■ REVIEW ARTICLE ■ SPINE SURGERY AND RELATED RESEARCH

A Review of the Clinical Utility of Therapeutic Facet Joint Injections in Whiplash Associated Cervical Spinal Pain

Kelechi Eseonu, Jaykar Panchmatia, David Pang and Bahram Fakouri

Spinal Surgery Dept, Guy's & St. Thomas' Hospitals, London, United Kingdom

Abstract:

Background and Objective: Whiplash neck injury was described by Crowe in 1928. Whiplash-associated disorder (WAD) is defined as a cervical spinal injury following an acceleration-deceleration mechanism. It is a constellation of symptoms due to psychological factors and neural adaptations, with significant social costs.

Review Summary: There are multiple classification systems for WAD in the literature. The Quebec Classification is most reported and is predictive of the likelihood of progression to chronicity. The facet joint has been identified as a pain generator in 50% of cases. We outline the likely anatomical cause of WAD and summarize the protocol of medial branch block injections for diagnostic and therapeutic purposes, as well as the indications for and published results of facet joint ablation in WAD. We also highlight the development of ultrasound as an alternative to computed tomography or fluoroscopy for injection guidance.

Conclusions: WAD is a complex condition associated with sensory disturbance, pain, motor chronic pain, and psychological distress. The literature supports a single diagnostic medial branch block followed by a therapeutic facet joint ablation for chronic pain. WAD should be managed in a multidisciplinary fashion, with an early involvement of psychological specialists when required.

Keywords:

whiplash, whiplash-associated disorder, WAD, cervical facet joint, medial branch block

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Background

Whiplash neck injury was first described by Crowe in 1928[1]. As our understanding of this condition has evolved, so has our nomenclature. The term "whiplash-associated disorder (WAD)" is now commonly used to describe the clinical manifestations of whiplash injuries[2].

WAD is defined as a cervical spinal injury secondary to an acceleration-deceleration mechanism. It is classically sustained following rear-end or side-impact, predominantly in motor vehicle accidents[3]. WAD can be associated with both short- and long-term sequelae, including neck pain, headache, dizziness, temporomandibular joint dysfunction, and sensory disturbance. This constellation of symptoms is known as WAD[4-6].

Over recent decades, the incidence of whiplash has increased because of various factors including a rising number of road accidents and traffic density, increased awareness of the condition among the general population and physicians, and socioeconomic factors[7,8]. A study by Holm et al suggested that the incidence in North America and Europe was approximately 300 per 100,000 inhabitants[9]. In the United Kingdom, the introduction of the compulsory wearing of seatbelts in 1983, an initiative to save deaths on the road, led to an increase in the number of reported whiplash cases[10]. It is also more common in women than men with almost two-thirds of women experiencing symptoms and several studies have shown a slower or more incomplete recovery in women compared with that in men[10].

The clinical manifestations of WAD are thought to be physiological, psychological, and socioeconomic in origin. There is now extensive evidence of neural adaptations in individuals with WAD, including sensory disturbance of widespread hypersensitivity and upregulation of spinal cord reflexes, indicative of central sensitization of pain receptors[11,12]. This phenomenon might explain why even lesions

Corresponding author: Kelechi Eseonu, Kelechi.eseonu@doctors.org.uk

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with minor nociceptive input can leave patients with significant persistent pain. Additionally, motor disturbances such as movement loss and altered muscle recruitment patterns have been demonstrated[13,14]. These studies highlight the complex physiology associated with WAD, which are at odds with the historical perception of whiplash as an innocuous injury with universally good outcomes.

Several studies have explored the association between whiplash and quality of life, with a number of these finding an association between psychological conditions such as posttraumatic stress disorder, anxiety, and depression with WAD, particularly once chronicity is established[3,6,15]. In the year following a whiplash injury, up to 17% of patients have been found to present with posttraumatic stress disorder[16]. Whether such psychological factors are causative for non-recovery or actually result from chronic pain itself remains unclear.

Whiplash is also frequently followed by litigation, and this has been noted as a potential confounder in studies that collate patient-reported outcome measures[17]. Previous work has suggested an association between higher pain scores and patients pursuing litigation. However, whether this is due to litigation only resulting from more significant trauma, the stress of litigation resulting in more significant pain, or the exaggeration of pain scores to maximize financial compensation is unclear[17,18].

