

## Original Article

# Outcomes of Therapeutic Selective Nerve Root Blocks for Whiplash Induced Cervical Radicular Pain

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This study was designed to investigate the clinical efficacy of fluoroscopically guided therapeutic cervical selective nerve root blocks (SNRBs) in patients with whiplash induced cervical radicular pain. Study design was retrospective with independent clinical review. Twenty two patients were included. Each patient met specific physical examination criteria and failed to improve clinically after at least four weeks of physical therapy and the use of oral analgesics. Each patient demonstrated a positive response to a fluoroscopically guided diagnostic cervical SNRB. Patients were excluded for radiographic evidence of a focal disc protrusion or foraminal stenosis at the symptomatic level. Therapeutic cervical SNRBs were administered in conjunction with physical therapy. Data collection and analysis were performed by an independent clinical reviewer. Outcome measures included VAS pain scores, work status, medication usage, and Oswestry disability scores.

Results showed the patients' symptom duration prior to diagnostic injection averaged 6 months. An average of 2.1 therapeutic injections was administered. Follow up data collection transpired at an average of 33.3 weeks following the final therapeutic injection. Good or excellent results were observed in 14% of patients. In higher functioning individuals a significantly greater ( $F=.0427$ ) improvement in pain of 48.9% was observed.

In these initial findings suggest that fluoroscopically guided therapeutic SNRBs, except possibly for higher functioning individuals, are not effective in the treatment of whiplash induced cervical radicular pain.

**Keywords:** Whiplash injury, cervical radicular pain, cervical radiculopathy, selective nerve root block

Originally described by Crowe (1) in 1928, whiplash remains a common cause of neck and extremity complaints. In 1994, in the United States alone, 18% of 6.5 million motor vehicle accidents were rear end impacts, resulting in injury to 500,000 individuals (2). Whiplash related symptoms often persist long after the inciting event, with 33-66% of patients remaining symptomatic two years after injury (3-5).

Radiographic studies following acute cervical hyperextension - hyperflexion injuries often fail to demonstrate focal pathology (6-8). Patients' symptoms have previously been attributed to cervical sprain and strain, myofascial pain, brachialgia, and thoracic outlet syndrome (9-11). These syndromes represent non-specific diagnoses which often suffice for the patient whose symptoms are short lived and responsive to non-specific interventions (12). General treatment approaches often prove inadequate for the more chronically symptomatic patients (3-5). Recent investigations have attempted to establish more precise diagnoses in the chronically symptomatic whiplash population (13-16). After identifying the pain generators in these individuals, specific therapeutic interventions can be provided. Additionally, outcome studies can be conducted to determine the efficacy of these more targeted treatments.

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Recently, the cervical zygapophyseal joints and discs have been investigated as nociceptors in the chronic whiplash population. Through provocative intra-articular injections in volunteers, the pain generating ability of these joints has been demonstrated (16). Using diagnostic injections

in chronically symptomatic whiplash patients, the prevalence of cervical zygapophyseal joint mediated pain has been estimated to be 54 to 60% (13,15). In the treatment of neck pain in this patient population, the therapeutic response to intra-articular corticosteroid injections has been investigated (17). Patients receiving intra-articular steroid demonstrated a return of pain to 50% of the preinjection level, as measured by a verbal pain score, similar to those receiving intra-articular anesthetic alone (17). Using provocative discography, 61% of chronic post traumatic neck pain patients have demonstrated painful discs (14).

The cervical nerve roots are also susceptible to injury from a whiplash event. Nerve root trauma may result in painful neck and extremity complaints with or without associated neurologic deficit (18-23). The specific etiology of such pain has eluded diagnosticians because of the absence of consistent radiologic or neurophysiologic correlates. Similar to the zygapophyseal joints, injuries to the roots are typically not demonstrated radiographically (6-8). Electrodiagnostic studies have a poor sensitivity in the evaluation of nerve root pathology (24). However, diagnostic cervical selective nerve root blocks (25,26) can be utilized to identify patients whose neck and extremity complaints are arising from a whiplash induced nerve root injury. Therapeutic selective injections can then be utilized in the treatment of symptoms arising from cervical nerve root pathology (27,28). Several studies have described a relatively poor prognosis for those whiplash patients presenting with initial upper extremity pain and sensory disturbances (4,5,29,30). These studies related outcomes to presenting symptomatology, as patients were not provided a specific diagnosis. It was the purpose of this retrospective study to evaluate the efficacy of therapeutic selective nerve root injections in a specific subset of patients with upper extremity pain following a whiplash event

