr>
<tr>
<td>2; Moderate cognitive activity</td>
<td>Reading less than 10 pages per day, less than 20 text messages per day, and doing less than 1 h combined homework, online activity, and video games per day.</td>
</tr>
<tr>
<td>3; Significant cognitive activity</td>
<td>Reading less, doing less homework, working less online, text messaging less, and doing crossword or other activities than you would normally do but more than listed in level 2.</td>
</tr>
<tr>
<td>4; Full cognitive activity</td>
<td>You have not limited cognitive activity at all.</td>
</tr>
</tbody>
</table>
Headaches

- Headaches found in 70% of concussed athletes
- Approximately 47% of global population suffers from a headache
- 20% of those are cervicogenic ~ 2.2% of population
- Females 4x more affected than men

Headache Types

- Migraine or tension headache
  - Headache studies
  - No difference in myofascial signs and symptoms

- Cervicogenic headaches
  (Quality of life decreases)

Cervicogenic Headaches

- Trauma or persistent muscle spasm affecting the deep and superficial cervical and sub-occipital muscles can also lead to irritation and impingement of the sensory nerves that innervate the neck and posterior scalp. This can lead to cervicogenic headaches and occasional neuralgia.

Cervicogenic Headache

- Soft tissue
- Articular
- Neural
  - Nerve roots
  - Neural integration
- Osseous
- Vascular


Cervicogenic Headaches

- Cervicogenic Headaches are defined as headaches associated with neck pain and stiffness.
  - Unilateral
  - Bilateral
    - Can have facet “lock”
    - Evidence of cervical dysfunction during manual exam
    - May occur with trigger point palpation in the head or neck
    - Aggravated by sustained neck positions
    - Normal imaging
Cervicogenic Headaches

- Upper cervical facets
- Upper cervical muscles
- C2-3 intervertebral disc
- Vertebral and internal carotid arteries
- Dura mater of the upper spinal cord
- Posterior cranial fossa

Cervicogenic Headache Treatment

- Manual manipulation
  - High-velocity, low-amplitude
    - Cautious
  - Strain-counterstrain
  - Craniosacral
  - Muscle energy technique

- Therapeutic exercise

Red flags Associated with HA

- Headaches that are getting worse overtime
- Sudden onset of severe headache especially when combined with decreased mental status or vomiting can be sign of intracranial bleed/hematoma
- Headaches associated with high fever, stiff neck, or rash

The National Football League (NFL)

- Concussion data
  - 1996-2001 148 concussions per season
  - 2002-2007 143 concussions per season
  - 2011-2014 236 concussions per season
- If helmets are better but concussion prevalence has not decreased…….
- What other factors contribute?

doi:10.1115/1.4034356.
Helmets

- Football helmet improvements 1970’s to 2010
  - 10-20% reduction in head response
- Helmet average changes 1970’s to 2010
  - Length 4.3cm
  - Height 7.6cm
  - Width 4.9cm
  - Mass 1.18kg (2.6lbs)


Helmets

- On human cadavers
  - Reduced linear accelerations
  - Reduced angular accelerations
  - Increased brain strain in the cerebrum
- Spinal cord kinematics
  - Tensile forces at neck on
    - SC, Brain stem, Cerebellum, CN V-XII
  - Causing concussion

Head Response

- “Lower neck strength is a significant predictor of the potential for concussion...” and further research on this is indicated.


Cervical Spine and Concussions

- Brain stem
  - Study on animals
  - Foramen magnum

- Brain hemisphere
  - Rotational and translational impact
  - Craniocervical joint

- Spinal cord

Cervical Collar

- Primates
  - Twice the head acceleration
  - No concussive symptoms
- Cats
  - Head fixed, no concussion
  - Head free to move, concussion

Physiological Changes

- Brain stem and midbrain
  - Heart and respiration rate changes
- Game film
  - 182 severe impacts
  - 71% of concussions
    - Side or back of the head

What about Mouth Guards?

- Prevents the severity of dental trauma
- Important to have athlete wear properly
- Research has shown OTC better than custom
- Concussion prevention (absorbs force of blow to jaw and mandible)
- More research on this topic
Brain Stem

- Physiology
- Information integration
- Autonomic regulation
  - HR, RR, Temperature


Brain Stem Anatomy (cranial to caudal location)

- **Motor Nuclei**
  - Oculomotor nucleus (III)
  - Trochlear nucleus (IV)
  - **Trigeminal motor nucleus (V)**
  - Abducens nucleus (VI)
  - Vestibular nuclei (VIII)
  - Facial nuclei (VII)
  - Salivatory nucleus
  - Nucleus ambiguus (IX, X)
  - Dorsal motor nucleus of X
  - Hypoglossal nucleus (XII)
  - Spinal accessory nucleus (XI)

- **Sensory Nuclei**
  - Mesencephalic trigeminal nucleus (V)
  - Main sensory trigeminal nucleus (V)
  - Vestibular nuclei (VIII)
  - Cochlear nuclei (VIII)
  - Nucleus of the solitary tract (VII, IX, X)
  - **Spinal trigeminal nucleus (V)**

