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Review Article

Fluoroscopically Guided Therapeutic Cervical Zygapophyseal (Facet) Joint Injections for Whiplash Injuries

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Abstract

Whiplash-associated disorders (WAD) occur when shifting of energy is transferred to the neck region during a crash or collision, from acceleration-deceleration mechanism. WAD are thus characterized by excessive extension-flexion movements, and/or excessive side bending of the head and neck, beyond the normal and regular range of motion.

The outcome of trauma associated with WAD can result in acute and chronic pain syndromes, functionality limitations and restrictions, psychological and psychosocial ramifications, financial crisis, unemployment, and certain cases, prolonged disability. This causes a significant economic burden on any nation.

In addition to motor vehicle collisions that constitute most causes of WAD, other injuries include contact sports injuries, falls, physical and domestic abuse, and other types of traumas.

Clinical presentations are variable. In general, these includes neck pain (the main feature), decreased range of motion of cervical spine, spasms and tightness, headaches, arm(s) numbness and/or pain, and many other symptoms depending on the extent of the insult, ranging range from fractures, joint dislocations, ligament tears, swelling and bruising, and even traumatic brain injuries/post-concussional syndrome, with its subsequent clinical sequalae.

This review manuscript will enumerate the latest in WAD with special emphasis on cervical facet joint injections. We recognize there are other available treatment options for whiplash injuries, but this article will only review the role of facet joint injections in whiplash injuries. Hence, we will not mention those options since it is not our goal. We base our review on relevant databases such as PubMed, Ovid-Medline, Embase, Web of Science, NIH website, Google Scholar, and the Cochrane Library, pulled in early 2024. No Institutional Review Board permission was obtained since this manuscript does not directly involve animals or humans.

Keywords: Whiplash; Whiplash-Associated Disorder; Whiplash Injuries; Neck Pain; Chronic Neck Pain; Motor Vehicle Collision; Chronic Pain Syndrome; Chronic Pain; Neck Trauma

Introduction

Early medical reports regarding whiplash injuries described it as 'railway spine'[1]. This term was used in the 19th century to describe the pain and other symptoms related to railway passengers and personnel reported following minor railway crashes [1].

In 1928, Harold Crowe, the first to use the term whiplash, described 8 types of injuries to the neck associated with car collisions [2]. In 1955, it was reported that even motor vehicle collisions at the speed of "20km/hour" (about 13 miles per hour) can result in injuries to the head and neck and can cause symptoms [3].

Published in 2015, and based on statistics for the year 2010, the U.S. Department of Transportation, National Highway Traffic Safety Administration reported there were "32,999 people killed, 3.9 million were injured, and 24 million vehicles were damaged in motor vehicle crashes in the United States". Studying the economic burden amounted to "$242 billion...this represents the equivalent of nearly $784 for each of the 308.7 million people living in the United States, and 1.6 percent of the $14.96 trillion real U.S. Gross Domestic Product for 2010. These figures include both police-reported and unreported crashes" [4].

In Arizona, where 2 of the authors reside, and according to a study published in 2021 [5], there were a total of 121,345 motor vehicle crashes, of which 1063 were fatal, and associated with 35,203 injuries [5]. This represents 22.45% increase compared to the year of 2020 [5,6].

Anatomic morphology, innervation of, and musculature around cervical facet joints

In general, pathology of the cervical facet joints causes cervical spine pain in a high number of adults, regardless of the age [7]. (Figure 2).

Studies have found there are great differences in innervation of the facet joints between the higher and the lower cervical regions [8]. In the higher part, a more "plexus-like", "chaotic" pattern was found, which makes targeted interventions very difficult. This plexus-like innervations, in addition to the large amount of blood vessels, and collagen tissue, make surgical exploration "problematic" [8]. On the other hand, lower cervical regions demonstrate a more organized and expected innervation pattern, with greater differences within its innervation [8].

