Overview:
Chronic pain is a major public health problem, and is now of epidemic proportions [1]. Medicare, social security, disability programs, workers’ compensation programs, and the private healthcare system all struggle to keep up with the never ending cost of chronic pain patients. Resulting in higher insurance premiums, loss of worker productivity, increased burdens on state and federal governments and a decrease in quality of life. Direct and indirect losses from chronic pain in the United States costs billions of dollars each year [1].

Chronic pain is defined as [2], “pain that extends beyond the expected period of healing or is related to a progressive disease. It is usually elicited by an injury or disease but may be perpetuated by factors that are both pathogenically and physically remote from the original cause. Because the pain persists, it is likely that environmental and psychological factors interact with the tissue damage, contributing to the persistence of pain and illness behavior.” Initially, general diagnosis’s such as cervical sprain / strain injury or acceleration / deceleration injury are appropriate when used within accepted guidelines. As the patient heals and time passes it is essential to obtain a specific anatomical diagnosis such as, a C5 cervical disc herniation or a right C5 cervical facet syndrome.

The scientific literature is very clear that cervical facet joints are the cause of chronic pain in 54% to 67% of chronic neck pain patients [3-9]. Despite the high prevalence of pain, the clinical diagnosis of the cervical facet joint as the primary source of pain is often overlooked [5]. These undiagnosed patients typically go through unproductive treatment such as; physical therapy, chiropractic, injections, medications and other procedures to relieve their pain. With the proper diagnosis, these patients may benefit from specific interventions designed to manage cervical facet joint pain [5]. The purpose of this chapter is to lay the ground work for the diagnosis of cervical facet pain in a clinical setting. A specific (I) history, (II) physical examination, (III) motion x-ray examination and / or (IV) a diagnostic facet block are instrumental in the diagnosis of chronic cervical facet joint dysfunction. With sound clinical judgment, a firm diagnosis can be made as to the probable level and structure of pain generation.

Background:

The cervical spine is generally separated into two distinct functional and structural parts: the upper cervical (Occiput to C2) and the lower cervical (C3-C7). The upper cervical spine has many muscle and ligamentous attachments, no intervertebral disc, and has uniquely shaped bones and joint surfaces. A typical lower cervical vertebra has a vertebral body, intervertebral disc, a right and left superior articular facet, and a right and left inferior articular facet. Facet joints are hinge-like structures that link the vertebrae together. They are located at the back of the spine and are true synovial joints. This means that each joint is surrounded by a thin ligamentous capsule of connective tissue, hyaline cartilage covers the articular surfaces, and synovial fluid nourishes as well as lubricates the joint.

Cervical facet joints have both mechanoreceptors and nociceptive (pain) nerve endings [10,11]. Within the joint are synovial folds, these folds are also pain sensitive [11]. The facet joints are richly innervated by the medial branches of the segmental dorsal rami and the medial branches of the segments above and below [10,11]. This multilevel innervation of the facet joint is one of the reasons for the broad referral pattern [12]. The facet joints are heavily innervated by nerves, but have poor blood supply. This poor blood supply impedes the healing process, which triggers scar tissue formation and adhesive capsulitis within the joint, resulting in chronic dysfunction and pain [12].

The multifidus are the deep muscles of the cervical spine and help to provide segmental stability. The multifidus are essential in a patient with facet pain because this muscle has been found to insert into the facet joint capsule ligaments. They have been found to cover 22.4 ± 9.6% of the facet joint capsule surface area [13]. The multifidus muscle insertion into the cervical facet capsular ligament provides a mechanism for injury to this ligament and the facet joint as a whole [13,14]. This anatomical fact may also play a major role in rehabilitation of cervical facet joint injuries.

A recent study identified the, “facet articular cartilage, the synovial fold, and the facet capsule as structures at risk for injury during whiplash due to excessive facet joint compression or capsular ligament strain.” [16]. It also found that, “facet joint components may be at risk for injury due to facet joint compression during rear-impact accelerations of 3.5g and above. Capsular ligament strains exceed the physiologic strains at 6.5g and were largest at the lower cervical spine.”[16]. Therefore, relatively low impact collisions can cause facet injuries[13,14,16].

