

## Surgical Cervical Level Selection Guided by Diagnostic Root Block: A Single Arm Pilot Study

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**BACKGROUND:** The optimum surgical outcome for patients with cervical radiculopathy caused by multilevel degenerative disease depends on an accurate preoperative diagnosis to achieve pain relief while limiting higher levels of fusion.

**OBJECTIVE:** Assessment of the clinical result of selective anterior cervical discectomy and fusion (ACDF) guided by selective nerve root block (SNRB) under ultrasound (US) guidance in patients with multilevel cervical disc disease.

**PATIENTS AND METHODS:** This prospective study was carried out on thirty patients who met the study's inclusion criteria and were diagnosed with multilevel cervical disc disease at our university hospital. Following the application of US-guided SNRB as a diagnostic test to identify the afflicted root or roots, they underwent selective ACDF.

**RESULTS:** Twenty cases had surgery for a single level, while the remaining ten cases underwent surgery for two levels, according to the nerve root block results. With one exception, all cases had reduction in the arm pain NRS (numeric rating scale) to 0–2. We discovered that there was an 80% association between the results of the SNRB and the level or levels with the highest degree of magnetic resonance imaging (MRI) degeneration, and a 36% correlation between the level or levels determined by neurological deficits/ dermatome radicular pain distribution.

**CONCLUSION:** The superior predictive value of US-guided SNRB is demonstrated by the excellent surgical outcome of selected ACDF guided by the results of US-guided SNRB.

**KEYWORDS:** Multilevel, Root block, Selective cervical discectomy, US guidance.

### INTRODUCTION

Disc degeneration is a natural aging process. Significant MRI findings occur in up to 60% of the asymptomatic people. So, morphological information is provided by MRI, but the true importance of the clinical results may not always be apparent.<sup>1</sup>

Many authors believed that patients who complained of cervical radiculopathy as a result of degenerative disc disease and who had multilevel pathology on imaging examinations were still linked to somewhat unsatisfactory surgical outcomes. That could be the result of making an incorrect diagnosis or executing surgery on several levels in spite of a single level that only presents symptoms.<sup>2</sup>

Due to the absence of normal biomechanics, individuals who have multilevel surgery may initially have a "good" surgical outcome; nevertheless, they may also be more susceptible to adjacent-segment degeneration and pseudoarthrosis. The incidence of pseudoarthrosis in

multilevel instances rose as more levels were operated on; it ranged from 0-4.3% for one level up to 56% for four level fusions.<sup>3,4</sup>

Because the 1- and 2-level ACDF procedures have such low rates of complications, they rank among the safest in spine surgery. Therefore, there is concern about the increased risk of problems with higher levels of fusion, such as the requirement for higher dosages of opioids to treat chronic axial neck pain, dysphagia, and increased postoperative pain.<sup>5,6</sup>

The optimum surgical outcome for patients with cervical radiculopathy caused by multilevel degenerative disease depends on an accurate preoperative diagnosis, which is typically challenging to determine the affected root or roots based solely on clinical complaints and MRI data.<sup>1,2</sup>

Depending on clinical presentation may be deceiving, as dermatomes may be more overlapped or be larger than the standard anatomical diagrams distribution.<sup>7,8</sup>

Electrophysiologic studies are usually used in questionable cases for diagnosis of radiculopathies;<sup>9</sup> however, a common problem is the discrepancy between abnormal MRI and normal electromyogram (EMG) studies, and vice versa. Concordance between the level

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of abnormality on EMG and MRI was found in 71% of cases in score studies.<sup>10</sup>