The costs resulting from these physiological, psychological, and socioeconomic factors are substantial, with the majority of the financial burden falling on individuals and health services[19,20]. Consequently, the symptoms associated with WAD must be treated effectively.

The management of WAD should be multidisciplinary in nature, involving pain specialists, physiotherapy, spinal surgeons, and cognitive-behavioral therapists where necessary[21]. Physiotherapy and oral analgesia can often be sufficient in the acute setting. Although there may be a role for nonsteroidal antiinflammatory drugs acutely, there are associated gastrointestinal and renal complications with prolonged use. Similarly, extreme caution in prescribing and monitoring opioid or antidepressant treatment for clinically related hyperalgesia or pain-associated insomnia is mandatory, given the lack of evidence for long-term benefits and the associated risks including tolerance and dependence.

In patients with acute whiplash injury, it has been shown that the most prominent factor for predicting chronicity is the intensity of high cervical spinal pain after trauma[16,22].

This review aims to outline the classification of whiplash injuries, the current literature on the efficacy of targeted facet joint injections, and to summarize the indications for facet denervation in the management of chronic WAD. Search terminology included cervical facet joint, cervical facet joint pain, cervical diagnostic facet joint blocks, cervical facet joint intraarticular injections, cervical medial branch blocks, and cervical radiofrequency neurotomy. Fig. 1 shows the detailed literature search.

Classification

The classification of WAD tends to be based on either duration or severity of symptoms. Regarding the duration of symptoms, there remains an absence of clear consensus as to when acute and subacute whiplash becomes chronic, suggesting that the transition between the two lies on a continuum. A lower probability of recovery characterizes the chronic phase of WAD. If patients still have symptoms 3 months after the accident, they are likely to remain symptomatic for at least 2 years, and possibly for much longer[23]. Curatolo et al suggest a classification of WAD by the duration of pain following the time of injury: Acute (0-3 months: likely recovery), subacute (3-12 months: possible recovery), and chronic (greater than 12 months: very unlikely recovery)[24].

Ritchie et al have proposed an algorithm for predicting the probability for the development of chronic WAD after acute whiplash with risk factors including older age (≥35 years), moderate/severe levels of pre-injury neck disability (Neck Disability Index≥40), and symptoms of neural hyperexcitation on the first examination. Younger age (≤35 years) and initial low levels of neck disability (Neck Disability Index≤32) have been associated with full recovery[25,26].

Two commonly used classifications based on symptom severity are the Quebec Classification and the Gargan and Bannister grading system. The Quebec Classification system grades the severity and extent of neck symptoms and signs from 0 to IV (Table 1)[27]. It is prognostic in that studies have shown that the risk for WAD at 6, 12, 18, and 24 months increases with increasing grade. Furthermore, those with a limited range of movement were found to have a poorer prognosis, prompting a suggestion that Grade II injuries should be further subdivided depending on whether the patient has a normal or limited range of movement.

The Gargan and Banister classification is based on symptoms alone and ranges from A to D (Table 2)[28]. More detailed classifications have been described including one by Sterling and the Swedish System (Table 3); however, their complexity is such that they are less frequently used in the clinical setting[16,29].

Applied Anatomy

The facet joints are synovial joints that provide structural integrity and facilitate flexion, extension, and rotatory movement throughout the spine (Fig. 2). They are innervated by the medial branches of the cervical dorsal rami[30]. The facet joint capsule contains low threshold mechanoreceptors, mechanically sensitive nociceptors, and silent nociceptors[31,32]. Studies have identified free and encapsulated nerve endings within facet joints, as well as nerve fibers containing substance P and calcitonin gene-related peptides in synovial folds of the facet joint[33,34].

A theory as to the exact mechanism of whiplash injury related to the facet joint specifically has been proposed[35].