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“It is consistent with known biological models that injuries to the osseous or soft tissues of a joint predispose that joint to premature, painful, osteoarthritic change.”[17]. Long term, the facet joints will undergo degenerative changes characteristic of osteoarthritis as seen in other synovial joints [18]. As the facet joint degeneration progresses the radiographic changes are more visible and often result in spinal stenosis, affecting both the nerve root and central canals [18].

Epidemiological studies, crash test studies and anatomical evidence all corroborate the reality that the cervical facet joints are prone to injury during a motor vehicle collision, have a rich nerve supply, heal poorly and are a source of pain [3-20]. Pain for prolonged periods of time can lead to reconditioning, neuroplastic changes and hyperexcitability of the nervous system [12].

HISTORY
A. Assessing risk factors for chronic cervical facet pain.
B. Pain behavior.
C. Pain patterns and characteristics.
D. Building an anatomical clinical picture.

A comprehensive history and consultation of the chronic pain patient is essential. This history should include: initial diagnosis (preferably according to Croft Guidelines) and all previous providers diagnosis, past treatment rendered, response to treatment, prior traumas or impairment ratings, ADL and disability evaluation, pain diagram, frequency of pain and headaches, severity of pain and headaches, duration of pain and headaches, aggravating factors, relieving factors, pain questionnaires, a systemic medical history, a family history, job description and a complete account of the accident. The doctor should also obtain all other medical records, and diagnostic testing results. Analyzing this information should give the doctor clues as to the source of pain. The rest of this section discusses the risk factors for neck injury, pain behaviors, pain associated with the chronic neck pathology and building a clinical picture.

A. Risk factors to identify:

Involvement in a motor vehicle collision:
An overwhelming amount of scientific literature has shown that the cervical facet joints are the primary source of chronic neck pain following motor vehicle collision injuries [3-7,9-16]. A review of injuries resulting from motor vehicle collisions indicates that most injuries will heal within 3 months, but that 25% of the injured will develop chronic pain [9]. Injuries involving the disc, cervical facet joints or alar ligaments will not resolve spontaneously and are more likely to become chronic. These patients may continue to improve over a period of 2 years, but are unlikely to improve after 2 years [9]. Bilateral facet joint involvement was found to be in 69% of patients and often involved more than one level of facet joints [5]. The most common levels of facet joint pain have been found to occur at the C2/3 and C5/6 levels [9].

General risk factors related to cervical spine injury following a motor vehicle collision [20-29] :
Female gender.
Immediate / early onset of symptoms.
Greater number of initial symptoms.
Use of seatbelt shoulder harness.
Having the head turned at impact.
Non-awareness of impending impact.
Initial physical findings of limited range of motion.
Initial neurological symptoms.
Past history of neck pain and / or headaches.
Degenerative changes seen on radiographs.
Loss or reversal of cervical lordosis.
Increasing age.
Front seat position.
Body mass index / head neck index (increased risk with decreasing mass and neck size)
Out-of-position occupant (leaning forward).
Non-failure of seat back.
Impact by vehicle of greater mass (25% greater).

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Pain behaviors are verbal or nonverbal actions understood by observers to indicated that a person may be experiencing pain, distress, and suffering. These actions may include audible complaints, facial expressions, abnormal postures or gait, use of prosthetic devices, or avoidance of activities [37]. These pain behaviors must be clinically relevant to the patients reported symptoms. Exaggerated behaviors should warrant further evaluation to determine the authenticity of the behavior. These pain behaviors should be observed when the patient enters the exam room, during the history, and consultation.

Note the presence of any of the following behaviors [38]:

1. Facial grimacing
2. Holding or supporting affected body part or area
3. Limping or distorted gait
4. Frequent shifting of posture or position
5. Extremely slow movements
6. Sitting with a rigid posture
7. Moving in a guarded or protective fashion
8. Moaning
9. Using a cane, cervical collar, or other device
10. Stooping while walking
11. Other: ____________________________________________

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Based on observing the above pain behaviors the doctor should come to one of three conclusions:
1. Pain behaviors seem exaggerated, this may or may not be of any clinical significance. But should cause the examiner to look for further indications of symptom amplification or malingering.
2. Pain behaviors are appropriate and confirm the other clinic findings. This is a strong clinical indicator.
3. Observation of the patient behaviors yielded no information positive or negative.

