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Pain Relief After Selective Nerve Root Block as a Predictor of Postoperative Functional Outcome in Patients with Degenerative Lumbar Spinal Stenosis Patients Undergoing Decompressive Surgery

Sangbong Ko, MD,[a] ChungMu Jun, MD,[a] Woo-Kie Min, MD,[b] Eunseok Son, MD,[c] Sukjoong Lee, MD,[c] Gun Woo Lee, MD,[d] and Hyunseung Yoo, MD[e], Daegu Spine Study Group (DGSSG)

Study Design. Retrospective study of data collected prospectively.

Objective. To investigate changes in the degree of lower leg radiating pain (LLRP) after selective nerve root block (SNRB) and to evaluate associations of this change with postoperative improvements in symptom severity, functional outcomes, and quality of life.

Summary of Background Data. SNRB is routinely performed as an initial treatment for lumbar foraminal or lateral recess stenosis with LLRP. The degree of improvement after SNRB has been suggested to predict the improvement in postoperative pain and functional outcomes. However, there have been no studies on the predictive value of this parameter.

Methods. We enrolled 60 patients who underwent SNRB followed by decompressive surgery. They were divided into three groups. The degree of improvement was evaluated as a percentage of the pre-injection values. Functional outcomes of the spine were assessed using the Oswestry Disability Index (ODI) and Roland-Morris Disability Questionnaire (RMDQ). Quality of life was assessed using the 36-item Short Form Survey (SF-36) physical component score (PCS) and mental component score (MCS). The degree of LLRP was measured preoperatively and at 6, 12, and 24 months after surgery. These functional outcomes were evaluated preoperatively and at 12 and 24 months after surgery.

Results. The improvement in LLRP in the short term (6 hours after SNRB) was found to be statistically significantly associated with the improvement in LLRP at 12 months after SNRB ($P = 0.044$, correlation coefficient = 0.261). No relationship between pain improvement after SNRB and functional outcome was identified.

Conclusion. The degree of improvement in symptoms 6 hours after SNRB can predict the degree of improvement in LLRP at 12 months after surgery. However, symptomatic improvement after SNRB does not predict postoperative functional outcome or quality of life.

Key words: nerve block, neuralgia, outcomes.

Level of Evidence: 4

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From the [a]Department of Orthopaedic Surgery, School of Medicine, Daegu Catholic University Hospital, Daegu Catholic University, Daegu, South Korea; [b]Department of Orthopaedic Surgery, School of Medicine, Kyungpook National University Hospital, Kyungpook National University, Daegu, South Korea; [c]Department of Orthopaedic Surgery, Dongsan Medical Center, School of Medicine, Keimyung University, Daegu, South Korea; [d]Department of Orthopaedic Surgery, Yeungnam University Medical Center, College of Medicine, Yeungnam University, Daegu, South Korea; and [e]Department of Orthopaedic Surgery, Daegu Fatima Hospital, Daegu, South Korea.

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Address correspondence and reprint requests to Sangbong Ko, MD, PhD, [42472] 33, Duryugongwon-ro 17-gil, Nam-gu, Daegu, South Korea; E-mail: bong@cu.ac.kr

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Selective nerve root block (SNRB) was introduced by Macnab *et al*[1] in 1971 as a treatment for lower leg radicular pain (LLRP). Since that time, there have been many reports of the diagnostic and therapeutic use of this approach.[2,3] Recently, SNRB has become popular as a minimally invasive treatment option for LLRP. Decompressive surgery offers satisfactory treatment outcomes in cases of severe LLRP caused by radiologically consistent nerveroot

compression; therefore, it is important to recognize pain caused by nerve-root compression and to identify the affected spinal nerve root.[4,5] The use of SNRB to identify the most problematic spinal nerve root has been reported for patients with multilevel lumbar spinal stenosis or for those suffering from LLRP with ambiguous radiographic findings.[6–9] Several reports have indicated the accuracy of SNRB for the prediction of affected nerve roots contributing to LLRP to be approximately 31% to 100%.[8,10–12] In addition, SNRB is among the most effective nonsurgical treatment options for intractable sciatica.[13] As reported by Pfirmmann *et al*,[14] therapeutic SNRB is not a curative therapy; that is, it does not eliminate the pathological factors contributing to LLRP but rather provides temporary relief of peak pain as required for spontaneous resolution.