## METHODS

### *Patient Selection*

All patients presenting to our Spine Center during a 19 month period with arm greater than neck pain precipitated by a motor vehicle accident were eligible for inclusion. Patients were required to have failed a previous course of non-surgical management, including physical therapy and the use of oral anti-inflammatory agents / analgesics. Each patient demonstrated either a positive Spurling's sign or symptom provocation with passive cervical extension and/ or ipsilateral rotation. Exclusion criteria included clinical evidence of radiculopathy as evidenced by myotomal weak-

ness, hyporeflexia, or an electrodiagnostic abnormality. Patients with symptoms suggestive of myelopathy were similarly excluded. Each patient underwent a magnetic resonance imaging (MRI) of the cervical spine. Patients were excluded if there was radiographic evidence of a focal disc protrusion or foraminal stenosis at the symptomatic level.

### *Data Collection*

At initial presentation, patients' work status, medication usage, Oswestry disability score, and visual analogue score (VAS) were recorded. Similar data was recorded upon discharge from the Spine Center when treatment was completed. Follow up data was collected at a later date through a telephone interview. During telephone interviews, pain intensity was measured with a verbal analogue scale. All data entry and telephone inquiries were performed by an independent clinical reviewer.

Patients eligible for employment were stratified into four functional categories (*excellent, good, fair, poor*) based upon work status, medication usage, and Oswestry score (Table 1), at initial evaluation and at follow up. An *excellent* rating meant the patient was working full time, using no or only over the counter medications, and scored 0-20 on the Oswestry questionnaire. A *good* rating meant the patient was working full time with job modification, using prescription NSAIDS, and scored 21-40 on the Oswestry questionnaire. A *fair* rating meant the patient was working part time, using narcotic medications, and scored 41-60 on the Oswestry questionnaire. A *poor* rating meant the patient was not working or performing only light work, using narcotic medications, and scored greater than 60 on the Oswestry questionnaire. Failure to satisfy any one of the criteria for a given category resulted in a patient being classified into the next lowest category.

### *Injection Technique*

Intravenous access following the establishment of blood pressure and pulse with monitoring of the patient was placed in the supine position on the fluoroscopy table. The neck was prepped and draped in sterile fashion. A bolster was placed beneath the ipsilateral shoulder. The head and upper torso was rotated toward the contralateral side to obtain an oblique position of the cervical spine. The cervical spine was then positioned to visualize the neural foramen in a plane parallel to the gantry angle. Using a single needle technique, a 22 gauge 1-1/2" needle was advanced to abut upon the superior articular process (SAP) to gauge depth.

**Table 1.** *Functional categorization based upon work status, medication usage, and Oswestry score*

Rating	Work status	Medications	Oswestry
Excellent	Full time	None / OTC	0-20 "minimal"
Good	Full time with modifications	NSAIDs	21-40 "moderate"
Fair	Part time	Narcotic	41-60 "severe"
Poor	No work / Light work	Narcotic	> 60 "crippled"

OTC: over the counter NSAIDs: non-steroidal anti-inflammatory drugs

For diagnostic injections, the needle was slightly advanced just medial to the base of the SAP. For therapeutic injections, the needle was positioned just medial to the mid-portion of the SAP. Then 0.5-0.75cc of Omnipaque was infused to confirm needle placement. Under fluoroscopic visualization, outlining of the targeted nerve root, without epidural flow, had to be observed. For diagnostic injections, 0.5-0.75cc of 2% Xylocaine was infused around the nerve root. With therapeutic injections, a mixture of 1.0-1.5cc of Celestone® Soluspan® and 0.5cc of 1% Xylocaine was infused around the nerve root.