Specific pain behaviors related to chronic cervical facet pain:

Facial grimacing:
During palpation and structural stress testing, watching the patients facial expressions this can often tell when a structure is aggravated, non verbally.

Holding or supporting affected body part or area:
This can often be a sign of instability, loss of structural integrity and pain. The patient often states that their head feels too heavy for their body. Watch for this as the patient gets on and off the table and during the range of motion evaluation. A chronic cervical pain patient may also grab their trapizus area and hold it or massage it.

Frequent shifting of posture or position:
Any instability, loss of structural integrity, or pain will make it difficult for a patient to sit in one position for any extended period of time. The shifting of position helps to alleviate the pain.

Moaning:
During the examination the patient may reflexively make a noise when the source of pain in aggravated. The patient may also reflexively move their body away or pull their arms up to their neck when the pain source is aggravated.

Concern about pain:
One of the most frequently asked question from the chronic pain patient is, “what do you think is causing the pain?”. An undiagnosed patient can result in frustration and depression.

C. Pain Patterns and Characteristics:

“Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.” [39]. There are several steps used to clinically determine the anatomical source of pain:

1. Subjective pain descriptions, drawings, with pain intensity and frequency scales.
2. The patient interview to clarify history, descriptive terms and to build a clinical picture.
3. Manual examination to link physical findings with the patients verbal and written descriptions.
4. Diagnostic testing to confirm the pain source.

Research has proven that cervical facet joints are the primary cause of chronic neck pain[3-9], with disc and endplate pathology second [40] and third is thought to be myofascial pain [41]. Myofascial is a very common as an initial pain source, but research has not supported myofascial pain as a primary source of chronic pain. Chronic myofascial symptoms are thought to be secondary to biomechanical stress, instability, and nervous system dysfunction, not continued nociception from the muscle [42-44 ].

A vertebral motion segment is defined as two adjacent vertebrae, the intervertebral disc, facet joints, ligaments and musculotendensous structure between the vertebrae [45]. The 3-joint complex of the cervical spine includes the disc and two facet joints. It is widely acknowledged that dysfunction of the 3-joint complex that leads to osteoarthritis and many chronic pain syndromes [46]. Bogduk found that 41% of neck pain patients had neck pain caused by both disc and facet pathology [47]. Therefore, it is common for more than one structure to cause pain, resulting in overlapping pain patterns and characteristics.

1. Joint / Sclerodermal Pain (54% to 67%):
Cervical facet joint pathology represents 54% to 67% of chronic neck pain patients [3-9] and results in sclerodermal pain.

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Sclerodermal pain patterns are different than dermatomal or myofascial pain patterns. Using these pain patterns and characteristics for differential diagnostic purposes is fruitful in building a clinical diagnosis [47-51]. The size of the area of referred pain correlates with the intensity and duration of the primary nociceptive input [52]. A large referred pain pattern may signify more than one joint involvement or that other deep somatic structures are involved, such as an annular tear. The C2-3 facet joints and above produce neck pain, sub occipital pain and headaches. While joints below the level of C2-3 can produce neck pain, upper arm pain, interscapular pain, and shoulder pain. In general, referred pain from the upper cervical segments travels upward and that from the lower cervical spine travels downward. Sclerodermal pain is characterized as being generally dull and ache, difficult to localize and fairly constant [12], any sharp pain reported is local to the pain generator [53]. The pain is made worse with motion, joint palpation and stressing the joint [53]. Passive range of motion is usually restricted and painful at the end ranges of motion, crepitus may also be present. Motion x-ray findings or diagnostic facet injections with clinical correlation are conclusive for joint pathology.

Manchikanti et al has shown that 69% of patients have more than one facet involvement and that a majority of patients had pain in three joints [5]. Barnsley et al [51] found that the most common levels for symptomatic facet joints were C2-3 and C5-6. It was also common to find patient with multiple levels of pain production, with the two most common double-level patterns being C2-3 with C5-6, and C5-6 with C6-7 [51]. Chronic facet joint dysfunction will cause the joint to undergo degenerative changes such as facet hypertrophy and spur formation. [18]. This degenerative process leads to lateral or central canal stenosis which are common causes of cervical myelopathy and radicular pain [18].