Image-guided nerve root block is commonly used in symptomatic cases to confirm the pain generator, decrease the severity of pain and improve surgical results,<sup>11</sup> but, several complications of the fluoroscopic techniques have been reported such as Horner's syndrome, transient quadriplegia, quadriparesis and brainstem ischemia, spinal cord infarction through anterior spinal artery syndrome, and even death from accidental perforation of the vertebral artery. Since none of these consequences have been noted in any of the extensive published research, the incidence of these issues is extremely low. The seriousness of these side effects has raised numerous concerns over the procedure's safety.<sup>12-20</sup> The majority of the uncommon cases that have been recorded seem to have been caused by arterial embolization as a result of an unintentional intra-arterial injection of particulate corticosteroids.<sup>18,19,21,22</sup>

In order to assess the utility of US-guided selective nerve root block (SNRB) for the prognostication of clinical outcomes following selective anterior cervical discectomy and fusion (ACDF) in patients with multilevel cervical disc disease, this study involved 30 patients.

## PATIENTS AND METHODS

Thirty patients who were admitted to our university hospital between December 2017 and December 2021 were the subjects of this prospective, non-randomized study. All patients have signed informed consent for operation and to be involved in this study. We also had approval from the research ethics committee in Tanta and AL-Azhar universities. Approval code 35819/9/22 from the research ethics committee in our Faculty of Medicine.

The study included all patients presented with unilateral brachialgia due to multilevel cervical disc disease, after failure of conservative treatment in the form of medical treatment and physiotherapy. Following the use of US-guided SNRB as a diagnostic technique to identify the impaired root or roots and their impact on surgical outcomes, all patients underwent selective discectomy by conventional ACDF. Patients with bilateral brachialgia, myelopathy, double crush syndrome, ossified posterior longitudinal ligament (OPLL), mixed anterior and posterior pathology necessitating posterior decompression, or medically unfit for surgery were not included in the study.

All patients in this study were subjected to a complete medical history, complete general examination, neurological examination, and arm & neck pain evaluation by NRS. Routine pre-operative laboratory investigations, plain x-ray cervical anteroposterior (A-P), lateral views and MRI cervical spine and US-guided SNRB for the suspected levels in the MRI were performed.

## Ultrasound Guided Selective Nerve Root Block Technique

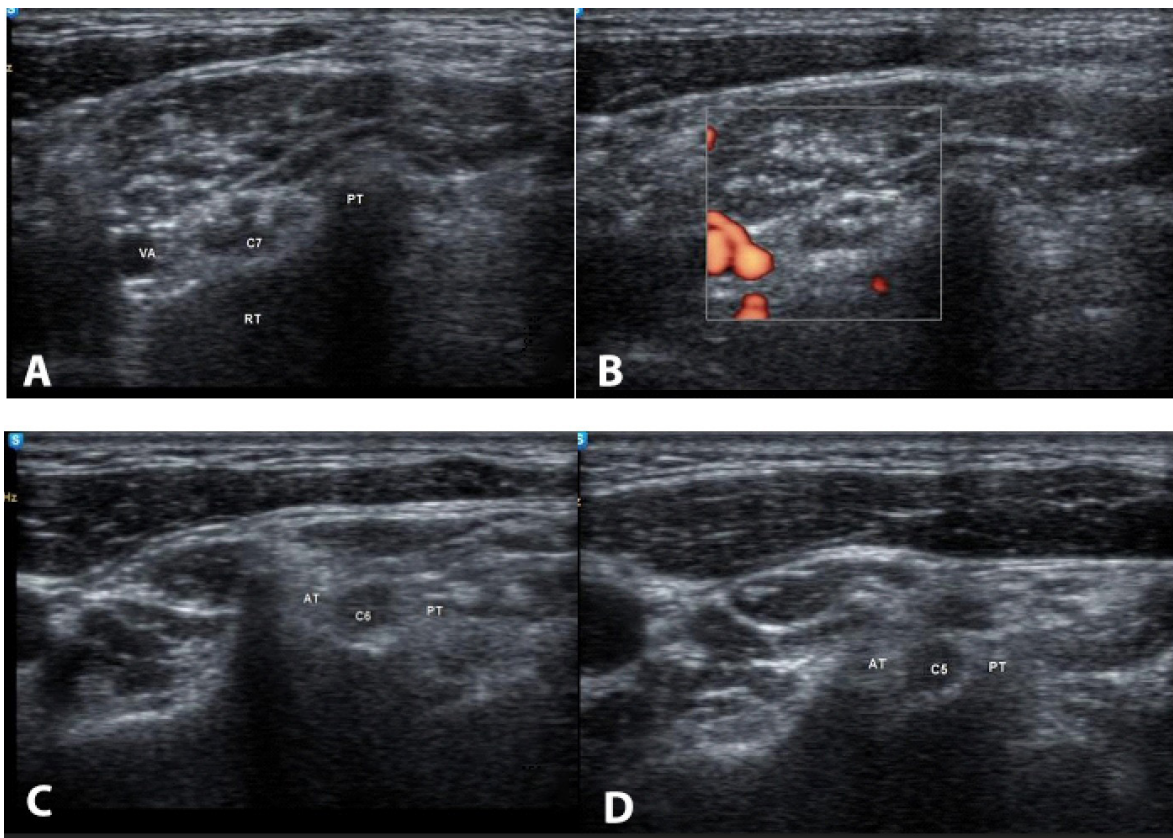
All patients underwent a nerve root block on the same side at all pathological levels on MRI, starting at the inferior level. The first and second blocks had to be separated by at least 4 hours in order to lower the possibility that the effects of the first injection would linger and promote appropriate selection. No analgesics were given within 12 hours before the SNRB. No local anesthetic was used for the skin. In patients with two pathological levels, the two blocks were executed on the same day. For patients with three or four pathological levels, the block was done in the same manner but, on 2 consecutive days.

