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## CASE ARTICLE

# CORRELATION OF LATERAL ATLANTO-AXIAL JOINT WITH CERVICOGENIC HEADACHE – A CASE REPORT

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### ABSTRACT

**Introduction:** Cervicogenic headache is a syndrome characterized by chronic hemicranial pain that is referred to the head from either bony structures or soft tissues of the neck. Since 1980, it was believed that there was an involvement of the cervical facet joints in the neck pain and Cervicogenic headache due to trauma (whiplash injury) or arthritic changes. Lateral atlanto-axial joints pathology can also be the cause for cervicogenic headache.

**Case report:** A 30 year old car mechanic, having chronic headache affecting the left upper part of the neck, had an h/o car accident after which the pain started. When conservative treatments as well as cervical facet joint injection failed to give satisfactory pain relief, a diagnostic lateral atlanto-axial joint block on the affected side was a great help to the patient.

**Conclusion:** Headache is a complex phenomenon. Proper history, examination and investigation is required to come to the diagnosis. In refractory cases cervical spine should be assessed properly. Diagnostic blocks are very useful to rule out the causes. Thorough anatomical knowledge is very important for every clinician.

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## INTRODUCTION

Cervicogenic headache is a syndrome characterized by chronic unilateral headache that is referred to the head or scalp from either bony structures or soft tissues of the neck. Since 1980, it was believed that there was an involvement of the cervical facet joints in the neck pain and Cervicogenic headache due to trauma (whiplash injury) or arthritic changes (Bogduk and Marsland, 1988). But like other cervical facet joints, lateral atlanto-axial joint pathology can also be the cause for cervicogenic headache (Bogduk, 1992).

### Case report

A 30 year old car mechanic was having chronic headache for last three years affecting the left upper lateral part of the neck and scalp. He had an h/o car accident after which the pain started. He was treated with conservative treatments by Orthopedics, Neurologists as well as Psychiatrists and all the routine investigation including related X-ray / CT / MRI were within normal limits. Though C3, C4 and C5 cervical facet joint injections achieved little relief but still he was

complaining of pain on the upper left-lower part of the scalp on lateral rotation on the same side. Then a diagnostic lateral Atlanto-Axial joint intra-articular steroid with local anesthetic injection under fluoroscopic guidance on the affected side was a great help to the patient.

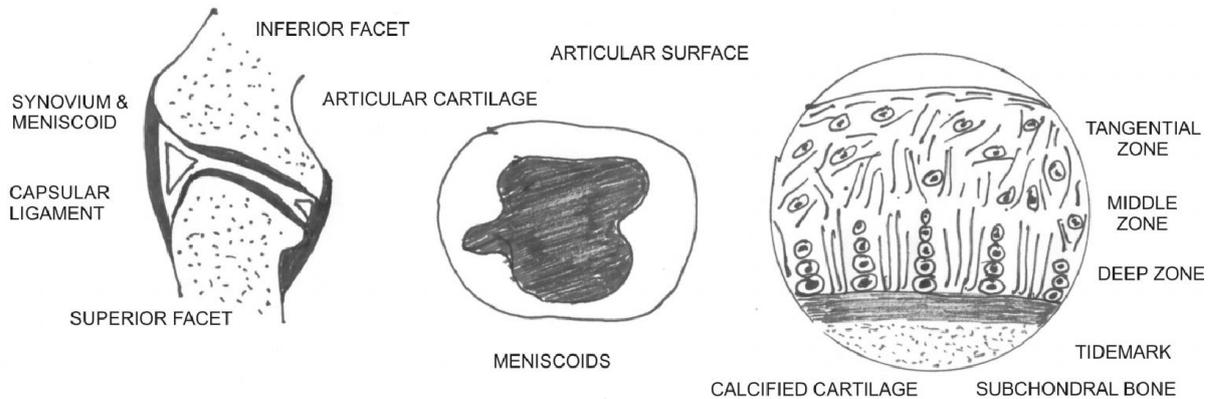
## DISCUSSION

Approximately 47% of the global population suffers from headache (Stovner *et al.*, 2007); 15-20 percent of those headaches are cervicogenic and Female: Male = 4: 1. Leaving different intracranial causes and extra-cranial causes coming from other structures from neck, it was believed that there was an involvement of the cervical facet joints in the neck pain and Cervicogenic headache due to trauma (whiplash injury) or arthritic changes. Since a huge portion of the spine's mechanical loading is supported by the facet joint, a variety of mechanical, physical, and chemical cascades are initiated in response to loading of the individual tissue components comprising the facet joint which may ranging from the macroscopic tissue-level, to cellular and molecular levels via many mechano-transduction mechanisms (Adams *et al.*, 2009). The zygapophyseal or facet joints are complicated biomechanical structures in the spine, with complex anatomy, mechanical performance and effects on overall spine behavior

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and health. At each spinal level, there is a pair of facet joints located on the postero-lateral aspects of each motion segment, spanning from the cervical to the lumbar spine. These facet joints are typical diarthrodial joints with cartilage surfaces (Figure 1) that provide a low-friction interface to facilitate motion during normal conditions in a healthy spine.