2. Neurogenic / Cervical disc / radicular pain (20%) [47]

Cervical disc pathology represents approximately 20% of chronic neck pain patients [47] and results in dermatomal pain patterns. Irritation or pressure on the dorsal root ganglion causes sharp, shooting dermatomal or radicular pain. The pain is accompanied by any of the following: paresthesia, hypesthesia, motor weakness, atrophy, antalgia, sensory disturbances or decreased reflexes. The pain is exacerbated by any motion that increases tension or pressure on the involved nerve root. Immobilization or decreased axial loading relieve the pain. Orthopedic and neurological examination is normally positive for nerve root irritation. The two most common causes of radicular pain are: a herniated disc “soft radiculopathy” and lateral canal stenosis “hard radiculopathy” [53].

Herniated cervical disc usually occurs in patients under 40 years of age, most commonly involving the C5-C6 and C6-C7 disc. MRI and nerve conduction studies with clinical correlation are conclusive for herniated disc pathology. Lateral canal stenosis (cervical spondylosis) is more common in patients over the age of 50 [53] and is a result of joint degeneration. The joint develops hypertrophic spurs along the margins of the disc, uncovertebral joints and the facet joints, as well as with dural adhesions. Hypertrophy of the facet joints is a major factor in both lateral canal stenosis and cervical myelopathy. Static and motion x-rays, CT , MRI or nerve conduction studies with clinical correlation are conclusive for lateral canal stenosis.

3. Myofascial pain and peripheral nerve entrapments:

Myofascial is a very common as a primary source of acute pain following an injury, but not as a primary source of chronic pain[42-44]. Chronic myofascial symptoms are thought to be secondary to biomechanical stress, joint dysfunction, overuse syndromes, repetitive stress, instability, neuroplastic changes and hyperexcitability of the nervous system, not continued nociception from the muscle [42-44 ]. A palpable band of muscle tissue with a trigger point is often present. Palpation of the muscle trigger point will refer pain in a predictable fashion for that particular muscle. Pain is typically described as localized burning pain, with dull ache pain that refers to the extremity [53]. Pain is present when the trigger point is palpated, as well as during active and resistive range of motion. There are also instances when a nerve passes behind or through a muscle and another structure, leading to a peripheral nerve entrapment. Therefore, muscle dysfunction can result in pain and / or peripheral nerve entrapments.

D. Building an anatomical clinical picture.

Following the history, patient observation and consultation the examiner should have an idea as to the possible anatomical cause of the patients pain. The table below will help to determine the anatomical cause of the pain and build a clinical picture going into the physical examination. Although, we break the body into anatomical diagnostic parts, it is important to note that the body functions undivided. Many anatomical pathologies have associated findings with other anatomical pathologies and
are generally progressive in nature. Finding the primary pain source and dysfunction is essential to proper patient management.

### PHYSICAL EXAMINATION

A.  Motion palpation end-range provocative testing.

Manual palpation and joint stress testing are two of the best physical methods to diagnose facet joint pathology, combining these methods is often referred to as motion palpation end-range provocative testing [54]. Before any motion palpation end-range provocative testing takes place a series of static radiographs should be view for contraindications to testing. If any lightheadedness, dizziness or any other neurovascular symptoms occur discontinue testing. Traditional orthopedic and neurological tests may pick up disc herniations and nerve pathologies, but may not detect the damage to the facet joints. Any practitioner who is trained in palpating segmental joints can use their fingers to deeply probe the facet joints and look for symptomatic reproduction of referred symptoms, and then identify which segments are involved. Palpation of cervical spine tenderness has been found to a highly reliable examination tool and has been found to accurately diagnose the correct segmental level when compared to a radiologically controlled block [54].
The examiner has a palpating hand, used to pinpoint the pain source and a controlling hand, used to passively control cervical motion. By using passive and not active range of motion any muscle involvement is limited. The examiner is to test each spinal segment individually and unilaterally. The movement should not be gross cervical range of motion, each joint should be isolated as much as possible. At the end range of motion, the joint is challenged to assess if the joint is restricted and for pain provocation. Any joint that produces pain is to be documented, as well as any myofascial findings. This documentation should include the segmental level palpated, side the pain was produced on, pain descriptions, and any pain referral patterns. To assess joint end feel, passively move the joint to the point at which resistance is first encountered and then provide gentle additional pressure feeling the quality of joint motion [55,56].