Patients were put in lateral decubitus Position with the symptomatic side up. A 12-MegaHertz (MH) linear transducer of a US machine was applied to the symptomatic side of the neck in a transverse plane after aseptic skin preparation.

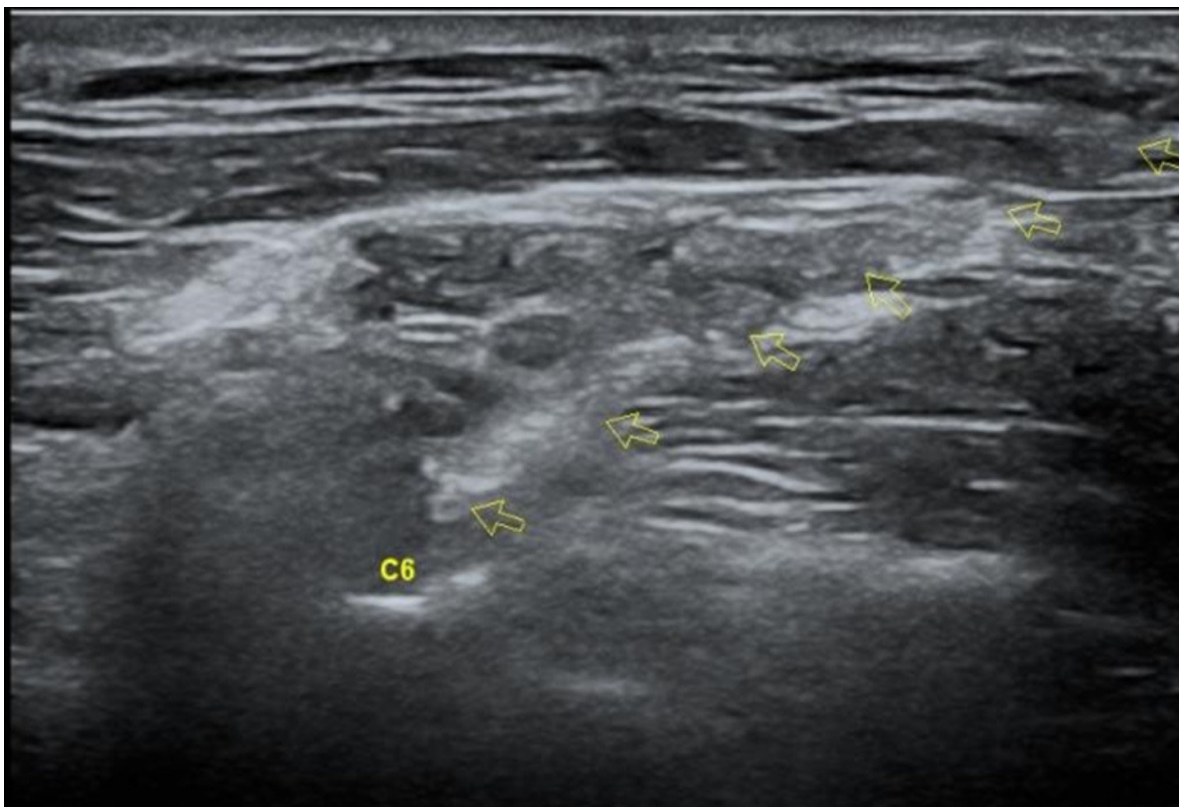
Cervical spinal level was determined by identifying the transverse processes. The cervical 7 (C7) transverse process was identified by rudimentary anterior tubercle, and prominent posterior tubercle (Fig. 1A). The C6 transverse process was characterized by its sharp and larger anterior tubercle (Fig. 1C). The C3- C5 transverse processes were identified by the "two-humped camel" sign formed by anterior and posterior tubercles. The nerve root was visualized as an oval hypoechoic punctate structure between the two tubercles (Fig. 1D). The vertebral artery must be identified where it runs anteriorly to C7 before it enters the foramen transversarium of C6. This could be confirmed using color doppler (Fig. 1B).