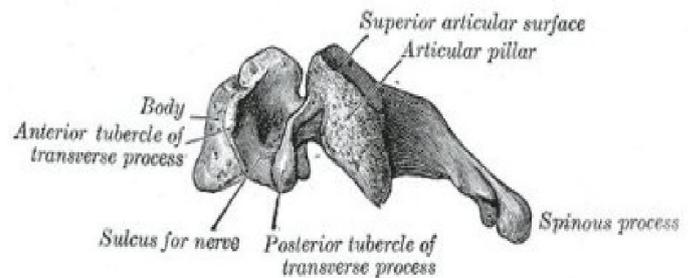
So, articular surfaces are more horizontally-oriented in the cervical and upper thoracic spinal regions than lumbar region (White and Panjabi, 1990; Panjabi *et al.*, 1993; Pal *et al.*, 2001). The Facet joints help in the motion of the vertebrae, while also facilitates the transmission of the loads applied to the spine.



**Figure 1. Macro and Microscopic structure of Facet Joint**

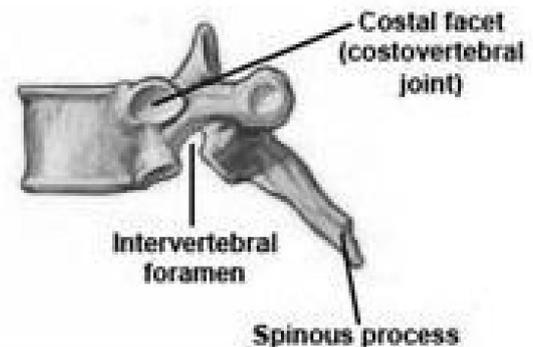
An a vascular layer of hyaline cartilage, with variable thickness in different spine region covers the articulating surfaces of each facet<sup>5</sup>. The cartilage is thinner at the edges and gradually increases to its thickest (~1 mm) towards the center of the articulating joint in cervical region. On the other hand the lumbar facet capsule has been reported to be 2.0 – 3.2 mm thick<sup>6</sup>. The synovium of the facet joint is a thin and soft peri-articular connective tissue with two main layers that secrete synovial fluid components involved in the maintenance of the synovial fluid used to lubricate and nourish the cartilaginous articular surfaces. However, subchondral bone can be exposed to mechanical compression during some loading scenarios. This not only presents the possibility for direct trauma to the bone but has also been hypothesized to lead to pain in some cases. The gap in cartilage coverage is greater in females, which may play a role in the greater susceptibility of women to suffer neck traumas (Yoganandan *et al.*, 2003).

The capsule, as well as the subchondral bone, synovium and folds, are richly innervated with mechanoreceptive, proprioceptive and nociceptive nerve endings. Therefore, mechanical loading of any of those innervated tissues in the facet joint could activate nerve endings and modulate the signals in the nervous system to initiate the development and maintenance of pain and/or cellular dysfunction (Womack *et al.*, 2008). Facet joints are located at the junction between the lamina and the lateral masses in the cervical region of the spine; whereas, in the thoracic and lumbar regions, they are joined to the vertebral body via the bony pedicles (Figure 2a, 2b, 2c). In general, the inclination angle (Figure 3) of the articular surfaces of the facet joint in the sagittal plane ranges from 20°–78° in the cervical region, 55°–80° in the thoracic region, and 82°–86° in the lumbar region. The angle between the articulating surfaces in the axial plane range from 70°–96°, 85°–120°, and 15°–70° off of the midline in the cervical, thoracic, and lumbar regions, respectively.



**Figure 2a. Cervical vertebra**

#### Lateral (Side) View



**Figure 2b. Thoracic vertebra**

When the compressive load is 3–25% is carried by the Lumbar facets (“facet force”), it is 22 - 24% in the cervical and upper thoracic spine (Yang and King, 1984). On the other hand, straining of the fibers in the facet capsule not only results from vertebral motion but also from the activation of the muscles that can occur during mechanical loading of the spine as the outer surface of the capsular ligament, covered by the surrounding paraspinal muscles.