Unlike lumbar herniated intervertebral discs (HIVD), degenerative lumbar spinal stenosis (DLSS) tends to progress with increasing age; therefore, DLSS is associated with chronic, rather than acute, lesions. Consequently, recurrent symptoms are common after therapeutic SNRB. It has been reported that 43.3% of patients' experience recurrences even after successful initial treatment by SNRB.[15] Surgical treatment is indicated in the case of increased frequency of recurrence, reduced intervals of recurrence, severe intensity of recurrent LLRP, or severe intermittent neurogenic claudication.

In cases of DLSS with LLRP, temporary symptomatic relief following therapeutic SNRB may be predictive of superior postoperative outcomes. Williams et al[8] reported a positive predictive value of 80.4%; however, their study investigated dorsal root ganglion block, and the degree of improvement in LLRP was based on subjective experiences of patients. In cases of only single level lumbar foraminal or lateral recess stenosis with LLRP, the degree of improvement after initial SNRB therapy may predict postoperative improvements in pain and functional outcomes; however, the positive predictive value has not yet been evaluated.

This study aimed to determine changes in the degree of LLRP after SNRB and to evaluate potential associations between postoperative improvements in symptom severity, functional outcome, and quality of life among patients with only single level DLSS undergoing decompressive surgery.

METHODS

Study Design and Patient Selection

This study was approved by the institutional review board (approval number: CR-19-134) of our institution and conducted in accordance with the declaration of Helsinki. We recruited all consecutive patients with no past medical history of spinal surgery or SNRB who underwent SNRB followed by decompressive surgery from March 2013 to February 2015 and complete more than or equal to 2 years of follow-up in the present study. All patients underwent symptomatic evaluation and neurological examination and were asked to complete questionnaires 30 to 60 minutes prior to undergoing SNRB. They all had LLRP (diagnostic criteria: Leeds Assessment of Neuropathic Symptoms and Signs [LANSS] score of >7) due to only single level lateral recess or foraminal stenosis. Preoperative magnetic resonance imaging (MRI) was used to confirm the compressed spinal nerve root in all patients, along with neurological examination and clinical findings, on which therapeutic SNRB was performed. Indications for decompressive surgery were recurrent or worsening LLRP following initial improvement after therapeutic SNRB during a 6-week follow-up period. Exclusion criteria were as follows: LLRP caused by an HIVD, spondylolisthesis, tumor, infection, trauma, and receipt of secondary gain such as work or motor vehicle accident compensation (Table 1). This study utilized prospectively collected data that was reviewed in a retrospective fashion.

Procedures for Conducting SNRB and Decompressive Surgery

All SNRBs were performed in the outpatient setting with no premedication. The patients were placed in the prone position on the operating table, and standardized sterilization procedures were carried out. Oblique plain radiographs were acquired to confirm injection sites. Local anesthesia

TABLE 1. Inclusion and Exclusion Criteria

Inclusion Criteria
1. Symptoms of single-level lateral recess or foraminal stenosis, with neurological and MRI findings matching the symptoms
2. Lesions determined as described above that are consistent with the lesions in which pain is provoked by the pricking of the spinal needle during SNRB
3. Symptomatic relief after early SNRB and recurrence of symptoms to a degree requiring surgical treatments
4. Completion of at least 2 years of follow-up after surgical treatment
5. Severe radiculopathy (LANSS > 7)
6. No signs of motor weakness
Exclusion criteria
1 Lumbar herniated intervertebral discs, spondylolisthesis, tumor, infection, or trauma
2 Secondary gain such as work compensation or traffic accident compensation
3 Inability to communicate properly
4 History of surgery or SNRB