<table>
<thead>
<tr>
<th>End feels and pathology</th>
<th>Feeling at end range of motion</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Soft to firm, slightly springy, the resistance builds as maximum joint motion occurs.</td>
<td>Normal</td>
</tr>
<tr>
<td>Ligamentous / capsular tear</td>
<td>Little end resistance, patient reports pain as maximum joint motion occurs.</td>
<td>Hypermobility or ligament instability.</td>
</tr>
<tr>
<td>Bony</td>
<td>Non giving abrupt stop, sharp pain.</td>
<td>Bony exostosis or arthritic changes.</td>
</tr>
<tr>
<td>Muscle spasm</td>
<td>Motion restricted by contraction, end feel can not be assessed, patient feels tight.</td>
<td>Acute injury or reflex muscle spasm</td>
</tr>
</tbody>
</table>

Joint assessment:
The upper cervical spinal segments (Occiput to C-2) are evaluated differently than the lower cervical spinal segments (C-2 to T-1), due to their structural and functional differences.

Joint Assessment Occiput thru C-2:

Patient is supine:
1. The C-1 transverse process is contacted with thumb or index finger and pressure is applied to cause lateral translation of the Occiput / C-1 / C-2 complex. This contact and pressure is continued during lateral flexion and rotation, with an effort to isolate upper cervical motion. These procedures are performed bilaterally. If any these procedures are painful, then observe the open mouth motion x-ray in during the full range of lateral flexion and rotation, examining the integrity of the alar and accessory ligaments.
2. With both hands contact the suboccipital space between the occiput and the posterior arch of C-1. Using the finger tips apply slight pressure with a mild flexion component. If this causes pain then observe the lateral cervical motion x-ray during the full range of flexion and extension, examining the integrity of the transverse ligament. Also look for limited motion between occiput and the posterior arch of C-1 this could indicated muscle spasm or adhesion formation, resulting in suboccipital neuritis (headaches).

Joint assessment C-2 thru T-1:

Patient is seated:
1. With one hand contacting the patients shoulder and the other hand on the patients head, put the patient in contralateral cervical rotation, lateral flexion with maximum flexion (maximum oblique flexion). Slight pressure is applied to stress the entire region. If this provokes pain then observe the motion x-ray during the full range of oblique flexion, examining the integrity of the facet capsular ligaments.
2. With one hand contacting the patients shoulder and the other hand on the patients head, put the patient in maximum flexion and then maximum extension. Apply slight pressure to stress the entire cervical region at the end of each range of motion. If this provokes pain then observe the motion x-ray during the full range of flexion and extension, examining the integrity of the anterior longitudinal ligament, posterior longitudinal ligament, facet capsular ligament, and the interspinous ligament.
3. The facet joints can be further assessed unilaterally in extension with the fingertip or thumb tip of the palpating hand producing a localized extension movement over the facet joint in question. The controlling hand maneuvers the patient's head and neck to cause full passive extension. At the same time, the palpating digit presses intersegmentally posterior to anterior, causing maximum extension of the joint. Pain and fixation are indicative of a dysfunctional joint, whereas pain-free motion signifies normal joint function. This method of testing the joint in extension is repeated at each facet joint on the right side, the left side and then over the spinous processes. All areas of pain should be documented and palpated further to isolate the most painful joint.

**MOTION X-RAY**

A. Upper cervical
B. Lower cervical

“Plain radiographs are of limited diagnostic value in painful pathology of the connective tissue..... Videofluoroscopy or digital motion radiography is currently a valuable diagnostic method in evaluating painful hypermobility and instability due to posttraumatic and degenerative pathology of capsular and axial ligaments. Evaluation of certain axial and peripheral joints in motion affords a noninvasive opportunity to identify specific segments responsible for nociception. At the upper cervical levels, this technology is capable of identifying excessive motions at atlanto-occipital, lateral and median atlantoaxial joints, and indirectly, pathology, of their respective fibrous articular capsules and periarticular ligaments. Capsule-related pathology with hypo- and hypermobility can be identified and documented in caudally situated cervical zygapophyseal articulations. The integrity of the posterior ligamentous complex contributing to listhesis-related pathology can be documented. Small avulsion fractures of articular pillars as well as vertebral bodies or spinous processes can be identified.” [57].