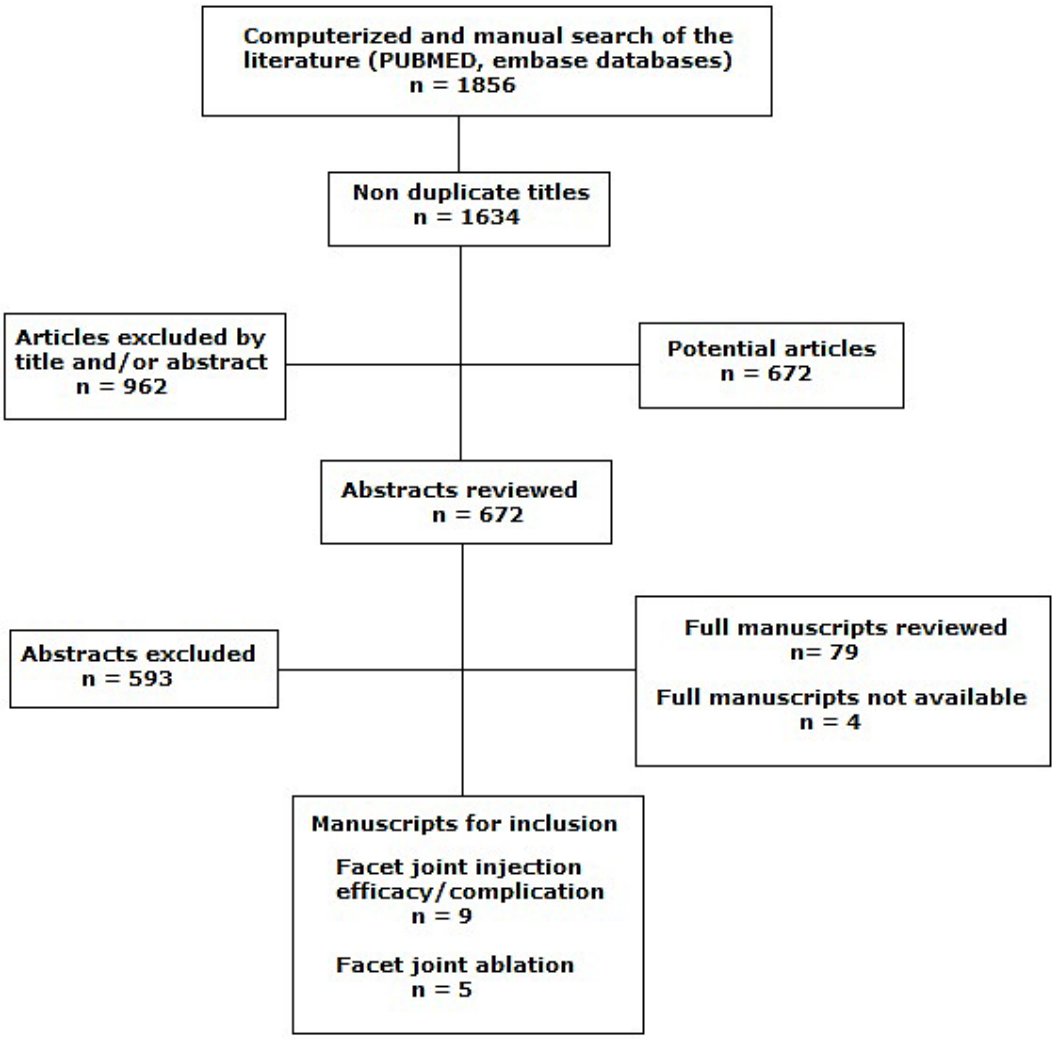

Figure 1. Flow diagram illustrating literature evaluating cervical facet joint interventions.

Rather than the facet articulating surfaces gliding along one another, the inferior articular process is thought to "chisel" into the superior articulating facet of its supporting vertebra, leading to a chondral injury and acceleration of facet osteoarthritis. From a pathoanatomical perspective, studies have reported a prevalence of facet joint pain in WAD varying from 36% to 67%[36-38].

Both facet joint injections and medial branch blocks are used to diagnose and treat pain stemming from facet joints but act via distinct mechanisms. The facet joint capsule is made of a synovial membrane and is richly innervated. Its superior aspect is typically fused with the fatty sheath of the spinal nerve[39]. When the joint capsule is inflamed, facet joint injections into and around the capsule act by inhibiting the production of inflammatory mediators and downregulating the sensitivity of nociceptors to reduce pain.

Medial branch nerves exit from the spinal nerves' dorsal rami and typically possess only sensory properties. All joint segments below C2-C3 receive medial branch innervation from two levels: the same level as the joint and from a level above the joint. Medial branch targeted injections block C-fibers within the nerves innervating each facet joint that transmit pain sensation to the brain and decrease pain transmission by decreasing the permeability of the nerve fibers[40]. Our review will focus on both types of targeted injection.