Initial studies performed by Bogduk [9], also confirmed by Busken., *et al.* [8], pointed that medial branches innervate the multifidus muscle (Figure 1) (deep branch) as well as the semispinalis cervicis muscle (superficial branch) [8]. We all know the multifidus muscle provides significant stability to the cervical spine. The multifidus muscle insertion is onto the lower cervical facet capsular ligaments [8A]. The cervical facet joints are the source of pain in chronic whiplash patients [8A]. "Reflex activation of the multifidus muscle during a whiplash exposure could potentially contribute to injuring the facet capsular ligament" [8A].

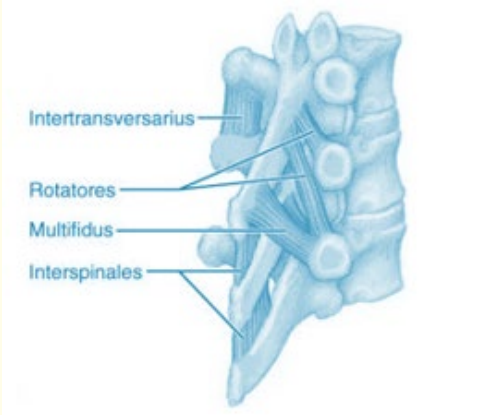

Figure 1: Main deep cervical muscles affected in WAD.

Because of the intricacy of innervation, during interventional pain procedures, the needle positioning is very important. McLain [10]., *et al.* suggested that damage of the mechanoreceptors and/or nociceptors located in the facet joint capsule has an essential effect on the stability of the cervical spine, suggesting that the innervation must be spared during spinal interventions [10].

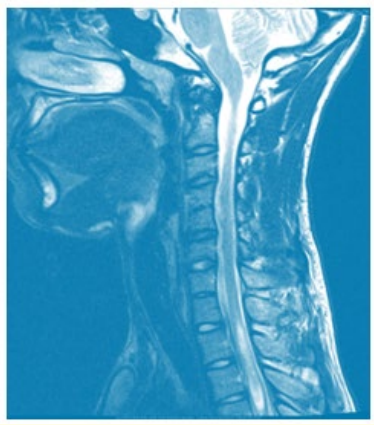

Figure 2: Sagittal cervical spine.

Yoganandan., *et al.* [11], studied the cervical spine of six human cadavers. Using cryomicrotome to slice cervical facet joints, in sagittal sectioning plane at 20- to 40-μm intervals, he concluded that cartilage gap in the upper cervical spine (C1-C2) was lower than the gap in the lower cervical spine (C3-C7). The gap at the

ventral and dorsal areas was lower in the upper than in the lower cervical spine [11]. There were also gender differences; the gap in the dorsal region for females was greater than that for males. The overall mean facet cartilage thickness was smaller in females than males in the upper and lower cervical spine [11]. The facet joint width demonstrated differences only between the upper and lower cervical spine, with higher magnitudes in the upper (17.4 mm ± 0.4) than in the lower (11.3 mm ± 0.3) region [11A].

Typically, in neck pain, the C2-3 and C5-6 joints are the most common clinically implicated levels [11A], whereas the C2-3, C3-4, and C4-5 being the most radiologically affected [11B].

Neck pain in whiplash injuries: the biomechanics of the main presenting symptom

Studies have shown that whiplash injuries are mainly associated with neck pain as a major symptom [12]. It is also reported that "neck pain is present in all patients with WAD, but headache is also a prevalent symptom (88%), especially in patients in whom the C2-3 facet joint is implicated as a cause of pain [12A,B].

Deans., *et al*. [13]. estimated neck pain occurred in "65% of patients within 6 hours, 93% within 24 hours, and 100% within 72 hours after neck injury". Evidently, there are many variations depending on many factors including the extent of neck injury, mechanism of injury, direction of the insult, force of the collision, and acceleration force [12].

Studies pointed that patient with WAD, that were examined within 3 days after the trauma, had a significant increase in pro-inflammatory tumor necrosis factor (TNF)-α and interleukin (IL)-6 and of anti-inflammatory IL-10. These normalized in the following 24 hours [14].

In one study, the incidence of cervical facet joint pathology in WAD, leading to neck pain was 71% [15].