We identify the targeted nerve root of each patient by moving the transducer cranially from the C7 level. After the targeted nerve root was identified, a 22-gauge (G) needle was slowly advanced toward the oval hypoechoic target located between the "camel humps." under real-time US guidance (Fig. 2). The needle was inserted just lateral to the transducer and advanced, from posterolateral to anteromedial, with an in-plane approach. Once the needle tip was in an ideal position between the nerve root and the posterior tubercle outside the intervertebral foramen, 1mL lidocaine 1% was slowly injected.

A substantial subjective pain reduction with at least 50% NRS pain decrease in the arm assessed 30 minutes following SNRB was required for a positive block response. Only the positive block levels were subjected to surgery by standard ACDF using a peek cage without a plate. Before surgery, the neurological examination and NRS of arm and neck pain were assessed. Postoperatively, all patients were assessed for the degree of radicular pain relief assessed by NRS. Neurological assessment as regards motor and sensory outcome, postoperative complication, plain x-ray cervical spine A-P and lateral views were recorded. An excellent surgical success was determined by the patient reporting a reduction in subjective arm and neck discomfort, accompanied by a comparable NRS reduction of 50% or more, and/or an NRS score of < 2.<sup>23</sup>



**Fig 1:** Ultrasound showing (A) C7 transverse process with rudimentary anterior tubercle & prominent posterior tubercle and C7 root, vertebral artery before entering C6 foramen transversarium. (B) confirmation of vertebral artery by color doppler. (C) C6 transverse process with sharp prominent anterior tubercle & posterior tubercle and C6 root in-between. (D) C5 transverse process with anterior tubercle & posterior tubercle “two-humped camel” sign and C5 root in-between.



**Fig 2:** C6 root injection showing trajectory & ideal position of needle between oval hypoechoic nerve root & posterior tubercle.

## RESULTS

In our institutes, during the study period, we received 228 patients with cervical disc disease; 184 were surgically treated, 74 of them were single level and 110 were multiple levels. This study was conducted on patients with multilevel cervical disc disease in whom identification of the affected root was difficult as there was no clear correlation between the image finding and clinical manifestations. There were 38 out of 110 multilevel patients (34.54%) who underwent selective nerve root block before surgery to help identifying symptomatic root/s.