Management of Whiplash Using Targeted Injections

Pain on examination of the cervical spine is poorly localized in whiplash and as such is of limited diagnostic value when attempting to isolate the pain generator. Patients with facet joint pain can complain of pain over the joint, elsewhere in the cervical spine or upper extremity, interscapular pain, and headaches[41]. Consequently, it has been postulated that the use of local anesthetic instilled into the facet joint capsule can act as a reliable diagnostic (and temporarily therapeutic) test[19,42].

Barnsley et al investigated the possibility of selective blockade of the medial branch with local anesthetic as a diagnostic procedure and several other studies have used this concept to survey the prevalence of facet joint pain in cohorts of patients with chronic WAD[43,44]. The use of comparative blocks or placebos in a number of these studies reduces

Table 1. The Quebec Classification of WAD Severity.

Grade	Classification
0	No complaints about the neck
1	Complaint of neck pain, stiffness, or tenderness only. No physical sign(s)
2	Neck complaint and musculoskeletal sign(s)
	Musculoskeletal signs include decreased range of movement and point tenderness
3	Neck complaint and neurological sign(s)
	Neurological signs include decreased or absent tendon reflexes, weakness, and sensory deficits
4	Neck complaint and fracture or dislocation

Table 2. The Gargan and Banister Classification of Whiplash-associated Disorder (WAD).

Grade	Symptoms
A	No symptoms
B	Nuisance symptoms. Do not interfere with leisure or activity
C	Intrusive symptoms requiring treatment analgesic, orthotics, and physical therapy
D	Disabling symptoms and requiring time off work, regular analgesia, orthotics, and repeated medical consultation

Table 3. The Swedish Classification of Whiplash-associated Disorder (WAD).

Step 1: Determination of area(s) of impact		
Area	Code	
Head/neck/shoulder	A	
Arm	B	
Neuropsychological	C	
Step 2: Categorization of condition based on the area of impairment according to step 1		
Category		
a	A	
a+b	B	
a+c	C	
a+b+c	D	
Step 3: Time course. A grouping is made on the basis of time after trauma		
Definition	Term	Abbreviation
Acute<12 weeks	X weeks	Xv
Chronic>12 weeks	Y months	Ym

the likelihood of a false-positive result. Painful facet joints were identified in 54% of patients with WAD[22].

Several papers have reviewed the efficacy of facet joint injections and medial branch blocks for the treatment of WAD (Table 4). One of the first studies dealing with cervical facet joint pain and local anesthetic injections was reported in 1993[45]. Authors performed an uncontrolled study without a placebo group of 318 patients with chronic neck pain referred to a tertiary care center and reported a positive result in 62% (26 of those 42 subjects).

Further studies have demonstrated that computed tomography (CT) or fluoroscopically guided injections improve symptoms and functional outcomes after WAD in the short (<6 months) and medium (>6 months) terms[22,46]. Existing work has suggested between 55% and 95% pain relief after targeted local anesthetic and steroid injections at medium-term follow-up, including a randomized controlled trial that reported up to 85% improvement in functional and pain scores at 2 year follow-up[47-49]. The findings of a systematic review by Boswell et al were more equivocal[33]. On review of three studies of targeted injections in WAD, one randomized study of 41 patients found a return to pre-injection pain levels of 50% in the short term[45], whereas two observational studies of 90 patients reported positive short- and long-term pain relief [50,51].

Ultrasound has emerged recently as an alternative to CT or fluoroscopy. It has the advantage of being free of radiation, speed, and the ability to identify vessels in the needle trajectory[52].

Reported complication rates associated with injections are low (Table 5). A prospective nonrandomized controlled trial of over 3300 facet joint blocks performed over a 20 month period reported no major complications[53]. Minor complications included local bleeding in 67%, oozing in 29% of cases, local hematoma in 2.3% of the patients with profuse bleeding, bruising, soreness, nerve root irritation, and all other major side effects such as vasovagal reactions observed in 1% or less of cases. Major complications were reported to be extremely rare in all the review articles assessed[22,46,48,49].