The distribution pattern of cervical facetogenic pain varies from level to another. Dwyer and team [16] performed intra-articular facet joint injections in 4 volunteers and 1 patient with neck pain to delineate the area of pain from injection. Injection of the C2-3 joint by capsular distension was associated with upper neck pain that extended into the head (often towards the ear, forehead, vertex, or eye). Injections into the C3-4 joint resulted in pain in the neck extending from the suboccipital region to the lower neck without involving the shoulder. Injection into the C4-5 joint caused a more 'caudal' pain, in the top of the shoulder and lower part of the neck. Injection of the C5-6 joint resulted in pain radiating into the lower neck, top of the scapula, and shoulder above the level of the scapular spine that was distinguishable from pain extending caudally to the scapular spine from irritation of the C6-7 joint [16]. (Figure 3)

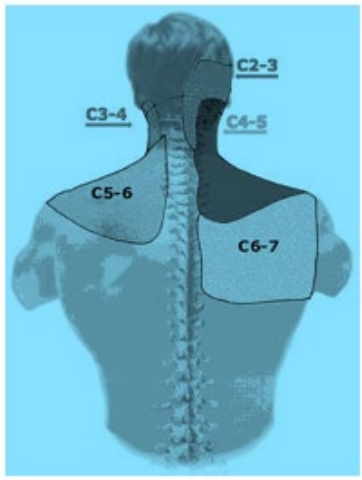

Figure 3: Distribution of cervical facet pain by level.

To further study cervical facet joint kinematics and injury mechanisms during simulated whiplash injuries, Pearson., *et al.* came up with the idea to emphasize on studying "facet joint compression, facet joint sliding, and capsular ligament strain at all cervical levels during multiple whiplash simulation accelerations" [17]. He concluded that the cervical facet joint components may be at risk for injury due to facet joint compression during a rear-impact accelerations of 3.5 g and above and added that capsular ligaments are also at risk for injury at higher accelerations [17].

Pearson and his team demonstrated that peak facet joint compression was the greatest at C4-C5, where it reached a maximum of 2.6 mm during the 5 g simulation. He added that increases over physiologic limits were initially observed during the 3.5g simulation. He also postulated that peak facet joint sliding and capsular ligament strains were largest in the lower cervical spine and increased with impact acceleration [17]. Capsular ligament strain reached a maximum of 39.9% at C6-C7 during the 8 g simulation [17].

Zygapophyseal cervical facet joint injections for whiplash injuries

In general, this manuscript authors opine that interventional pain procedures should be reserved to cases where "lower level of care" has been exhausted and/or if the pain is becoming a daily debilitating burden, even early on after the initial insult. In addition, we believe the patient has the right to decide and 'go directly' to interventional procedures. We also promote considering pain procedures in patients with high risk of development of chronic pain syndrome, such as chronic pain patients with pre-existing pain syndromes, chronic smokers (or vapers), patients with degenerative spondylosis, and other chronic complicated cases [6]. These procedures must be performed by an experienced interventional pain clinician with skills not only to master the procedure under fluoroscopy, but also address any untoward potential immediate or late complications and/or side effects [6].

In the United States, in the arena of motor vehicle collisions, due to "other party" payors and for litigation purposes, for non-radicular neck pain, the authors recommend performing Zygapophyseal joint injections under fluoroscopy, with 3 levels done on each side at a time, 2-3 weeks apart, rather than diagnostic medial branch blocks leading to radiofrequency ablation (RFA) [6]. RFA remains a good option and is indicated after whiplash injuries once you establish relief from 2 diagnostic medial branch blocks [18]. It is also indicated for neck pain unrelated to whiplash injury [18]. It typically will last about 6-9 months before the pain starts to recur [18]. At that time, another RFA is indicated without subsequent diagnostic blocks [18]. The second and subsequent RFA will be performed under insurance rather than personal injury, in case of a collision, since most likely the litigation would have resolved, and it will then be up to the patient's health insurance to decline or approve the procedure [6].