Thirty-eight patients underwent US-guided SNRB, eight patients were excluded from our study where one patient did not experience positive block, i.e. arm pain did not decrease > 50%, and he continued on medical treatment and physiotherapy. Another patient had satisfactory pain improvement that made him postpone the decision of surgery. Another six patients had a positive nerve root block for more than 2 levels and were operated on for all pathological levels seen in the preoperative MRI without any selection, so were excluded from our study. It was preferable to send them for the posterior decompression rather than ACDF. The remaining 30 patients (**Table 1**) subjected to our study were 12 women and 18 men with a mean age of 49.6 years (range 34–59 years). Duration of symptoms varied from 3 to 24 months (mean 13.8 months). All patients had arm pain with NRS ranging from 6-8 starting at the shoulder and radiating below the elbow, 90 % of patients had neck pain with NRS ranging from 3-7. Three patients had a preoperative motor deficit with the C5 root in 2 cases & C7 in 1 case. Sixteen patients had two pathological levels, and eleven patients had three pathological levels. Only three patients had four pathological levels.

20 patients had significant arm pain relief after a single root block while, in the other 10 cases 2 roots block was

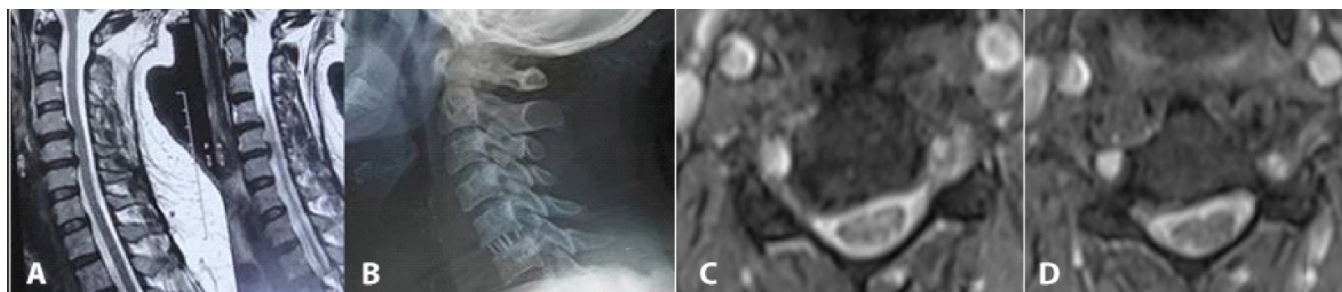
significant in achieving arm pain reduction. Arm pain NRS reduced to (0-2), which was statistically significant [ $P=0.0001$ ] from the NRS before the SNRB. Neck pain NRS was reduced to 1-3 in cases that had pre-treatment neck pain.

The distribution of radicular pain determined by neurological deficits/dermatome was linked with the SNRB results in 11 patients (36%) and the level(s) with the most severe degree of MRI degeneration in 24 patients (80%) (**Table 1**).

Twenty cases (Fig. 3) had surgery for a single level, whereas the remaining ten cases had surgery for two levels, following the nerve root block results. In all cases, arm pain NRS was reduced to 0-2 after surgery (Except in one case where NRS was reduced to 3), which was statistically significant [ $P=0.0001$ ] from the NRS before the SNRB. The neck pain NRS was reduced to 1-3.

We had no mortality or morbidity from US-guided SNRB. However, only one patient suffered from dysphagia and hoarseness of voice after surgery due to right recurrent laryngeal nerve palsy from intraoperative excessive retraction which was managed conservatively.

