The Effect of Gray Ramus Communicans Nerve Block on Radicular Pain in Patients With Lumbosacral Radicular Pain Who Underwent Transforaminal Epidural Block

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Abstract- Lumbosacral radicular pain (LRP) is usually caused by herniation of intervertebral discs and is characterized by pain arising in the back and radiating to the lower extremities. The current study evaluated the efficacy of gray ramus communicans nerve block (GRCNB) in decreasing LRP in patients with intervertebral disc herniation who underwent transforaminal epidural block. Thirty patients with magnetic resonance imaging indicating a disc herniation on the L4-L5 level participated in this study. All patients were randomly divided into two groups: one whose members underwent GRCNB (n=15) after transforaminal epidural block, and a second group (n=15) whose members underwent only transforaminal epidural block on L4-L5 on the affected side. Follow-up after the procedure ran for a period ranging from 6 to 10 months (mean=8.2±2.1 months) for radicular pain score and the need for analgesics. The mean age of the patients was 54.8±18.4 years (range: 30-65 years). LRP duration in all patients before the procedure was 6-24 months (mean: 12±10.9 months), and there was no significant difference between the two groups. A greater reduction in the numerical rating scale (NRS) one week, 1, and 6 months after the procedure was observed in the group with GRCNB compared to the other group. The reduction in need for analgesics one week, 1, and 6 months after the procedure was statistically significant in the group with GRCNB compared to the group without GRCNB. No major complications were observed in any of the patients in either group. GRCNB is effective in reducing radicular pain and the need for analgesics in patients with lumbosacral radicular pain.

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Keywords: Lumbosacral radicular pain; Transforaminal epidural block; Gray ramus communicans nerve block

Introduction

Low back pain is highly prevalent, and a lot of money is spent annually on this issue worldwide. Most patients with low back pain report a reduction in their daily activities and their ability to work (1). About 14% of sufferers need surgery due to severe pain, especially when it is accompanied by neurological symptoms (2). Surgical treatment, however, is relatively expensive and sometimes associated with mortality and morbidity. Moreover, the patient's symptoms may return after a short time, so the long-term results are unclear (3). Approximately 40% of patients with low back pain complain of radicular pain in their lower extremities. Radicular pain is usually caused by chemical and mechanical stimuli following herniation of intervertebral discs containing nucleus pulposus, but the pathological mechanism is still unclear (4,5). Lumbosacral radicular pain (LRP) is characterized as pain arising in the back and radiating to the lower extremities, and often extending along the path of one or more spinal nerve dermatomes (6). Epidural steroid injection (ESI) often ameliorates

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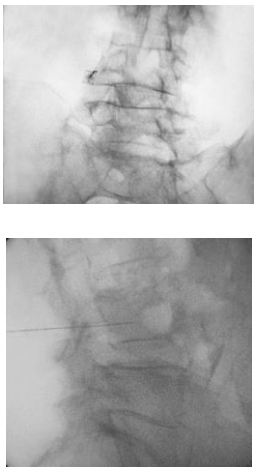
LRP and may eliminate the need for surgery intervention, but the evidence for this is speculative. Unlike the variety of other epidural delivery routes, transforaminal epidural injection results in the steroid reaching the points that are involved due to irritation and inflammation caused by herniated intervertebral disc, such as the exiting spinal nerves root, dorsal root ganglion, and anterior epidural space (7). Therefore, ESI by the fluoroscopically guided transforaminal route is the best option for ensuring the steroid reaches the site of the nerve pathology and is more effective than other routes (7). Two types of neuropathic pain such as LRP have been identified, i.e. sympathetically maintained pain and sympathetically independent pain. The former can be decreased by sympathetic nerve block or sympathectomy procedures (8). The role of the sympathetic system in the occurrence of radicular pain is known (9). It has been shown in neuropathic pain models that with ligation of the sciatic nerve, the sympathetic nerve fibers sprout to dorsal root ganglion somata and form a diametrically large basket-like structure around the axotomized sensory neurons (9). Previous studies have also reported clinical sympathetic system block as effective in reducing radicular pain (10). Ramus communicans nerves, which are closely related to the sympathetic system, provide the greatest source of disc and vertebra innervation, and the blocking of these branches is used in treating painful osteoporotic vertebral compression fracture (11). Because ramus communicans nerves play an important role in the sympathetic innervation of the lumbar discs and spine, we hypothesized that we can further reduce patients' radicular pain with gray ramus communicans nerve block (GRCNB) accompanied by transforaminal epidural block. We designed this study to evaluate the efficacy of GRCNB in reducing radicular pain in subjects with intervertebral disc herniation who underwent transforaminal epidural block.