Preparation for the injections

Identification of the patient is essential. "Time out" to confirm the actual procedure and side is important to avoid mishaps. Patient must sign an informed consent. The clinician must explain what the patient is to expect from these injections [19]. Thorough and detailed explanation of the risks, benefits, alternatives, pros, and cons should be established [19]. Using a spine model to explain the procedure is beneficial.

It is preferable to perform the injections in a monitored suite, either at an outpatient surgery center or office-based with monitoring. Experienced staff must be present [19]. Authors promote the use of at least heart and blood pressure monitoring, but full monitoring is also advised [19]. Patient will decide whether to receive oral or intravenous (IV) sedation or not. Authors do not see a need for IV access if no sedation is to be administered. Sedation will not create outcome bias since these injections are considered therapeutic injections. Sedation will control anxiety related to the procedure.

Patient positioning involves a prone position with slight neck flexion. Pillows should be placed under the chest to support the shoulders and convey a relaxing posture.

Whether to use local anesthetic to numb the skin prior to inserting the needle for this type of intra-articular facet joint injections has been the focus of attention in last few years. Our experience demonstrate that patients typically complain more about the local anesthetic related pain rather than the pain procedure itself. We typically use distraction techniques prior to inserting the needle, and this usually suffices to alleviate patient discomfort. A study has addressed this issue and indicated that pain experienced after cutaneous anesthesia up to the point of a 1-inch depth treatment needle insertion, was significantly associated with overall procedural pain scores [20].

The use of certain needle types, length, and gauge, the use of local anesthetic versus normal saline, and which contrast material, is a personal clinician preference. This manuscript will not delve in.

The choices of steroids are numerous for the cervical facet joints. The most frequently used steroids include methylprednisolone, dexamethasone, triamcinolone, and betamethasone [21]. The authors recommend the use of dexamethasone in injections of the cervical facet joints, since it is non-particulate, powderless, rapid onset, and is long-acting. It also lacks the sodium retentive properties of other steroids [6].

Injection technique

Once the patient is comfortable and ready to start, the skin is thoroughly prepped with Chlorhexidine, in an aseptic fashion using sterile gloves. Sterile draping of the site of injections is then carried out. Visual identification of the cervical facet joint of

interest is then performed using fluoroscopic guidance (Figure 4). A Quincke spinal needle, 3.5-inch long or 5-inch for obese patients, with gauge range 22 to 25 gauge is gradually introduced towards the facet joint. A small aliquot of 0.3 ml of contrast material is then slowly injected to confirm needle location. Images will confirm intraarticular access with linear streaks between articular surfaces. Lateral imaging is then obtained to confirm the location of the needle. (Figure 5) Prior to injecting the Decadron (typically 1-2 mg per joint), aspiration is carried out to confirm negative heme and CSF. Then either sterile, preservative free local anesthetic or sterile, preservative free normal saline is then injected slowly along with the Decadron with a total volume of no more than 1 cc in each level, to avoid facet capsule rupture. Needles are removed and the patient is given a quick motor and sensory examination. Patient will then be transported to recovery area.

Once intraarticular access is confirmed, a combination of local anesthetic and steroids may be injected. It is recommended that the volume injected be between 1 to 1.5 mL as larger volumes may rupture the joint capsule.

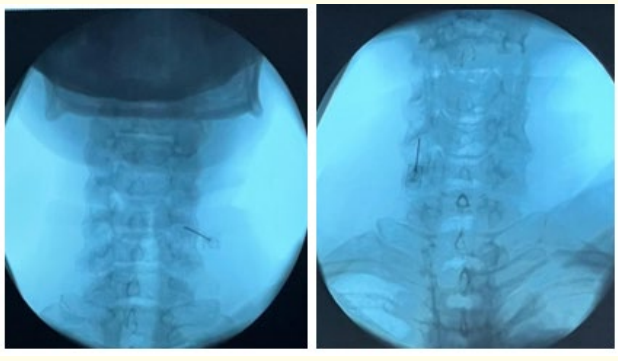

Figure 4: Injection techniques of cervical facet joint injections.

Figure 5: Lateral confirmation of cervical facet joint injections.