Trigeminocervical Nucleus

- Sensory bidirectional communication
  - Upper cervical nerve roots
  - Trigeminal (CN V) sensory information

Anatomy and Pathophysiology

- C1 dorsal ramus
  - Atlanto-occipital joint
  - Suboccipital pain
- C2 dorsal ramus
  - Located close to atlantoaxial zygapophyseal joint
  - Innervate AA and C2-3 zygapophyseal joints
  - Referring to the head
  - C2 injury may cause vascular occlusion

Anatomy and Pathophysiology

- C3 dorsal ramus
  - Near and innervates C2-3 zygapophyseal joints
  - 3rd occipital nerve
  - Acceleration-deceleration injuries
  - Occipital, frontotemporal, periorbital
  - Cervicogenic headache
- Diagnostic nerve block
- Occipital nerve
  - Pain and paresthesia in occipital region


Anatomical Understanding C3-T3

- 30 ossified vertebral columns (adult)
  - Zygaphophysseal joints
  - Facets (articular surfaces)
- Research limitations….
- Posteromedially facing superior facets
  - All at C3 level
  - 73% at C4 level
- Posterolaterally facing superior facets
  - C7 level and below

Anatomical Understanding C3-T3

- Transition from posteromedial to posterolateral
  - Sudden (single vertebra)
  - Gradual (2-5 successive vertebrae)
- C5-6
  - Most common transition point
- C3-5 facets
  - Generally more round
- C7-T1 facets
  - Transversely elongated (oval)


Cervical Proprioception

- Or joint position sense (JPS)
  - Ability to naturalize the head position without vision
- Dysfunction
  - Whiplash associated disorder (WAD)
  - Idiopathic neck pain (INP)
  - Dizziness

Carotid Artery Dysfunction

- Prior to
  - Assessment
  - Therapeutic exercise
  - Manual treatment
- Cervical arterial screen
  - Informative
  - Not diagnostic
- Risk: Benefit analysis
  - Rare
  - Serious


Therapeutic Exercise - Isometric

- Isometric Deep Cervical Flexor (DCF)
  - Flexion bias
  CORRECT
  INCORRECT
Therapeutic Exercise - Isometric

- Isometric Deep Cervical Flexor (DCF)
  - Extension bias
    CORRECT
    INCORRECT

Therapeutic Exercise - Eccentric

- Deep cervical flexion eccentric control
  - With towel assistance
  - Without assistance - more advanced
Therapeutic Exercise - PRE

- DCF with progressive resistance
  - Change angle of resistance
  - Change body positions to advance
- Cervical stabilization
  - Load
  - Athletic stance
  - Variable force directions

Manual vs. Therapeutic Exercise

- A 2016 literature review
  - 7 randomized control trials
    - 5 of those with high level of methodology

Upper Cervical Instability

- Causes
  - Trauma
  - Inflammatory conditions (rheumatoid arthritis, ankylosing spondylitis)
  - Congenital deviation (Trisomy 21)
- Symptoms
  - Stiffness
  - Pain
  - Torticollis
  - Neurological signs and symptoms


- Literature review of 5 studies
  - Manual assessment has poor sensitivity
- Thorough subjective
  - PMHx trauma
  - Visual/vertigo signs and symptoms
- Objective
  - Neuromotor control

Upper Cervical Instability Screen

- OA instability screen - Kaltenborn
  - Alar ligament
  - Sharp purser test
  - Transverse Ligament test
  - Tectorial membrane test

Upper Limb Tension Tests (ULTT)

- Median
  - Scapular retraction and depression
  - External rotation
  - Elbow extension
  - Forearm supination
  - Finger and wrist extension
- Radial
  - Scapular retraction and depression
  - Internal rotation
  - Elbow extension
  - Pronation and ulnar deviation
  - Finger and wrist flexion
- Ulnar
  - Scapular retraction and depression
  - Abduction and external rotation
  - Elbow flexion
  - Forearm supination or pronation
  - Wrist extension and radial deviation
  - Finger extension
Manual Treatment

- Atlantis-Axis flexion active mobilization
  - Promote upper cervical flexion
  - Suboccipitals
  - DCF
- Anterior segmental treatment
- Atlantis-Axis rotation
  - Assessment
  - Treatment

Sphenoid
Anatomy and Pathophysiology

- C3 dorsal ramus
  - Near and innervates C2-3 zygoapophyseal joints
- 3rd occipital nerve
- Acceleration-deceleration injuries
- Occipital, frontotemporal, periorbital
- Cervicogenic headache
- Diagnostic nerve block
- Occipital nerve
  - Pain and paresthesia in occipital region


Return to Play Protocol

- CIF Return to Play Protocol
  - Can be used for PCS population
  - CA state law (effective 1/1/2015) that all return to play CANNOT BE SOONER than 7 days AFTER evaluation by a physician who has made the diagnosis of concussion
- Must be completed by trained concussion monitor who initials each stage after you successfully pass it
- Stages I-II take a minimum of 6 days to complete
- You must complete one full practice without restrictions (stage III) before competing in first game
- After stage I, you cannot progress more than one stage per day
- If symptoms return at any stage Immediately stop
Evaluation