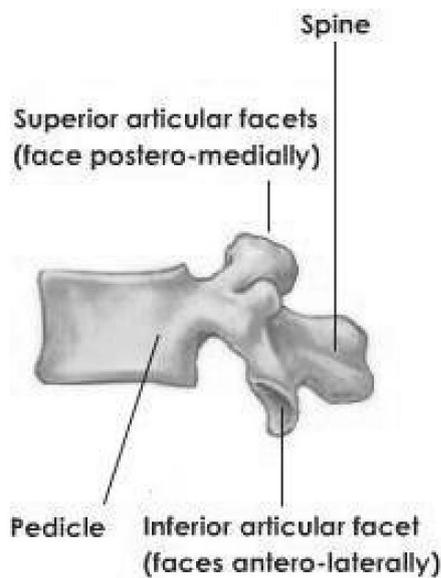


Figure 2c. Lumbar vertebra

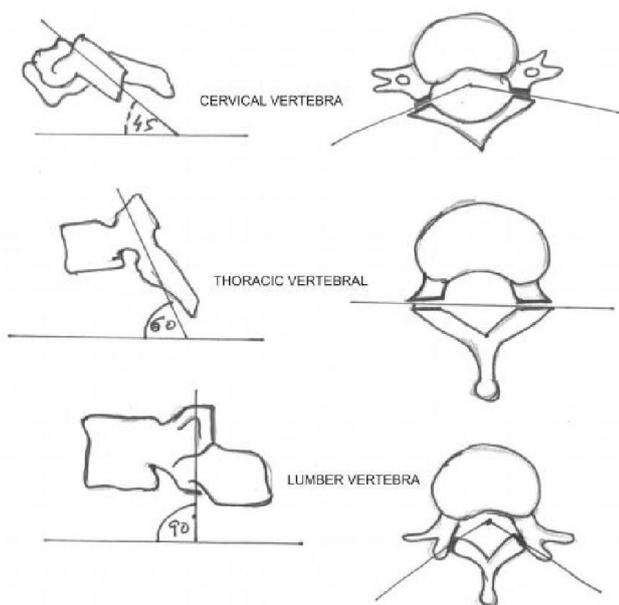


Figure 3. Incline of Facet joints

When the capsule is stretched, the nerve afferents that innervate it are also stretched, which has been shown to trigger the generation of neuronal signaling to the central nervous system (CNS). Some studies found that the capsule contained afferents that responded with firing at both low- and high-thresholds of strain (10% and 47%, respectively) and also that afferents of both types exhibited persistent generation of after discharge for up to 5 mins after the release of the applied strain (39–57%) that did not produce tissue rupture (Lu *et al.*, 2005). So this may be the possible mechanism for chronic pain because the after discharge was hypothesized as having long term effects in the CNS. The neural signals from the capsule travel via the primary afferents to the dorsal root ganglion (DRG) and spinal cord, and can induce several hallmarks of neuro-inflammation, including glial activation (Winkelstein and Santos, 2008) and cytokine upregulation (McMahon *et al.*, 2005; Igarashi *et al.*, 2007)

The particular relationship between the mechanical, chemical, and cellular responses to compression in the cartilaginous matrix of the different zones remains largely unreported for the human spinal facet joint. Nevertheless, damage to the cartilage structure elicits an inflammatory response (Pelletier *et al.*, 2001; Côté *et al.*, 2001), which itself can also elicit not just osteoarthritis of the joint but can modulate pain signals from other regions of the joint. For example, one study showed that the inflammatory cytokines IL-6 and IL-1 $\beta$  were present in the facet cartilage retrieved from patients undergoing surgery for lumbar spinal canal stenosis and disc herniation (Igarashi *et al.*, 2007). This result led to the conclusion that pain symptoms might be due not only to mechanical tissue insults but also to chemical irritation of the tissue from the inflammatory agents leaking from the facet joint into the spinal space.

Facet joint injuries result most-often from motor vehicle and sports trauma, such as skiing, snowboarding, cycling, and diving (Stemper *et al.*, 2004), and include a wide range of bony and ligamentous lesions depending on the extent and type of tissue trauma (Hadley *et al.*, 1992). In fact, even sub catastrophic or “subfailure” loading of the facet capsule has been shown to induce pain in a variety of scenarios<sup>21</sup>. Perhaps the best example of sub catastrophic capsular distortions modulating physiological responses is highlighted by spinal loading and whiplash-associated disorders (Stemper *et al.*, 2005; Quinn *et al.*, 2007). Whiplash-associated disorders are particularly challenging in terms of understanding the biomechanics of the tissue injury and the physiological consequences because there is often no radiologic or other imaging evidence that reveals any obvious indicators of tissue trauma (Chen *et al.*, 2009; Barnsley *et al.*, 1994).