Each patient underwent a diagnostic selective nerve root block. Immediately prior to, and within 30 minutes following a diagnostic injection, each patient completed a VAS and pain drawing supervised by a trained nurse or medical technician. Prior to completion of the post-injection VAS, the patient was required to assume any position or perform any maneuver that typically provoked upper extremity pain. A minimum reduction of 80% in the VAS rating was required to be considered a positive diagnostic response. Those patients receiving therapeutic injections were reevaluated at two week intervals, and the second injection was canceled if the initial injection resulted in 90% or greater symptom relief. Patients were then reevaluated. If a steroid effect was not realized, no further injections were scheduled. A steroid effect was defined as a minimum of 50% symptom reduction of at least one day duration within a seven day period following the therapeutic injection. If the patient experienced progressive but less than 90% relief, an additional injection was scheduled. No patient was administered more than four injections. Each patient participated in a physical therapy program, emphasizing cervical spine stabilization techniques, during the administration of therapeutic injections.

### **Outcome Measures**

Patients' functional categorization was selected as the pri-

mary outcome measure.

### **Statistical Analysis**

Statistical analyses were performed to determine the relationship between any patient variables and outcomes. Fishers Exact test was utilized when the data was categorical, and an F-test was employed for the analysis of continuous data.

## **RESULTS**

Twenty four patients satisfied the inclusion criteria for the study. Two patients were excluded from the study due to either a refusal to participate in or an inability to be contacted for a follow up phone interview.

Twelve males (54.5%) and 10 females (45.5%) were included. Patients' ages ranged from 27-67 years with an average age of 39.8 years. Patients' symptom duration prior to diagnostic injection ranged from a minimum of 1.5 months to a maximum of 186 months, with an average of 6 months. Seventeen (77.3%) patients presented with both periscapular and arm pain, 4 (18.2%) with periscapular pain alone, and 1 (4.5%) with arm pain alone.

**Table 2.** *Frequency of symptomatic levels as determined by diagnostic injection*

Level of positive diagnostic block	Number of patients
C5	3
C6	7
C7	13
C8	8
T1	1

**Table 3.** *Patients experiencing steroid effect in each work status category*

Work status at follow up	Number of patients with steroid effect	Number of patients without steroid effect
Full time	7	2
Part time / Light day	2	2
Not working	4	5

Fisher's exact test = .390

Twenty one of 22 patients had their diagnosis confirmed by a diagnostic selective nerve root injection. Twelve patients (57%) demonstrated involvement of a single root, 8 (38%) two roots, and 1 (5%) three roots. The levels diagnosed by selective injection and the number of patients affected at each level is outlined in Table 2. A therapeutic selective nerve root injection was performed at each affected level on at least two occasions. Thirteen patients (59%) experienced a steroid effect. A similar incidence of steroid effect was noted in patients in each of the three follow up work categories (Table 3).

Patients were contacted by phone for follow up data at an average of 33.3 (range 4 to 65) weeks after their final therapeutic injection

All patients were considered eligible to work, and at initial presentation, 8 patients (36.4%) were working full time, 4 (18.2%) part time, 3 (13.6%) light duty, and 7 (31.8%) were not working. At follow up, 9 patients (40.9%) were working full time, 2 (9.1%) part time, 2 (9.1%) light duty, and 9 (40.9%) were not working.

The average initial Oswestry disability score was 45.5 (range 12 to 66). The average follow up Oswestry disability score was 40.7 (range 8 to 60). This represented a mean absolute reduction of 4.8 (range 34 to 30) points or

1.6%. No patients were observed to change their Oswestry disability categorization.

The average VAS score at initial presentation was 73.3 (range 15 to 100). The average VAS score at discharge was 57.3 (range 5 to 100). The average follow up verbal pain score was 50.7 (range 2 to 90). By comparing the initial VAS score with the follow up verbal pain score, a mean absolute reduction in pain rating of 22.0 (range 18 to 67) points or 29.1% was observed. The changes in pain scores among patients in each work category at the time of follow up is outlined in Table 4.