LANSS indicates Leeds Assessment of Neuropathic Symptoms and Signs scale; MRI, magnetic resonance imaging; SNRB, selective nerve root block.

was administered (2% lidocaine injection) followed by injection of medication via a 23-gauge spinal needle under fluoroscopic guidance. Spinal needles were advanced until the patients experienced a twinge in their legs. The patients were asked if the twinges were identical to their original LLRP; if so, contrast medium (Iohexol; Omnipaque GE Healthcare Ireland, Cork, Ireland; 300 mg/mL) was administered to confirm the injection site and location of the affected spinal nerve root. If the confirmed injection site was consistent with the site of symptoms and MRI findings, then medications were injected into the nerve root via the same route. The injected medications were a mixture of 1 mL each of triamcinolone (40 mg/mL; Triam Injection, Dong-Kwang Pharm Co., Seoul, Korea), 0.25% bupivacaine, and normal saline (total injected volume: approximately 3 mL). The maximum volume was 1.5 mL, with a range of 0.5 to 1.5 mL. STI was measured while staying in the recovery room for 6 hours after SNRB, and mid-term improvement (MTI) and LTI were measured using the patient's pain calendar at an outpatient visit 5 days after SNRB.

Surgical decompression (laminotomy, medial facetectomy, and no instrumented fusion) was performed by one spine surgeon. Analgesics were used when necessary, and there were no adjunctive treatments (medical or physiotherapy) either SNRB or postoperatively.

Outcome Measurements

The primary outcome was degree of LLRP, evaluated using a visual analog scale (VAS) where a rating of 0 related to no pain and 10 was the most severe pain that could be imagined. Considering the effect of local analgesics such as lidocaine and bupivacaine, patient ratings after SNRB were classified into three groups: short-term improvement (STI; improvement in VAS score was seen within 6 hours after SNRB), mid-term improvement (MTI; 6–48 hours after SNRB), and long-term improvement (LTI; over 48 hours after SNRB). Since we tried to find out the relationship between the degree of improvement of the LLRP after SNRB, the degree of improvement for each group is expressed as a percentage compared with the pre-injection score instead of pre-injection VAS and post-injection VAS. The degree of LLRP was evaluated preoperatively using the VAS and at 6, 12, and 24 months after surgery.

Functional outcomes of the spine were assessed using the Oswestry Disability Index (ODI) and Roland-Morris Disability Questionnaire (RMDQ), and quality of life was assessed using the 36-item Short Form Survey (SF-36) physical component score (PCS) and mental component score (MCS). These outcomes were assessed preoperatively and at 12 and 24 months after surgery. The improvement in functional outcomes and quality of life were defined as the difference between preoperative and postoperative scores.

Statistical Analyses

One-way analysis of variance, correlation analysis, and repeated-measures single-factor analysis methods were used. Data are presented as mean ± standard deviation. The IBM Statistical Package for the Social Sciences (SPSS) version 19.0 for Windows (SPSS Inc., Chicago, IL) was used for all statistical analyses. A P-value of < 0.05 was considered statistically significant.

RESULTS

Epidemiological Results

A total of 60 patients (20 males and 40 females) with a mean age of 64.44 ± 12.90 years (range, 18–84 yrs) were enrolled in this study. The mean ages for male and female participants were 59.32 ± 15.14 and 66.88 ± 11.08 years, respectively. The affected spinal levels were all L4 to L5. The mean body weight was 64.52 ± 22.16 kg.

Correlation Between Improvement in LLRP After SNRB and Decompressive Surgery

The STI, MTI, and LTI after SNRB and the improvement in LLRP, ODI, RMDQ, and SF-36 PCS are shown in Table 2.

The improvement in LLRP 12 months after surgery was significantly associated with STI after SNRB ($r = 0.261$, $P = 0.044$); however, improvements at 6 and 24 months after surgery were not significantly associated with STI. Improvements in LLRP at all time points after surgery were not associated with MTI or LTI after SNRB (Table 3).