For spinal impairment evaluations the motion of the individual spine segments cannot be determined by a physical examination but is evaluated using radiographs [58]. The stability of the cervical spine depends on bony structures to only a minor degree: stability depends to a major degree on the ligamentous structure [59]. Thus any abnormal bony motion is indicative of ligamentous damage and instability.

Observing the full arc of spinal segmental motion can detect abnormal motion such as hypermobility or hypomobility, anterolisthesis or retrolisthesis, widening of the facet joints, and lateral translation of C1 on C2. This examination should confirm or deny the presence of functional loss and structural damage [60]. Below is a radiographic classification of joint dysfunctions once fracture, dislocation and gross instability have been ruled out:

<table>
<thead>
<tr>
<th>Static Intersegmental Malpositions (Malpositions many be coupled)</th>
<th>Motion (Kinetic) Intersegmental Dysfunctions</th>
<th>Broad Kinetic and Static Cervical Spine Dysfunctions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc space angulation or torsion</td>
<td>Asymmetry of spinal motion</td>
<td>Anterior weight carriage</td>
</tr>
<tr>
<td>Flexion Misalignment</td>
<td>Hypomobility</td>
<td>Alteration of cervical curvature</td>
</tr>
<tr>
<td>Extension Misalignment</td>
<td>Hypermobility</td>
<td>Abnormalities global motion</td>
</tr>
<tr>
<td>Lateral flexion Misalignment</td>
<td>Increased translation</td>
<td>Aberrant coupled motion</td>
</tr>
<tr>
<td>Rotational Misalignment Translation</td>
<td>Increased angular motion</td>
<td>Scoliosis</td>
</tr>
<tr>
<td>Anterolisthesis</td>
<td>Loss of motion segment integrity</td>
<td></td>
</tr>
<tr>
<td>Retrololisthesis</td>
<td>Developmental fusion</td>
<td></td>
</tr>
<tr>
<td>Laterolisthesis</td>
<td>Instability</td>
<td></td>
</tr>
<tr>
<td>Axial</td>
<td>Increased translation</td>
<td></td>
</tr>
<tr>
<td>Decreased interosseous spacing</td>
<td>Increased angular motion</td>
<td></td>
</tr>
<tr>
<td>Increased interosseous spacing</td>
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</tbody>
</table>
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Many studies have been conducted to depict the normal patterns of intervertebral motion of the cervical spine during flexion, neutral, and extension positions using motion radiographs. Using a normal population researchers [61] found, “From extension to flexion, the angles of intervertebral angular displacement changed from lordosis with different degrees to nearly 0°, which means the adjacent endplates are almost parallel, except at C1-C2; the intervertebral translation changes from slightly retrolisthetic to zero displacement. Using C2-C3 as a baseline to calculate the intervertebral differences of angular displacement and translation in flexion radiographs, nearly all the intervertebral differences of angular displacement were less than 7°, and those of translation were less than 0.06 mm.” Consequently, any measurements over 1mm of translation and / or over 7° Angular variation are considered to be clinically significant and in excess of normal flexibility of the cervical spine. Any displacement of more than 2mm in any plane of vertebral motion is an indicator of possible major ligamentous injury [62,63]. Abnormal measurements over 11° Angular Variation and / or greater than or equal to 3.5mm translation by definition constitutes ligament damage which results in instability or a loss of motion segment integrity [64].