At initial presentation, 4 patients (18.2%) were using no pain medications, 5 (22.7%) were using opiates, 7 (31.8%) were using prescription NSAIDS, 7 (31.8%) were using over the counter medications, and 11 (50.0%) were using adjuvant analgesics (i.e. muscle relaxants, antidepressants, benzodiazapines). At follow up, 6 patients (27.3%) were using no pain medications, 7 (31.8%) were using opiates, 4 (18.2%) were using prescription NSAIDS, 7 (31.8%) were using over the counter medications, and 11 (50.0%) were using adjuvant analgesics. Similar medication usage was observed among patients in each follow up work category (Table 5).

At initial presentation, 2 patients (9.1%) were categorized *excellent*, 2 (9.1%) *good*, 7 (31.8%) *fair*, and 11 (50.0%) *poor*. At follow up, 2 patients (9.1%) were categorized *excellent*, 1 (4.5%) *good*, 8 (36.4%) *fair*, and 11 (50.0%) *poor*. An overall 14% *good* and *excellent* and 86% *fair* and *poor* outcome was observed.

Of 13 variables analyzed, four demonstrated statistical significance for predicting functional categorization at follow up. Those initially categorized as *good* and *excellent* were likely to be categorized *good* and *excellent* at follow up ( $F=.00013$ ). Additionally, patients with *good* and *excellent* outcomes demonstrated a lower follow up verbal pain score ( $F=.0305$ ), a lower discharge VAS score

**Table 4.** *Initial and follow up pain ratings and reduction in pain in each work status category*

Work status at follow up	Initial VAS	Follow up verbal pain score	Percent reduction
Full time	71.0	39.0	48.9
Part time / Light duty	71.8	56.5	21.3
Not working	76.2	60.9	10.9

**Table 5.** Patient medication usage at follow up in each work status category

Work status at follow up	Number of patients using no medications	Number of patients using medication
Full time	3	6
Part time / Light duty	1	3
Not working	2	7

Fisher's exact test = 1.000

( $F=.0421$ ), and a greater percentage pain reduction when comparing initial and discharge VAS scores ( $F=.0427$ ).

## DISCUSSION

While recent investigations of chronically symptomatic whiplash patients have focused on zygapophyseal joint pain (15,33), earlier studies describe a high prevalence of cervical radicular pain in patients with whiplash injury (21,23). Several studies have described a relatively poor prognosis for those individuals presenting with initial upper extremity pain and sensory disturbances (4,5,29,30).

During a whiplash injury, the patients head is initially thrown into hyper extension, with nothing to impede backward motion until the occiput contacts the posterior chest wall (31,32). The head then rebounds into acute flexion, accelerated by a stretch reflex contraction of the flexor musculature (21,31,32). The cervical nerve roots may be injured secondary to a resultant disc protrusion (21,23,33,34). Zygapophyseal joint fracture, hemarthrosis, and capsular disruption (22,35-37) may similarly result in nerve root trauma and irritation. The nerve roots are also susceptible to significant injury in the absence of more overt trauma to contiguous structures (21,23,38).

During the extension phase of injury, the nerve root may become entrapped in a transiently narrowed neural foramen (19,21,23). Significant reductions in neuroforaminal diameter(67) and increases in neuroforaminal pressures (39,40) have been observed with increasing neck extension. The initially compressed nerve may then be subjected to a traction injury as the neck is thrown into a rebound flexion (19,21,23). This direct root trauma likely leads to intra-neural vascular congestion and edema (21,23,41,42). Edema formation in nerve roots has been shown to be particularly pronounced in the setting of rapid compression (41).

These combined insults render the nerve root susceptible to chronic injury and dysfunction. Inflammatory materials such as PLA<sub>2</sub> (43) and synovial cytokines (44) may continue to leak from the adjacent injured disc and zygapophyseal joint, resulting in sustained neural irritation (45). Intraneural and perineural fibrosis may then evolve in the setting of longstanding intraneural edema and the continued presence of surrounding irritants (20,21,42,46). Continued mechanical insult may result as adhesions develop between the nerve root and surrounding structures, minimizing root glide within the foramen (47,48). The dorsal root ganglia has been shown to fire repetitively following minimal compression, in the absence of neural irritation, and likely demonstrates even greater mechanosensitivity in the setting of chronic injury (49,50). The end stage of these multiple insults and alterations may include a sensitization of the peripheral and central nervous systems, resulting in persistent radicular pain (45).