Materials and Methods

This prospective study evaluated the effects of GRCNB on radicular pain in patients with LRP who underwent transforaminal epidural block. After the institutional ethics committee of the pain research center, Tehran University of Medical Sciences approved the study, details of it were explained to all participating subjects and informed written consent was obtained from them. We confirm that all experiments were performed in accordance with relevant guidelines and regulations (12). Thirty patients aged 30 to 65 years with broad-base and paracentral disc herniation and magnetic resonance imaging indicating a disc herniation on the L4-L5 level were included in this study. Patients were randomly divided into two groups: the group with GRCNB (n=15) who underwent GRCNB after transforaminal epidural block on L4-L5 level on the affected side, and the group without GRCNB (n=15) who underwent only transforaminal epidural block on the L4-L5 level on the affected side. Patients with extruded and migrated disc, sequestrated disc, spondylosis, spondylolisthesis, coagulopathy, post-laminectomy syndrome, facet dysfunction, sacroiliac dysfunction, peripheral neuropathy, nerve entrapment syndrome, regional myofascial pain, fibromyalgia, psychological disturbance, and the inability to provide consent were excluded from the study. Transforaminal epidural block and GRCNB were performed on the side where the herniated disc had a compressive effect on the nerve roots. Patients were brought into the procedure room and placed in a prone position on the table. A pillow was placed under the abdomen to flatten the lumbar lordosis. The operation site was prepared with betadine solution and draping was done with sterile sheets. All procedures were done under standard basic monitoring. First, all patients underwent transforaminal epidural block on the L4-L5 level of the affected side by fluoroscopic guidance with a sub-pedicular approach. After confirming the correct location of the needle by contrast injection in posteroanterior and lateral views, 2 ml of solution of lidocaine 1% and dexamethasone 4 mg was injected. Then, in the group with GRCNB, the C-arm was placed in a posteroanterior position, and the midpoint of the intervertebral space at the L4 level was identified. The lower endplate of the L4 vertebral body was aligned by moving the C-arm in a cephalocaudal direction. The C-arm was turned obliquely towards the ipsilateral side approximately 30°. Then the transverse process and neural foramen were identified as anatomical landmarks at the targeted site. The entry point was just below the transverse process, approximately 6-7 cm from the midline. The entry point was infiltrated with 1% lidocaine and the 20 G, 15 cm needle was advanced using tunnel vision toward the lateral edge of the L4 vertebral body until bony contact was made. The C-arm was then turned laterally to confirm that the tip of the needle was in the middle portion of the L4 vertebral body and had bony contact (Figure 1,2). Next, 1 ml of contrast material was injected and expected to spread behind the facet line, parallel to the needle. Then, a combination of 2 ml lidocaine 1% and 4 mg dexamethasone was injected into the affected side of the gray ramus communicants. After the procedure was completed, the patient was sent to

recovery and monitored for up to 2 hours for any events or delayed complications. The therapeutic effects of treatment were evaluated by following up with the patients after the procedure for a period ranging from 6 to 10 months (with a mean=8.2±2.1 months) for changes in radicular pain score and the need for analgesics administration. We evaluated the radicular pain degree using the numerical rating scale (NRS) in all patients. Patients were asked to assess the severity of pain they experienced upon walking, sitting, and standing on a scale of 0 to 10, with 0 being no pain and 10 being the worst pain imaginable. A Chi-square test was used to compare the discrete variables, and Student's t-test was also applied for continuous variables. NRS between the two groups was compared by the Mann-Whitney U test. The statistical significance level was considered at $P<0.05$.