<table>
<thead>
<tr>
<th>IMPAIRMENT</th>
<th>Angular variation greater than or equal to:</th>
<th>Translation greater than or equal to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymmetry of spinal motion</td>
<td>7° Angulation</td>
<td>greater than or equal 1 mm</td>
</tr>
<tr>
<td>Loss of motion segment integrity</td>
<td>11° Angulation</td>
<td>greater than or equal 3.5 mm</td>
</tr>
</tbody>
</table>

**Loss of Motion Segment Integrity** - Increased or decreased back-and-forth motion (translation) or abnormal angular motion of a motion segment with respect to an adjacent motion segment. The loss of integrity is defined as an antero-posterior motion or slipping of one vertebra over another greater than 3.5mm for a cervical vertebra; or a difference in the angular motion of two adjacent motion segments greater than 11° in response to spine flexion and extension [64].

Below are tables of motion x-ray views, ligaments tested and associated findings[65-69] :

<table>
<thead>
<tr>
<th>Ligaments observed during a motion x-ray exam</th>
<th>Best view to evaluate each ligament</th>
<th>Key findings</th>
</tr>
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<tbody>
<tr>
<td>Alar and Accessory Ligaments</td>
<td>AP open mouth view (Lateral flexion)</td>
<td>Lateral translation of C1 on C2</td>
</tr>
<tr>
<td>Transverse Ligament</td>
<td>Lateral cervical view (Nodding / Flexion)</td>
<td>Increase in ADI space to greater than or equal to 3.5 mm</td>
</tr>
<tr>
<td>Oblique Flexion view (Flexion), AP lower cervical view (lateral flexion) &amp; Lateral cervical view (Flexion)</td>
<td></td>
<td>Nonparallel facet surfaces, facet gliding in excess when compared to other facets, facet joint gapping or loss of coupled rotation</td>
</tr>
<tr>
<td>Posterior Longitudinal Ligament</td>
<td>Lateral cervical view (Flexion)</td>
<td>Disc space angulation, or anterolisthesis (translation) of one vertebra over another</td>
</tr>
<tr>
<td>Anterior Longitudinal Ligament</td>
<td>Lateral cervical view (Extension)</td>
<td>Disc space angulation, or Retrolisthesis (translation) of one vertebra over another</td>
</tr>
<tr>
<td>Interspinous Ligament</td>
<td>Lateral cervical view (Flexion)</td>
<td>Fanning of interspinous space, or localized hyperkyphosis</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Motion x-ray assessment Occ thru C-2</th>
<th>Findings consistent with joint pathology.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ligament</td>
<td></td>
</tr>
<tr>
<td>Lateral cervical view (Static)</td>
<td>1. Fracture</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. ADI space greater than or equal to 3.5 mm</td>
</tr>
<tr>
<td>• Transverse Ligament</td>
<td></td>
</tr>
<tr>
<td>Lateral cervical view (Nodding / Flexion)</td>
<td>1. Fracture</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Increase in ADI space to greater than or equal to 3.5 mm</td>
</tr>
<tr>
<td>• Transverse Ligament</td>
<td>3. Loss of joint separation between occiput and the posterior ach of C1</td>
</tr>
<tr>
<td>Lateral cervical view (Extension)</td>
<td>1. Fracture</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Closure of the ADI spac</td>
</tr>
<tr>
<td>• Transverse Ligament</td>
<td>3. Loss of joint convergence of occiput and the posterior ach of C1</td>
</tr>
<tr>
<td>AP open mouth view (Static)</td>
<td>1. Fracture</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Lateral translation malposition of C1 on C2</td>
</tr>
<tr>
<td>• Alar and Accessory Ligaments</td>
<td></td>
</tr>
<tr>
<td>AP open mouth view (Lateral flexion)</td>
<td>1. Fracture</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Translation of C1 on C2 greater than 1 mm for asymmetry of spinal motion or greater than 3.5 mm for loss of motion segment integrity</td>
</tr>
<tr>
<td>• Alar and Accessory Ligaments</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion x-ray assessment C-2 thru T-1</th>
<th>Findings consistent with joint pathology:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ligament</td>
<td></td>
</tr>
<tr>
<td>Lateral cervical view (Static)</td>
<td>1. Fracture.</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Spondylosis.</td>
</tr>
<tr>
<td>• Posterior Longitudinal Ligament</td>
<td>3. Loss of cervical curve and/or localized hyperkyphosis.</td>
</tr>
<tr>
<td>• Interspinous Ligament</td>
<td>4. Disruption of the posterior or anterior vertebral body line.</td>
</tr>
<tr>
<td>• Capsular Ligament</td>
<td>5. Nonparallel facet surfaces (loss of superimposition of facets).</td>
</tr>
<tr>
<td>• Anterior Longitudinal Ligament</td>
<td>6. Disc space angulation (nonparallel vertebral end plates).</td>
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<td></td>
<td>7. Fanning of interspinous space (increased interspinous space).</td>
</tr>
<tr>
<td>Lateral cervical view (Flexion)</td>
<td>1. Anterolisthesis (translation) of one vertebra over another.</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Increased separation between the spinous processes.</td>
</tr>
<tr>
<td>• Posterior Longitudinal Ligament</td>
<td>3. Facet gliding in excess when compared to other facets (&gt;2mm).</td>
</tr>
<tr>
<td>• Interspinous Ligament</td>
<td>4. Posterior angulation of disc space or facet joint space.</td>
</tr>
<tr>
<td>• Capsular Ligament</td>
<td>5. Avulsion fractures.</td>
</tr>
<tr>
<td>Lateral cervical view (Extension)</td>
<td>1. Retrolisthesis (translation) of one vertebra over another.</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Anterior widening of disc space.</td>
</tr>
<tr>
<td>• Anterior Longitudinal Ligament</td>
<td>3. Facet jamming or asymmetry of facet motion.</td>
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<tr>
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<td>5. Avulsion fractures.</td>
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<tr>
<td>Oblique view (Static)</td>
<td>1. Asymmetry or widening of facet joint space.</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Facet joint arthrosis.</td>
</tr>
<tr>
<td>• Capsular Ligament</td>
<td></td>
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<tr>
<td>Oblique Flexion view (Flexion)</td>
<td>1. Facet joint gapping. (asymmetry of motion)</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td></td>
</tr>
<tr>
<td>• Capsular Ligament</td>
<td></td>
</tr>
<tr>
<td>Oblique Extension view (Extension)</td>
<td>1. Facet joint jamming.</td>
</tr>
<tr>
<td>This view examines the integrity of the:</td>
<td>2. Intervertebral foraminal encroachment.</td>
</tr>
<tr>
<td>• Capsular Ligament</td>
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</tbody>
</table>
ATLANTA SPINE AND MOTION X-RAY CENTER
DIAGNOSIS OF CHRONIC CERVICAL FACET PAIN