The therapeutic efficacy of selective nerve root injections in this study was poor, as evidenced by an overall 14% *good* and *excellent* outcome. Fifty nine percent of patients, though, did experience a transient steroid effect.

This transient symptom relief may have resulted from the therapeutic properties of the injected anesthetic agent, corticosteroid, or their combination. In addition to serving as a short acting anesthetic, lidocaine has demonstrated anti-inflammatory properties (51), may improve blood flow (52), and reduce neural dysfunction (53) in injured nerve roots. Corticosteroids are well known for their anti-inflammatory properties (54). Relief of radicular pain may also result from the ability of corticosteroids to stabilize neural membranes, thus suppressing ectopic discharges within the sensitized dorsal root ganglion and injured nerve fibers (55). Additionally, corticosteroids may have a direct anesthetic effect upon small unmyelinated nociceptive C-fibers within irritated neural tissue (56,57). These mechanisms likely explain the temporary relief offered by therapeutic injections with corticosteroid and anesthetic combinations. These therapeutic effects, though, remain short lived in the setting of continued chemical / mechanical insult and chronic nerve injury.

The current study raises questions regarding the role of selective nerve root blocks in patients with whiplash induced root injury. Oftentimes, it remains unclear if the neck and extremity complaints in these individuals are radicular or somatically referred (58,59). Diagnostic selective nerve root injections have demonstrated a low false positive rate in studies of the lumbar spine (24,60), but

their utility in the study of cervical spine pathology, to the authors' knowledge, has not been previously described. Selective diagnostic injections might serve as a valuable tool in both providing a diagnosis and in helping to avoid unnecessary intervention. The complication rate of selective nerve root blocks performed by an experienced clinician has been investigated. In both a retrospective and prospective analyses of over 600 injections, a 0.17% complication rate was observed, without a single major complication (61,62).

There may be a particular role for therapeutic injections in those patients in higher functional categories. In those patients with a *good* and *excellent* result at the time of follow up, a 48.9% improvement in pain rating was observed. Patients with a *good* and *excellent* outcome were likely to be similarly categorized initially, and these individuals demonstrated a significantly greater percentage pain reduction ( $F=.0427$ ). This suggests that therapeutic injections may have improved the quality of life in these higher functioning individuals.

Interestingly, patients' initial VAS score alone was not a significant predictor of outcome. This suggests that it is not the degree of initial pain which predicts outcome, but rather the patients' perception of symptom relief and their response to pain as measured by their functional stratification. Otherwise stated, those individuals whose extreme perception of and reaction to pain led to activity restriction and narcotic use demonstrated the poorest outcomes.

There are several limitations to this study. The study group was small and the design was retrospective. There was no control group to which outcomes might be compared.

Additionally, although follow up data was obtained by an independent investigator, telephonic verbal pain ratings were used to measure pain at the time of follow up. While the use of a telephone interview has been previously supported as a means of determining disability (63), verbal pain scores have not been validated as an outcome tool.

Similarly, the Oswestry scale, typically used for patients with low back pain, was utilized as a measure of disability in our patient population. The Oswestry scale has not been validated as a disability measure in patients with neck and arm pain (64). For this reason, a functional categorization of patients (*excellent, good, fair, poor*) was also established using work status and medication usage alone; no change in patient stratification was observed.

Previous studies have supported the role of therapeutic injections in those patients with cervical radicular pain who have first failed a trial of nonsurgical treatment, including physical therapy and the use of oral anti-inflammatory agents and analgesics (28,65). Such intervention is recommended to either offer a cure or a therapeutic window for further treatment. Considering the poor results obtained in this study, it would seem a more refined diagnostic stratification is required in selecting candidates for injection procedures.

## CONCLUSION

The preliminary data of this study suggests that the use of therapeutic cervical selective nerve root blocks, except perhaps for higher functioning patients, are not effective in the treatment of whiplash induced cervical radicular pain. Prospective clinical trials with a randomly assigned control group are needed to further clarify the role of therapeutic injections in the treatment of this challenging patient population.

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