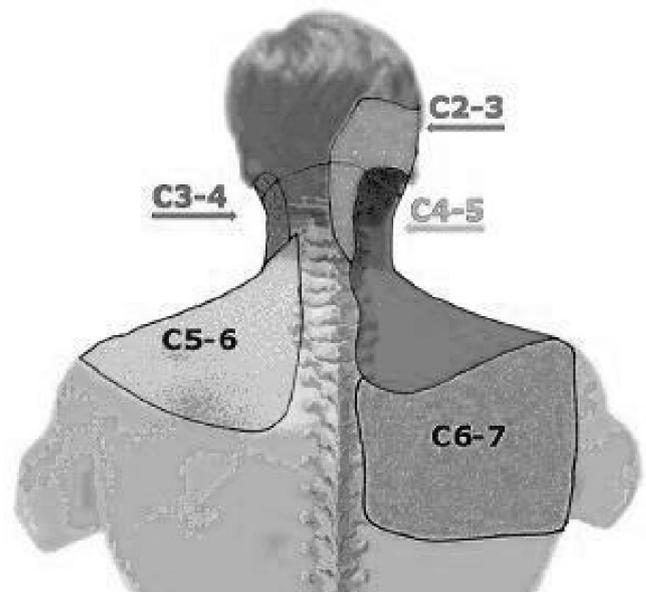


Figure 4. Pain pattern from cervical facet joint disorders

Degeneration is a progressive condition that often proceeds from modifications of the material, biochemical, and structural properties of many tissues. The degenerative process also alters the material and mechanical properties of the joint which eventually lead to further damage of the material integrity of the affected tissues. Since the mechanical behavior of the facet

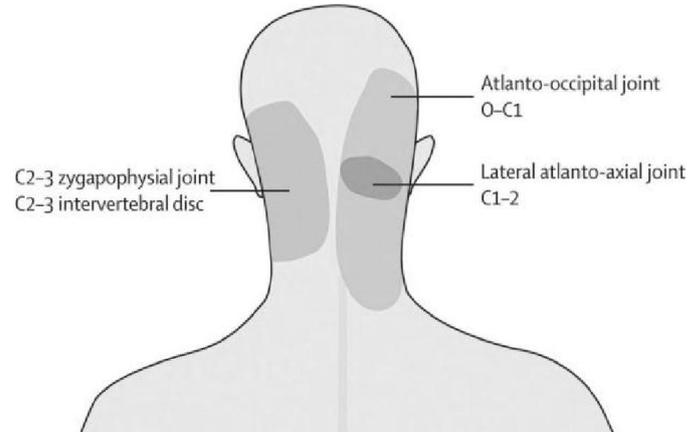
joints and intervertebral disc are inter-dependent, degeneration of the facet joint will also affect the mechanical behavior of the whole vertebral motion segment, and similarly, disc degeneration can impact the overall spinal degenerative cascades. Tissue degradation occurs at the structural and cellular levels during degeneration and that process can result from and/or be associated with aging (Taylor and Twomey, 1986; Manchikanti *et al.*, 2008), injury (Barnsley *et al.*, 1994), and also infection or inflammation (septic arthritis, synovitis, and rheumatoid arthritis) (Chan *et al.*, 1987).

However, defining degeneration of the articular cartilage is more challenging and necessitates the use of MRI because this tissue is enclosed in the joint and it is “transparent” to X-rays (Ryu *et al.*, 2010). The above discussion was needed to show that how cervical facet joint is responsible to generate neck pain and headache in our day-to-day activities. This pain pattern (Figure 4) showing that when the upper cervical facets are getting affected the pain radiates to the upper part of neck and scalp which calls ‘Cervicogenic Headache’ whereas the lower cervical facet pain radiates to lower part of neck and shoulder. But many a times Lateral Atlanto-Axial joints or Atlanto-Occipital joints also cause symptoms like “Cervicogenic Headache” (Bogduk, 1992).