Indications of cervical facet joint injections

In our practice, in the field of motor vehicle collisions and the arena of litigation, considering the frequency of whiplash injuries, we opine cervical facet joint injections have been a very good alternative to regular cookie-cutter cervical epidural injections and RFA. We have performed a significant number of these procedures and found a high percentage of patients carry on with their lives with no chronic cervicalgia. We recognize the superiority of RFA for long term relief but also recognize the majority of these personal injury patients will eventually be discharged and will again need subsequent RFA sessions. Many do not have health insurances and with the changes in health care, many RFA many be denied. Facet joint injections can always be repeated.

In a study published in 2022 [22], thirty patients with chronic and persistent cervical facetogenic pain were prospectively observed after whiplash trauma. Facet joint injections were then performed under fluoroscopy. The patients were then followed up for pain relief at 1 and 2 months after the intervention. It was found that pain scores, in both follow-ups "were significantly decreased compared to pretreatment scores". Furthermore, 26.7% patients reported pain relief of ≥50% 2 months after the treatment[22.] It encouraged the use cervical facet joint injections as it as "a management option" for whiplash-related cervical facetogenic pain [22].

Additionally, Kim., *et al.* [23]. conducted a study on 20 patients after cervical facet joint injections for the treatment of cervical facetogenic pain related to WAD amongst other etiologies [23]. The study found there was "clear evidence why the intraarticular injections are superior to medial nerve blocks in case of presence of inflammation. Pain from nociceptive signals may result from a combination of inflammatory and mechanical joint stress, possibly in the presence of additional central sensitization" [23].

In a case series observational study [24], that recruited 118 patients, the researchers postulated the effectiveness of therapeutic intraarticular cervical zygapophyseal joint injections in atraumatic patients. They indicated facet joint injections should be considered as an alternative treatment before RFA [24].

Other studies sought to study forty patients with cervical facetogenic pain that were randomly assigned to one of 2 groups: the radiofrequency group and the facet injection group. There were 20 patients in each group. Pain intensity was evaluated using a numeric rating scale (NRS) at pre-treatment, and one, 3, and 6 months after treatment [25].

When compared to the pretreatment NRS scores, patients in both groups showed a significant decrease in NRS scores at one, 3, and 6 months after treatment [25]. Changes in the NRS scores over time were not significantly different between the groups. Six months after treatment, 10 patients (50.0%) in the radiofrequency group and 12 patients (60.0%) in the intraarticular steroid injection group reported successful pain relief (pain relief of ≥ 50%) [25]. It was concluded that intraarticular injections were as effective as IA corticosteroid injection in attenuating CFJ pain [25].

Complications

Kim., *et al*. [26]. retrospectively studied cases from January 2007 to December 2017, with a total of 11,980 facet joint injections procedures in 6066 patients. Of these, the team retrospectively reviewed 489 cases in 432 patients [26]. The overall incidence of injections-related adverse events was 0.84% (101/11,980) per case and 1.63% (99/6066) per patient [26]. The incidence of procedure-related complications and drug-related systemic adverse events was 0.07% and 0.15%, respectively; the rate of uncertain etiology events was 0.63% [26].

The importance of sterile techniques is imperative. The risk of infection is always there since the clinician is 'invading' the integrity of the skin, with a needle, and introducing substances to the body.

Other than mild systemic and transient side effects, mainly related to the Decadron, such as feeling "flushed, hot, and sweaty", leg cramping, headaches, and mild stomach irritation, we have not encountered any other major side effects in our practice. A high clinical vigilance is always in order.

Conclusion

In the personal injury clinical practice world, WAD pain is a common syndrome and often refractory to physical therapy and chiropractic. NSAIDs have limited role and may have untoward effects related to chronicity of pain and systemic side effects. We opine cervical intra-articular facet joint injections using a steroid of choice, may serve as an alternative and safe management option for whiplash-related cervical facetogenic pain.

Outside personal injury and motor vehicle collisions, in the realm of health insurances, we feel positive diagnostic medial branch blocks followed by RFA may provide adequate longer-term relief.

The authors are optimistic that in the future, researchers will continue to conduct non-biased high-quality prospective comparative clinical research to answer many of our curious questions.

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