In our study, comparing the arm pain NRS post block and postsurgical, we found that pain reduction was better in postsurgical than post block in 15 cases and both were equal in 14 cases and only in one case postsurgical pain reduction (NRS reduced to 3) was less than post block pain reduction (NRS reduced to 2). Generally, the NRS for arm pain decreased from 6-8 (mean 7.4) before the intervention to 0-2 (mean 1.3) after SNRB and 0-2 (mean 0.7) after surgery via ACDF. The NRS for neck pain decreased from 3-7 (mean 4.7) for those patients who already had pre-treatment neck pain to 1-3 (mean 2.1) after SNRB and to 1-3 (mean 1.8) after surgery via ACDF.



**Fig 3:** Female patient 40 years old presented with RT brachialgia (NRS 8) and neck pain (NRS 4). (A) MRI preoperative showing C4-5 and C5-6 CDP. Only C6 had positive SNRB. (B) X-ray postoperative after ACDF for C5-6. Brachialgia improved after surgery (NRS 0) and neck pain (NRS 2). (C) Axial cut of C4-C5, (D) Axial cut of C5-C6.

Table 1: Patients clinical data, imaging, significant US-guided SNRB, selected surgical levels

Case Number	Dermatomal Distribution of Pain	Motor Deficit	MRI Pathological Levels	Significant MRI Pathological Levels	Basal Arm Pain NRS	Basal Neck NRS	Significant Root Blocked	Post Block Arm Pain NRS	Post Block Neck Pain NRS	Selected ACDF Levels	Post-Surgical Arm Pain NRS	Post-Surgical Neck Pain NRS	Complications
1	C7	C7	4-5&6-7	C6-7	8	4	C7	2	2	C6-7	1	2	
2	BE	No	3-4&4-5&5-6&6-7		7	6	C6--C7	2	3	C5-6 & C6-7	2	3	RLN palsy
3	C5	No	3-4&4-5&5-6	C4-5	6	7	C5	1	3	C4-5	1	2	
4	BE	No	4-5&5-6		6	5	C6	1	1	C5-6	0	2	
5	C5-C6	No	4-5&5-6	C4-5, C5-6	8	5	C5--C6	2	3	C4-5 & C5-6	0	1	
6	C7	No	3-4&4-5&6-7	C3-4, C6-7	7	6	C4--C7	1	2	C3-4 & C6-7	1	1	
7	BE	No	4-5&5-6	C5-6	8	4	C6	0	2	C5-6	0	2	
8	C5	C5	3-4&4-5&5-6	C5-6	7	7	C5	1	3	C4-5	3	3	
9	BE	No	3-4&5-6&6-7	C6-7	7	5	C7	1	3	C6-7	0	2	
10	BE	No	5-6&6-7	C5-6	8	0	C6	0		C5-6	0		
11	BE	No	4-5&5-6&6-7	C5-6	7	6	C6	2	3	C5-6	1	3	
12	C5-C6	No	4-5&5-6&6-7	C4-5, C5-6	8	5	C5--C6	2	2	C4-5&C5-6	0	2	
13	BE	No	5-6&6-7	C5-6, C6-7	8	0	C6--C7	2		C5-6 & C6-7	0		
14	C6	No	5-6&6-7	C5-6	7	5	C6	1	1	C5-6	1	1	
15	BE	No	4-5&5-6&6-7	C4-5, C5-6	8	6	C5--C6	2	2	C4-5&C5-6	1	2	
16	BE	No	3-4&4-5&5-6&6-7	C5-6, C6-7	8	5	C6--C7	1	2	C5-6 & C6-7	1	3	
17	BE	No	4-5&6-7	C6-7	8	3	C7	1	2	C6-7	1	2	
18	BE	No	3-4&5-6	C5-6	8	5	C6	1	3	C5-6	0	2	
19	C7	No	4-5&6-7		8	4	C7	2	2	C6-7	1	2	
20	BE	No	3-4&4-5&5-6	C5-6	8	5	C6	2	2	C5-6	2	2	
21	BE	No	3-4&4-5&5-6&6-7	C4-5, C6-7	7	6	C5--C6	2	3	C4-5 & C5-6	2	3	
22	BE	No	4-5&5-6		6	5	C6	1	1	C5-6	0	2	
23	BE	No	3-4&4-5&6-7	C4-5, C6-7	7	6	C5--C7	1	2	C4-5 & C6-7	1	1	
24	BE	No	4-5&5-6	C5-6	8	4	C6	0	2	C5-6	0	2	
25	C6	No	5-6&6-7	C5-6	8	0	C6	0		C5-6	0		
26	BE	No	4-5&5-6&6-7		7	6	C6	2	3	C5-6	1	3	
27	C5-C6	C5	4-5&5-6&6-7	C4-5, C5-6	8	5	C5--C6	2	2	C4-5&C5-6	0	2	
28	BE	No	5-6&6-7		7	5	C6	1	1	C5-6	1	1	
29	BE	No	4-5&5-6	C5-6	6	5	C6	1	1	C5-6	0	2	
30	C6	No	3-4&5-6	C5-6	8	5	C6	1	3	C5-6	0	2	