Management of Whiplash Using Radiofrequency Ablation

Radiofrequency neurotomy (ablation) is indicated in the chronic phase of WAD (Table 6). This procedure is typically performed after a positive diagnostic block to confirm the facet joint as the pain generator. The tip of a radiofrequency probe is heated, typically at 80°C around the medial branch of the cervical dorsal rami that supply the facet joint. The

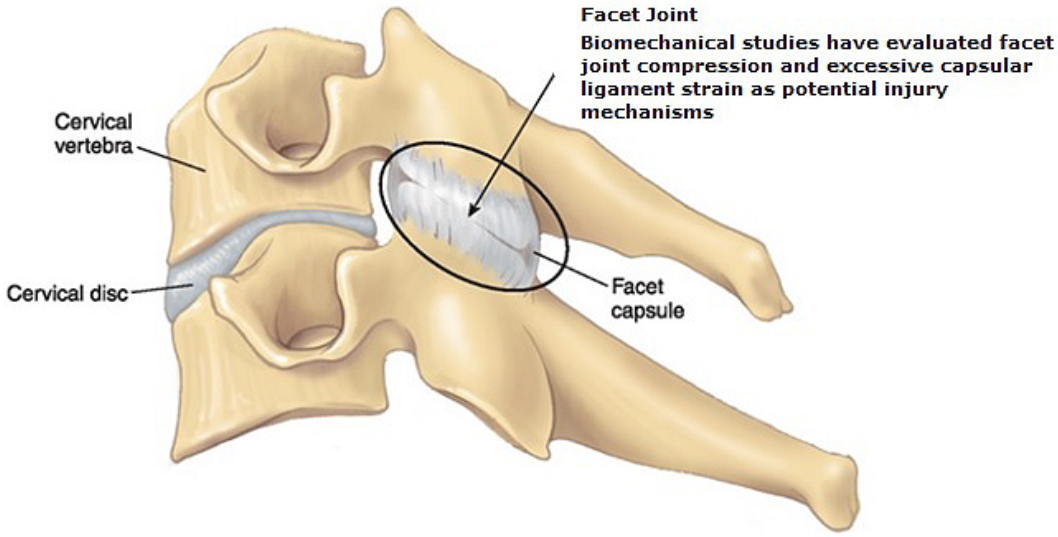

Figure 2. Cervical spine facet joint.

Table 4. Efficacy of Therapeutic Facet Joint Injections on Neck Pain in WAD.

Author	Year	Study type	No of patients/procedures	Summary of findings
Barnsley[43]	1993	Prospective nonrandomized	16 (25 levels)	11/15 patients obtained complete or definitive pain relief
Barnsley[45]	1993	Prospective nonrandomized	42 patients	26/42 positive blocks
Folman[51]	2004	Prospective nonrandomized	30 patients (>12 months duration)	Positive short and long-term relief. Mean time of relapse of 50% of the pre-injection level of pain: 12.47±1.9 weeks
Manchikanti[49]	2004	Prospective nonrandomized	100 patients	Baseline VNS 8.0±0.9, 6 months: 3.4*±0.8, 12 months 3.5*±0.8
Kim[50]	2005	Prospective, nonrandomized	20 patients	Mean reduction of 3.60±0.07 on numerical rating scale with the mean symptom-free period after blockade 3.0±0.8 months.
Manchikanti[47]	2010	Randomized controlled trial (Group 1: LA vs. Group 2: LA and steroid)	120 patients	85% of patients in Group 1 and 93% in Group 2 showed significant (>50%) pain relief at 2 years
Park[52]	2017	Retrospective comparative (Group 1: USS guided vs. Group 2: fluoroscopy-guided)	Group 1: 68 patients (104 injections) vs. Group 2: 58 patients (82 injections)	Group 1: Baseline VNS* 6.46±1.06, 6 months VNS 2.74±1.36 Group 1: Baseline NDI** 24.25±5.39, 6 months 12.68±4.06 Group 2: Baseline VNS 6.40±1.06, 6 months VNS 2.71±1.66 Group 2: Baseline NDI 23.95±4.45, 6 months 12.75±4.01

* VNS: verbal numeric pain scale

** NDI: Neck Disability Index

heated tip coagulates the nerve if in close proximity, rendering it unable to transmit the nociceptive signal from the facet joint. One of the first randomized controlled trials of percutaneous radiofrequency ablation compared its clinical utility with that of a placebo group. All patients had previously had diagnostic medial branch block and a previous whiplash mechanism of injury with ongoing pain. They reported excellent results, with a median time to the return of at least 50% of the pre-ablation level of pain of 263 days in the active treatment (ablation) group, compared with 8 days in the placebo group ($p = 0.04$)[54].