<table>
<thead>
<tr>
<th>AP lower cervical view (Static)</th>
<th>1. Interspinous space widening.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Lateral flexion malposition.</td>
</tr>
<tr>
<td></td>
<td>3. Uncovertebral joint arthrosis.</td>
</tr>
</tbody>
</table>

| AP lower cervical view (lateral flexion) | 1. Loss of coupled rotation. |
| This view examines the integrity of the: | 2. Lateral facet gapping. |
| • Capsular Ligament | |

*It is common to have multiple ligaments damaged at a the same segmental level [66].

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### Diagnostic Facet Injection

Traditionally, the most reliable way to diagnose the painful zygapophyseal joint is through anesthetic blocks of the joints themselves or the nerves that supply them [70]. This procedure is however invasive and is not always available to the clinician. Additionally, it does not always provide a long term solution to the problem [71] as it does not address the stability of the ligamentous tissue.

The facet joints can be anesthetized with intraarticular injections of local anesthetic or by anesthetizing the medial branches of the dorsal rami of the target joint. If pain is not relieved that joint is ruled out as a source of pain. The true source may be another facet joint or some other structure. If the pain is relieved with the block then a diagnosis of facet joint pathology is make. Given that it is common to have more than one facet joint involvement, using motion x-ray and motion palpation end-range provocative testing to help determine the segmental level and number of facets involved may aid in the success of facet joint injections.

### Conclusion:

Facet injury following a motor vehicle accident is common, the intersegmental laxity or instability can result in impairment and disability, advancing to chronic pain and degeneration. Further investigation is needed concerning the diagnostic procedures relating to the diagnosis of cervical facet joint syndrome. As well as proper management of patients with facet joint injuries, with an emphasis on active rehabilitation to strengthen the multifidus and other supporting muscles. It is my hope that this paper will lay the groundwork for future study and awareness of facet cervical joint syndrome.

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