BE: The radicular pain distribution is bizarre and reaching below elbow.

RLN: Recurrent laryngeal nerve.

## DISCUSSION

As levels of fusion in ACDF surgery increase, there is concern about potential increased complications.<sup>5,6</sup> Accurate preoperative diagnosis is essential for a favorable surgical outcome in patients with cervical radiculopathy who have multilevel degenerative disc degeneration, as it is typically challenging to identify the affected root or roots based solely on clinical symptoms and MRI.<sup>1,2</sup>

By reviewing the literature, two studies reported utilizing the same idea of surgical level selection guided by the results of the preoperative SNRB but under fluoroscopy guidance and one study showed superiority of the SNRB over clinical and MRI leveling.<sup>1,2,23</sup> To our knowledge, this is the first study utilizing SNRB under US guidance as a preoperative diagnostic method for the selection of surgical level/ levels in multilevel cervical disc prolapse patients.

In terms of pain alleviation and functional improvement, the US-guided cervical SNRB was just as successful as the fluoroscopy-guided technique. It also avoided the consequences of radiation exposure. Good visibility of tissue, including blood vessels in the foramen and surrounding the nerve root, is made possible by ultrasound guidance. This reduces the chance of intravascular injection while enabling precise needle insertion.<sup>20,24-26</sup>

Twenty consecutive patients with cervical radiculopathy and corresponding single-level MRI pathology were examined in a study by Anderberg et al. Every patient had a clinical examination as well as an NRS evaluation for arm and neck pain. Everybody had transforaminal SNRB guided by fluoroscopy. Subjective substantial pain reduction and at least 50% NRS pain decrease in the arm were required for a positive block. The study group experienced mean reductions in NRS arm pain of 86% and mean reductions in NRS neck pain of 65%. Following an ACDF operation, eighteen patients were found to be free of radicular pain. After the first steroid injection, two patients reported significant pain reduction and expressed no desire for additional injections. They came to the conclusion that there may be a connection between radiological pathology and clinical symptoms and indicators through the block process.<sup>23</sup>

In our study, the degree of neck pain reduction either post-block or post-surgical was less than the degree of arm pain reduction in most of the cases with preoperative neck pain. This may be explained by early evaluation (Before the occurrence of fusion) and residual other-level degenerative changes.

In another study conducted in 2006,<sup>1</sup> the effectiveness of fluoroscopy-guided transforaminal SNRB to correlate clinical complaints with MRI results was evaluated in thirty patients who had two-level MRI degeneration on the same side as the painful cervical radiculopathy. In one level, the block method proved beneficial for eighteen patients. A noteworthy block effect was noted by eleven patients from both levels. Of the thirty patients, one had

no pain relief at all. Of the thirty patients, twenty-two underwent therapeutic transforaminal steroid injections or surgery. The remaining eight patients were treated conservatively with physiotherapy and work adjustments because they were deemed medically unfit for surgery and did not respond well to steroid injections. Out of the twenty-two patients, eighteen had satisfactory or excellent results (82%).