Figures 1,2. Rami communicans block via c-arm (AP/lateral view)

Results

The data of 30 patients (15 cases in each group) with intervertebral disc herniation on the L4-L5 level and unilateral LRP was analyzed. No patients were excluded from the study due to failure of telephone follow-up or refusal to complete the questionnaire. The mean age of the patients was 54.8±18.4 years (range: 30-65 years). The duration of LRP in all patients before the procedure was 6-24 months (mean: 12±10.9 months), and there was no significant difference between the two groups. The demographic characteristics of both groups were evaluated and compared (Table 1), and the two groups were comparable in terms of these variables. The procedure characteristics and adverse events of both groups are shown in Table 2. The procedure duration in the group with GRCNB was 36.8±10.2 minutes and in another group was 20.5±8.2 minutes ($P=0.01$). Evaluation of radicular pain severity between the two groups revealed a greater reduction in NRS one week ($P=0.01$), one month ($P=0.02$), and 6 months ($P=0.02$) after the procedure in the group with GRCNB compared to the group without GRCNB, and the difference was clinically and statistically significant. The need for analgesics one week ($P=0.02$), one month ($P=0.03$), and 6 months ($P=0.03$) after the procedure was also statistically significantly lower in the group with GRCNB compared to the group without GRCNB (Table 3). No major complications such as aspiration positive for blood, vascular uptake noted on imaging, paresthesia during the procedure, hypotension, segmental nerve injury, or inadvertent puncture of the paravertebral artery were observed in any of the patients in either group.

Table 1. Baseline demographics and pain-related comorbidities and analgesic use of both groups

Variables	Group with GRCNB	Group without GRCNB	*P*
No. subjects	15	15	
Age, years	55.2±16.4	54.2±20.8	0.2
Gender, M/F	9/6	10/5	0.7
Symptom duration (months)	12.8±11.2	12.4±8.9	0.2
Foraminal stenosis	12	10	0.1
Spinal canal stenosis	11	12	0.1
Analgesic administration	15	14	0.9
NRS for radicular pain (mean±SD)	8.2±1.8	8.0±1.9	0.1

Table 2. Procedure characteristics and adverse events of both groups

Variables	Group with GRCNB	Group without GRCNB	*P*
Side level injected, right/left	9/6	7/8	0.1
Procedure duration (min)	36.8±10.2	20.5±8.2	0.01
Aspiration positive for blood	1	1	0.8
Vascular uptake noted on imaging	1	0	0.7
Paresthesia during procedure	0	0	NS
Hypotension	0	0	NS
Segmental nerve injury	0	0	NS
Inadvertent puncture of the paravertebral artery	0	0	NS

Table 3. Post-procedure characteristics of both groups

Variables	Group with GRCNB	Group without GRCNB	*P*
NRS one week after the procedure	2.4±1.2	3.2±1.4	0.01
Need to analgesics one week after the procedure	2	4	0.02
NRS one month after the procedure	2.5±1.0	3.4±1.2	0.02
Need to analgesics one month after the procedure	2	5	0.03
NRS 6 months after the procedure	2.8±1.8	3.5±1.6	0.02
Need to analgesics 6 months after the procedure	3	6	0.03