Correlation Between Improvement in LLRP After SNRB and Functional Outcomes of Surgery

Functional outcomes of the spine (ODI and RMDQ) and quality of life (PCS and MCS) after surgery were not associated with STI, MTI, or LTI after SNRB at any time point (Tables 3 and 4).

DISCUSSION

Nerve-root decompression is widely used as a treatment for degenerative DLSS.[16–19] However, persistent pain and disability after surgery have been reported in approximately 25% and 12.5% of patients, respectively.[20] Consequently, problems related to costs of ongoing medical treatment, reduced earning power, and increased requirements for disability payment may occur. Predicting the outcome of nerve root decompression surgery may enable the prevention of some of these problems in patients with short segmental spinal stenosis who are experiencing LLRP. In some cases, compressed nerve roots are not symptomatic, and radiating pain does not always originate from the lumbar region. Thus, there are many reports that suggest that the outcomes of SNRB may predict the presence of symptomatic compressed nerve root.[8,21,22]

In a prospective study including 62 patients who underwent SNRB, Dooley *et al*[23] reported the provocation of pain and response to local analgesic infiltration to be strong positive and negative predictors of postoperative outcomes, respectively. Sasso *et al*[24] reported that 90% of positive SNRBs exhibited good functional outcomes and 60% of negative blocks had good functional outcomes;

TABLE 2. Result of Improvement After Selective Nerve Root Block and Decompressive Surgery

Outcome			Improvement
After SNRB			
STI (within 6 hours)			62.67 ± 33.274%
MTI (6–48 hours)			26.17 ± 29.233%
LTI (after 48 hours)			8.08 ± 18.733%
After decompressive surgery			
Lower leg radicular pain		6 months	4.10 ± 2.735
		12 months	4.73 ± 2.863
		24 months	5.75 ± 2.260
Functional outcome	ODI	12 months	0.92 ± 7.967
		24 months	2.73 ± 10.156
	RMDQ	12 months	1.75 ± 10.426
		24 months	3.75 ± 11.046
Quality of life	SF-36 PCS	12 months	3.99 ± 24.893
		24 months	12.86 ± 27.243
	SF36 MCS	12 months	3.51 ± 25.156
		24 months	11.63 ± 27.229

LTI indicates long-term improvement; MTI, mid-term improvement; ODI, Oswestry Disability Index; RMDQ, Roland-Morris Disability Questionnaire; SF-36 MCS, 36-item Short Form Mental Component Score; SF-36 PCS, 36-item Short Form Physical Component Score; SNRB, selective nerve root block; STI, shortterm improvement.

however, this study only focused on correction of the affected nerve root. There have been no previous studies investigating the correlation between symptomatic improvements after preoperative SNRB and after surgery, and none have been carried out on the correlation between the degree of symptomatic improvement after surgery and pre- and postsurgical functional outcomes and quality of life.

In addition to mechanical compression, recent studies have reported that chemical irritation of the nerve root caused by disc materials triggers radiating pain, both of which play a critical role in the development of pain.[25–27] Thus, injection of corticosteroids into the compressed and inflamed area of the nerve root may be a reasonable treatment option,[14] although repeated use may cause side effects of adrenal suppression.[28]

TABLE 3. Correlation of Improvement After Selective Nerve Root Block and After Surgery

Variable	Lower Leg Radicular Pain *P*-Value			Functional Outcome *P*-Value			
				ODI		RMDQ	
6 months		12 months	24 months	12 months	24 months	12 months	24 months
STI	0.089	0.044 $r = 0.261$	0.088	0.860	0.604	0.945	0.951
MTI	0.227	0.170	0.307	0.745	0.738	0.788	0.540
LTI	0.118	0.189	0.182	0.239	0.409	0.961	0.741

LTI indicates long-term improvement; MTI, mid-term improvement; ODI, Oswestry Disability Index; RMDQ, Roland-Morris Disability Questionnaire; STI, short-term improvement.