One further study<sup>1</sup> found that there was a 60% link between SNRB findings and the level of MRI degeneration with the highest degree of severity, and a 28% correlation between SNRB results and levels determined by neurological deficits/dermatome radicular pain distribution. This can be explained by the anastomoses that exist between the various components of the brachial plexus and between the intra- and extradural cervical nerve roots. As a result, a clinical examination is not very useful. The SNRB results led the treatment for 22 out of the 30 patients, and 18 of them had good or exceptional results.

The classic clinical presentation may be deceiving as dermatomes may be larger and have more overlap than standard diagrams suggest. Anastomosis between nerve structures at various levels in the nerve tree is demonstrated by cadaveric research. A 30% anatomical integration of C4 into the brachial plexus has also been demonstrated by these researches. This may interpret difficult clinical examination of cases of multilevel cervical disc prolapse in which dermatomal distribution is not accurate.<sup>7,8</sup>

The effectiveness of fluoroscopy-guided transforaminal SNRB to correlate clinical symptoms with MRI results in 101 patients with inconsistencies between radiologic imaging and presenting examination and cervical (18) and lumbar (83) radiculopathy was evaluated in a prior study. The goal is to validate or disprove a degree of suspicion prior to considering surgery. An NRS score of 0–1 and the rapid alleviation of 95% of the subjective limb pain were requirements for a positive block response. At the level operated, 91 patients (90%) had positive SNRB values and 10 patients (10%) had negative results. A residual NRS score of less than two was considered a favorable surgical outcome, and at the 12-month follow-up, (S) he expressed satisfaction or extreme satisfaction with the surgical outcome.<sup>2</sup>

In our study, we performed surgery only at the pathological level/levels with positive SNRB (<50% pain relief with NRS became  $\leq 2$ ). In research by Sasso et al<sup>2</sup>, 91% of patients with a positive fluoroscopy-guided SNRB had good surgical results, but only 60% of patients with a negative SNRB had the same. Of these, 97% of patients with a positive SNRB had good surgical outcomes. According to that study, SNRB guided by fluoroscopy has a much higher predictive value than MRI. Patients with a negative SNRB had a considerably lower chance of having a successful surgical outcome than those with a negative or confusing MRI. Compared to patients undergoing surgery on negative SNRB levels, those with

positive SNRB levels had a 9.1-fold increased chance of better results.<sup>2</sup>

In our study, we did not therapeutic US-guided SNRB as a part of the conservative therapy, however, another study 27 utilized therapeutic US-guided SNRB in 41 patients without any complication and concluded that US-guided SNRB is a part of the conservative therapy for cervical radiculopathy especially after failure of drug treatment or physical therapy and also US-guided SNRB is suitable for patient with much pain who may need to wait for few weeks before having surgery.<sup>27</sup>

## CONCLUSION

Our study showed that ultrasound-guided selective nerve root block for patients suffering from multilevel degenerative cervical disc disease, where clinical examination and MRI can not detect which level should be operated upon is an excellent bedside, safe, non-radiating, reliable test to detect the level at which surgery should be done. This will result in decreasing the need for an increasing number of operated levels that in turn will decrease complications rate specially pseudarthrosis and adjacent segment disease. Our study was limited by the small number of participants, and future studies recruiting larger numbers are recommended.

## List of Abbreviation

ACDF: Anterior cervical discectomy & fusion.

A-P: Anteroposterior.

C: Cervical.

EMG: Electromyogram.

G: Gauge.

MH: Megahertz.

MRI: Magnetic resonance imaging.

NRS: Numerical rating scale.

OPLL: Ossified posterior longitudinal ligament.

RLN: Recurrent laryngeal nerve.

SNRB: Selective nerve root block.

US: Ultrasound.

## Disclosure

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