Discussion

This study evaluated the effect of GRCNB on radicular pain in patients with LRP who underwent transforaminal epidural block. The results showed that GRCNB significantly reduced LRP in patients receiving GRCNB compared with cases who underwent transforaminal epidural block alone. The results support our primary hypothesis that the sympathetic system is involved in the pathogenesis of radicular pain, and by blocking this system through GRCNB, we can help reduce radicular pain in LRP patients. To the best of our knowledge, this is the first clinical study to evaluate the effect of GRCNB on radicular pain in patients with a history of LRP. The sympathetic system has been shown to play an important role in the production of pain (13,14), and growing evidence indicates its important role in low back pain (15). The effectiveness of sympathetic block on chronic pain control is clinically known not only for causalgia, but also for LRP (9). Previous immunohistochemical and neuroanatomical studies have shown the presence of sympathetic neurons in the disc and nervous tissue around the spine (9). One previous study shone new light on this subject (16). It concluded that the anterior and lateral part of the disc are innervated through the sympathetic nervous system. These parts are innervated both by the sympathetic trunk and by rami communicant networks. Therefore, nervous signals of pain from the anterior and lateral part of disc are conducted through the sympathetic nervous system. Subsequent studies have supported this research on innervation of the anterior and lateral aspect of disc and adjacent tissue (17,18). Moreover, the posterior annulus of intervertebral disc has been shown to be innervated by recurrent meningeal nerves or sinuvertebral nerves (19). Previous anatomical and histological studies have shown that these nerve branches may originate either from gray rami communicants, ventral or dorsal rami, or from spinal nerve roots (20). However, other previous studies have shown that sinuvertebral nerves ascend only via sympathetic trunk through gray rami communicants, and they have no connection with segmental spinal nerves (21). These results are supported by another study which concluded that sinuvertebral branches run via gray rami communicants and do not join segmental spinal nerves at the same segment (12). It has been shown that rami communicant block is an effective treatment in reducing discogenic back pain. Blocking and radio frequency lesioning of the L2 ramus communicans has also been shown to be effective in reducing discogenic pain (22). Further randomized have supported these results and reported that rami communicant block and denervation could reduce discogenic pain when other options have failed (23). Vertebral bodies have innervation similar to discs, and rami communicans fiber block has shown good results in vertebral body compression fractures (24). A

neuroanatomical experimental study in a rat model suggested the role of the sympathetic afferent pathway in low back pain and identified low back pain as a type of visceral pain (9). Moreover, a neurophysiological study reported that sympathetic afferents from the lower lumbar disc have pathways to the DRG of L2 (25). Clinical research in patients with lower lumbar discogenic pain have determined that the injection of local anesthetic and steroid into the L2 nerve roots reduced low back pain (26,27). Due to the effectiveness of rami communicans block in reducing discogenic pain and vertebral body compression fracture pain, we hypothesized that the sympathetic nervous block by blocking rami communicans fibers can be effective in reducing lumbosacral radicular pain. Our hypothesis was based on basic studies in experimental models which reported that after ligation of the rat sciatic nerve, sympathetic nerve fibers sprouted and increased in the corresponding dorsal root ganglions (9). Moreover, concentrations of alpha-adrenergic receptors in sensory nerves have been shown to increase after nerve injury (28). Elevated norepinephrine levels in peripheral sensory nerves have also been shown to increase central sensitization to pain in animal models (29). In this regard an experimental study revealed that the sympathetic nervous system is closely associated with lumbar radicular pain and blocking the sympathetic nervous system led to radicular pain relief (30). In patients with LRP from disc herniation and spinal canal stenosis who experienced no relief from pain after epidural steroid injections, sympathetic nerve block reduced radicular pain one month after block (9,31). Previous studies have further concluded that sympathetic nerve block is also effective in reducing radicular leg pain in patients with LRP due to spinal canal stenosis (9,32-34). Research has shown the effectiveness of sympathetic nerve block in reducing radicular pain in patients with disc protrusion and spinal canal stenosis. The current study was performed based on evidence from relevant studies indicating that the sympathetic nervous system is involved in the pathogenesis of radicular pain. Because gray ramus communicant fibers play an important role in the sympathetic system innervation of the discs and tissues around the spinal cord and to our knowledge no study has been done on the role of GRCNB in reducing radicular pain, the current study was designed. The results showed that GRCNB accompanied by transforaminal epidural block in patients with lumbar disc herniation and spinal canal stenosis can reduce radicular pain and the need for analgesics within a few months compared to patients who underwent transforaminal epidural block alone. In conclusion, GRCNB is an effective strategy for reducing radicular pain and the need for analgesics administration in patients with LRP, and we recommend this procedure along with transforaminal epidural block for these patients.

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