Statistical significance was accepted at $P < 0.05$.

TABLE 4. Correlation of Improvement After Selective Nerve Root Block and Quality of Life After Surgery

	SF-36 PCS		SF-36 MCS	
P-Value	12 months	24 months	12 months	24 months
STI	0.945	0.694	0.408	0.811
MTI	0.254	0.240	0.411	0.055
LTI	$P = 0.857$	$P = 0.121$	$P = 0.920$	$P = 0.187$

LTI indicates long-term improvement; MTI, mid-term improvement; SF-36 MCS, 36-item Short Form mental component score; SF-36 PCS, 36-item Short Form physical component score; STI, short-term improvement.

Statistical significance was accepted at $P < 0.05$.

The effects of SNRB could be augmented by other therapies such as medication or physiotherapy. The improvements after SNRB are somewhat controversial. Sasso *et al*[24] reported that immediate improvement of symptoms was achieved after SNRB at a rate of more than 95% among patients with a post-therapeutic VAS rating of 0 to 1. Therapies administered after SNRB have been standardized to overcome the limitations of the technique. In addition, the degree of symptomatic improvement after SNRB differs depending on the time frame investigated. Pfirrmann et al[14] assessed the degree of early (<15 minutes) and late (<2 weeks) symptomatic improvement after SNRB using corticosteroids and ropivacaine (Naropin 0.2%). Considering the half-life of bupivacaine (2.7 hours in adults) and the absorption of corticosteroids (2 days), improvement in the degree of LLRP was classified as STI (within 6 hours after SNRB), MTI (6–48 hours after SNRB), and LTI (over 48 hours after SNRB).

William et al[8] reported positive and negative predictive values of 80.4% and 22.2%, respectively, for selective dorsal root ganglion block, with a sensitivity of 85.4% and specificity of 16.7% compared with postoperative symptom improvement. However, the study was limited by its retrospective design, use of patient-reported outcomes to evaluate the success of surgery, and evaluation of symptomatic improvement immediately after SNRB. Our study categorized the degree of symptom improvement by time periods, evaluated the degree of symptom improvement, and included more objective outcomes.

It has been shown that SNRB is associated with few major reversible complications and does not cause persistent structural damage of the nerve root.[14] McGrath et al[29] reported that SNRB is a safe procedure associated with no major complications, with only 2.4% of the 2964 patients in their study experiencing minor complications. Among the 60 patients included in this study, none reported major or minor complications.

Our study has some limitations which should be acknowledged. First, we only evaluated LLRP caused by foraminal and lateral recess stenosis as a symptom of DLSS; we did not evaluate neurological claudication, which may have a more significant influence on surgical results.[30] Second, as a result of the small sample size, conclusions from this study are provisional; further studies involving larger cohorts are required. Third, we did not analyze radiological parameters of MRI such as lumbar canal diameter, the degree of stenosis, and the type of foraminal stenosis. Fourth, lack of reporting of other nonoperative treatment deployed during the duration of the study and these can influence results greatly. In conclusion, the degree of improvement in LLRP within 6 hours after SNRB can predict the degree of improvement that will be experienced 12 months after surgery for only single level DLSS. However, symptomatic improvement at any time point after SNRB does not predict postoperative functional outcome or quality of life. A major limitation of the present study was the lack of available, reliable, and objective measures of the variables included, which could have influenced the results. However, to the best of our knowledge, this is the first study to investigate the relationship between symptomatic improvement after preoperative SNRB and postoperative outcome.

➢ Key Points

- ❑ Many spine surgeons use the degree of improvement after selective nerve root block to predict the outcome after decompression surgery.
- ❑ The degree of improvement in symptoms 6 hours after selective nerve root block can predict the degree of improvement in lower leg radiating pain at 12 months after surgery.
- ❑ Symptomatic improvement after selective nerve root block does not predict postoperative functional outcome or quality of life.

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