Atlanto-Axial joints (AA) are the joint of “negative expression”, as these joints allow the head to rotate laterally. On the contrary Atlanto-Occipital (AO) joint is a joint of “Yes” or nodding (flexion or extension) (Edmeads, 1988). As there is no disc between AA and AO level, the facet joints and the numerous ligaments provide the major stability between the two bones, which are thought to possess the articular nociceptors and sensory afferents necessary to mediate the pain and facet syndrome (Clemente, 2010). Two lateral Atlanto-axial joints compliment the median Atlanto-axial joint. The lateral AA joints help to transfer the weight of the skull from the AO joint. Both lateral and median AA joints are morphologically equivalent to the uncovertebral joints of the lower cervical vertebrae (Bogduk and Marsland, 1986). The obliques capitis inferior, splenius capitis and rectus capitis posterior major muscles of one side of the body, work in tandem with the sternocleidomastoid of the other side, to control the motion of the AA joint. That’s why a spasm in these muscles can also create symptoms of Cervicogenic headache (Dreyfuss *et al.*, 1994)

The articular cartilage of Lateral AA joint is quite thick (1.4mm to 3.2mm) and accommodates large, intra-articular menisci emerging from the flaccid roomy joint capsule. Sometimes degeneration of this menisci cause sharp local catching pain (Dreyfuss *et al.*, 1994). Vertebral artery is lying lateral to the AA joints, which is protected from the sharp osseous surface of the lateral joint by a pericapsular soft tissue. In old age, with severe degenerative changes, its course may vary. Neck pain may be associated with vertebro-basilar insufficiency with or without head turning which create symptoms like headache, lightheadedness, dizziness, vertigo, facial numbness, nausea, vomiting, blurred vision, diplopia, dysphagia, gait abnormality and tongue symptoms (Bogduk and Marsland, 1986; Dreyfuss *et al.*, 1994). A joint has a wide range of motion on all articulation in the neck, which doesn’t

happen at any other vertebral levels. Rotation around the axis through the dens is limited to 40 - 45 degrees to each side, but it allows only 5 – 10 degrees of flexion or extension. That’s why the pain pattern (Figure 5) is different from other cervical facet pain. It is focal pain around the joint area during lateral rotation of the neck on the same side. This actually helped to diagnose the actual cause of pain of the above mentioned patient (Jofe *et al.*, 1989; Worth and Selvic, 1987).



**Figure 5. Pain pattern from Atlanto-axial and Atlanto-occipital joint disorders**

On account of its proximity to the brain stem, importance in stabilization, fracture or injury at this level can be catastrophic. The common trauma and pathologies are (Dreyfuss *et al.*, 1994):

- Fracture of Dens
- Rupture of transverse ligament of the Atlas
- Down syndrome exhibits laxity or agenesis of the ligaments
- Rupture of the Alar ligaments
- Compression of the C2 spinal ganglion, with severe lateral rotation in the hyper-extended state, which may cause prolonged severe headaches and excruciating cervico-occipital pain.
- Death by judicial hanging may be due to a rupture of the transverse ligaments of the Atlas or fracture of the Dens. As a result, the Atlas is dislocated from the axis and compresses the brain stem with a fatal damage.
- In spite of having problems in this area some patients may be relatively asymptomatic because of the “Steele Rules of Thirds” i.e. approximately one third of the atlas ring occupied by the dens, one third by the spinal cord and the remaining third by the free fluid space and tissue surrounding the cord. This is the reason why some patients with anterior displacement of the Atlas may be relatively asymptomatic until a large degree of movement (> 1/3 of the diameter of the Atlas ring) occurs.

#### Treatment

1. Intra-articular Steroid with Local anesthetic injection under fluoroscopy (posterior and lateral approach), which helped the above mentioned patient satisfactorily (Bogduk *et al.*, 2009; Racz *et al.*, 1996).
2. C2 selective nerve root block under fluoroscopy (Bogduk and Marsland, 1988).

3. Radiofrequency Ablation (Pulse mode) of AA joint is a good option (Halim *et al.*, 2010).

## Conclusion

Headache is a complex phenomenon or disorder. Proper history, examination and investigations are required to diagnose properly. Many times diagnostic injections are helpful to come to a conclusion. Cervical spine has a great role in development of Cervicogenic headache. Cervical Facet joint disorders as well as the Lateral Atlanto-axial joint or Atlanto-occipital joints are one of the most important structures involved in the pathogenesis of Occipital headache or Cervicogenic headache. Thorough anatomical knowledge is very important for the clinicians for proper diagnosis through exclusion of other causes. On the other hand interventional pain therapy under skilled hands will support these kinds of patients satisfactorily.

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