- Subjective (SCAT5, CIF)
- Cervical evaluation
- Aerobic activity assessment
- Oculomotor screen
- Postural control assessment
- Plan of Care based on their presentation

Return to Play Protocols

- CIF graded concussion symptoms checklist
  - Grade 22 symptoms with a score of 0-6
  - For athletes fill out at the beginning of the season as a baseline
  - You can use this checklist if you have a patient you suspect suffered a concussion and record their symptoms each visit
  - No scale compare your patient's total score; helps you follow your patient's symptoms on more frequent basis
  - Your patient's total score (out of 132) should be decreasing
    - (see next slide)
CIF Graded Concussion Symptom Checklist

Return to Play Protocols

- SCAT-3
- Most recent development of SCAT-5
- Graduated return to sport (RTS) strategy
### Graduated RTS Strategy

<table>
<thead>
<tr>
<th>Exercise step</th>
<th>Functional exercise at each step</th>
<th>Goal of each step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Symptom-limited activity</td>
<td>Daily activities that do not provoke symptoms.</td>
<td>Gradual reintroduction of work/school activities.</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking or stationary cycling at slow to medium pace. No resistance training.</td>
<td>Increase heart rate.</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Harder training drills, e.g., passing drills. May start progressive resistance training.</td>
<td>Exercise, coordination, and increased thinking.</td>
</tr>
<tr>
<td>5. Full contact practice</td>
<td>Following medical clearance, participate in normal training activities.</td>
<td>Restore confidence and assess functional skills by coaching staff.</td>
</tr>
<tr>
<td>6. Return to play/sport</td>
<td>Normal game play.</td>
<td></td>
</tr>
</tbody>
</table>

In this example, it would be typical to have 24 hours (or longer) for each step of the progression. If any symptoms worsen while exercising, the athlete should go back to the previous step. Resistance training should be added only in the later stages (Stage 3 or 4 at the earliest).

### Graded Aerobic Activity Assessment

- Walk on treadmill
- Speed 3.0-3.3mph
- 0% grade
- Increase grade by 1%/min during first 15 min
- Speed then increases 0.2-0.4mph/min
- Rates patients symptoms every minute (Likart scale and Borg)
- Continuous heartrate monitor
Clinical Case Study

30 year old female
DOI: September 25, 2017
MOI: MVA rear-ended at stoplight
Symptoms: initially constant posterior neck headache, described as dullness in the morning, worsening in the afternoon
HA pain level: 3/10 to a 7/10 by evening
Sleeping: disturbed 3 hours sleepless
Occupation: Medical reception specialist busy OP PT clinic

Aggravating Activities: looking down, looking at computer, head movement, noises, malls, shopping, lights
Activities Alleviated: less light, ice at base of neck, resting, closing eyes, less head movement, not being at computer
CIF score IE (95/132) worst with vision and balance disturbances
Clinical Case Study

Objective Measures:

- Cervical ROM limited in rotation, flexion (+pn)
- Special tests: + Flexion rotation, + cervical compression (increases headache symptoms)
- Palpation: moderate tenderness suboccipitals, levator, scalenes, UT SCM
- Neuro: + SLUMP (with cervical flexion), +ULTT median nerve
- Oculomotor: + dizziness with saccadic eye movements to L: + headache increase with convergence testing; visual disturbance with tracking from
- Vestibular/balance testing: (see videos)

Clinical Case Study

Vestibular/balance testing:

- Tandem walking eyes open
- Tandem walking eyes closed
- Tandem walking head turns EO
- Tandem walking head turns EC
- Fukuda
Clinical Case Study

Vestibular/balance testing:

Videos Amanda 1-5

Oculomotor Screen: Test for gaze stability

Eyes turn to object

Head turns 2nd
Clinical Case Study

Assessment

Clinical Case Study Progress

- Improvements in pain level/tenderness
- Decreased headache frequency and intensity
- Improved activity tolerance
- Improved Sleeping hours
- Continues to have visual disturbance
- Continues to have dizziness with fatigue and head movement
- CIF decrease from 95/132 to 63/132
- Improved CROM from 60 to 70 degrees
Clinical Case Study Progress
Amanda Videos (6-10)

Clinical Case Study
Progress exam (4 weeks since IE; 5 weeks since MVA)
Clinical Case Study

Progress exam; cervical HEP

Clinical Case Study

Progress exam; cervical HEP
Conclusions:

Physical Therapy interventions for athletes and non-athletes with PCS may facilitate recovery and improve function. Further research is needed to validate effective tools for assessment of pts who experience prolonged concussion symptoms as well as establishing support for specific post mTBI physical therapy interventions. We hope this webinar helps to guide you through a more comprehensive evaluation and assist you to establish a more thorough plan of care for your patients with PCS.

References

- Dhao O, Barr W, Balcer L, Galetta S, Minen M. Post-traumatic headache; the use of the sport concussion assessment tool (SCAT-3) as a predictor of PCS. J of Headache and Pain 2017;18:60
References