Falco et al systematically reviewed six studies on the clinical utility of cervical facet ablation in WAD[22]. They reported rates of significant pain relief of between 55% and 74% at 2 year follow up[55-59]. These studies also concluded that although the rates of minor complications such as local bleeding and oozing after ablation were relatively common, major complications were extremely rare.

Some authors have reported a rate of recurrent neck pain after the first ablation procedure, requiring a repeat ablation procedure. This is thought to be due to the rerouting of neural pathways around the facet joint rather than a failure of the primary procedure to ablate the nerve. A long-term follow-up study by McDonald et al reported 71% complete

Table 5. Complications Following Therapeutic Facet Joint Injections for Neck Pain in WAD.

Author	Year	Study type	No of patients/procedures	Summary of findings
Manchikanti[49]	2004	Prospective, nonrandomized	100 patients	No adverse events were reported. Minor complication rates not reported
Manchikanti[46]	2008	Randomized controlled trial	120 patients	No adverse events were reported. Minor complication rates not reported
Manchikanti[53]	2012	Prospective, nonrandomized	3370 encounters (no of patients not reported)	No major complications were reported. Local oozing: 28.9% local bleeding: 66.9% local hematoma: 2.3%

Table 6. Results Following Cervical Facet Joint Radiofrequency Ablation (Neurotomy) in WAD.

Author	Year	Study type	No of patients/procedures	Summary of findings
Lord[54]	1996	Randomized, double-blind trial (Group 1: percutaneous radiofrequency neurotomy vs. Group 2: control)	24 patients (12 in each group)	Median time before the pain returned to at least 50% of the preoperative level: Group 1: 263 days, Group 2: 8 days in the control group. At 27 weeks, seven patients (Group 1) and one patient (Group 2) were free of pain.
McDonald[60]	1999	Prospective, nonrandomized	28 patients	Complete relief of pain was obtained in 71% of patients. The median duration of relief after a first procedure—219 days (failures included) but 422 days (only successful cases included)
Sapir[55]	2001	Prospective, nonrandomized comparative	60 patients (nonlitigant vs. litigant)	Reduction in visual analog pain scores was significant immediately after treatment (nonlitigants vs. litigants: 2.0 vs. 2.5, P=0.36) and at 1 year (nonlitigants vs. litigants: 2.9 vs. 4.0, P=0.05). One-year follow-up scores higher than immediate post-treatment scores (nonlitigants vs. litigants: 2.5 vs. 3.6)
Speldewinde[59]	2011	Prospective, nonrandomized	282 patients (379 procedures)	76% successful procedures (at least 50% reduction of pain, for at least 2 months)
Cohen[57]	2007	Retrospective series	92 patients (three centers)	Male: 50% and female: 62% success rate (at least 50% pain relief lasting at least 6 months)

pain relief after the initial procedure[60]. In their cohort, only 33% of patients who failed to respond to a first procedure responded to a second procedure; however, if a first procedure had been successful in leading to at least 3 months of significant pain relief, they found that a second procedure was successful in achieving complete pain cessation for at least 90 days in 100% of cases. The median duration of relief per successful ablation in procedure in their study was 421 days (IQ range 223-730d).

Conclusion

WAD is a complex condition associated with sensory disturbance, motor dysfunction, chronic pain, and psychological distress. Management in the acute setting should be multidisciplinary in nature. Although diagnosis can be challenging, the consensus from the current literature suggests that the facet joint is the likely pain generator in whiplash in 50% of patients.

Progression to chronicity is along a continuum and risk factors include older age, moderate/severe levels of a preinjury neck disability, and symptoms of neural hyperexcitation on the first examination. WAD is a common cause of workplace absenteeism and litigation. There is good literature to support the use of diagnostic and therapeutically targeted injections to identify and treat pain generators in WAD. There is also a corpus of evidence supporting the use of nerve ablation following a successful diagnostic nerve root block to achieve long-term pain relief. Despite an incidence of minor complications such as minor bleeding, both targeted injections and nerve ablations have been shown to be safe and clinically effective procedures.

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