Journal of Pain Research

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

The Short-Term Outcome of Transforaminal Epidural Steroid Injection in Patients with Radicular Pain Due to Foraminal Stenosis from Lumbar Isthmic Spondylolisthesis

Gyu-Sik Choi[1], Mathieu Boudier-Revéret[2], Min Cheol Chang[3]

[1]Cheokbareun Rehabilitation Clinic, Pohang-si, Gyeonsangbuk-do, South Korea; [2]Department of Physical Medicine and Rehabilitation, Centre Hospitalier de l'Université de Montréal, Montréal, QC, Canada; [3]Department of Rehabilitation Medicine, College of Medicine, Yeungnam University, Daegu, Republic of Korea

Correspondence: Min Cheol Chang, Department of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, 317-1, Daemyungdong, Namku, Daegu, 705-717, Republic of Korea, Tel +82-53-620-4862, Email wheel633@gmail.com

Purpose: In this study, we evaluated the therapeutic outcomes of transforaminal epidural steroid injection (TFESI) in managing chronic radicular pain due to foraminal stenosis. Furthermore, we evaluated its effectiveness according to isthmic spondylolisthesis (IS) severity.

Patients and Methods: We included 40 patients with radicular pain due to IS-derived foraminal stenosis in our study and treated them with TFESI. Two patients were lost during follow-up. Based on the lateral lumbar radiograph findings, we allocated the recruited patients with < 25% slippage by IS to Group 1 (n = 23) and those having 25–50% slippage to Group 2 (n = 15). The degree of pain was measured using a numeric rating scale (NRS) at pre-treatment and 1 and 2 months after TFESI.

Results: In 38 patients who completed the study, the NRS at pre-treatment was significantly reduced at the 1- and 2-month follow-ups. In the Group analysis, the NRS scores were significantly reduced after TFESI in both Groups 1 and 2, regardless of IS severity. However, the reduction in NRS scores 1 month after TFESI was significantly greater in Group 1 than in Group 2. Moreover, the rate of successful treatment outcomes was significantly higher (65.2%) in Group 1 than in Group 2 (26.7%).

Conclusion: After TFESI, chronic radicular pain was significantly reduced regardless of IS severity, and its effect persisted for at least 2 months. However, its effect was superior when the vertebra slippage by IS was less than 25% compared to patients with 25%–50%.

Keywords: isthmic spondylolisthesis, foraminal spinal stenosis, lumbar spinal transforaminal epidural steroid injection, magnetic resonance imaging, corticosteroids

Introduction

Isthmic spondylolisthesis (IS) is a spinal condition in which the vertebral body slips forward over the vertebra below.[1] It is caused by a defect or fracture of the pars interarticularis connecting the upper and lower facet joints.[2,3] Defects in the pars interarticularis can result from genetic failure of bone formation in the spinal vertebrae.[2,3] Furthermore, the pars interarticularis fracture is induced by spinal stress from repetitive motions of spinal vertebrae, such as repetitive flexion/extension, axial loading, and rotational loading.[2,3] Notably, IS is a common spinal condition with an incidence of between 4% and 8% in the general population.[3]

Further, IS accelerates the degeneration of the intervertebral disc, which results in a diminished height of the neural foramen and increased stress on the facet joints posteriorly.[3] Consequently, increased stress can result in hypertrophy of the facet joint and ligamentum flavum.[3] These changes can lead to lower back pain and radicular pain. Importantly, the lowered height of the neural foramen typically causes foraminal stenosis.[4] Moreover, the nerve root within the narrowed

Received: 21 September 2023
Accepted: 30 January 2024
Published: 3 February 2024

spinal foramen can be mechanically compressed and irritated by inflammation,[4] and, in IS, the L5 nerve root in the L5-S1 foramen is the most commonly affected.[3]

For the management of radicular pain from foraminal stenosis, various conservative treatments such as physiotherapy, oral medication, exercise, and other procedures can be applied.[4–6] Transforaminal epidural steroid injection (TFESI) is one of the most effective conservative treatments for managing radicular pain caused by foraminal stenosis.[4] Corticosteroids inhibit the synthesis of various pro-inflammatory mediators;[7] thus, TFESI can reduce inflammatory pain, and the reduced inflammation on and around the nerve roots can partially relieve mechanical compression of the narrowed foramen.[4] Previous studies have demonstrated the positive therapeutic effects of TFESI in reducing radicular pain due to foraminal stenosis.[8–10] However, little is known regarding the therapeutic outcomes of TFESI for foraminal stenosis caused by IS.

In the current study, we evaluated the therapeutic outcomes of TFESI in patients with chronic radicular pain due to foraminal stenosis in IS. Furthermore, we evaluated outcomes according to the severity of IS.

Materials and Methods

Patients

From March 2019 to February 2023, we prospectively evaluated 40 consecutive patients who had radicular pain due to foraminal stenosis from IS according to the following inclusion criteria: (1) aged 20–79 years; (2) presence of IS on the lateral lumbar spine radiograph; (3) presentation with ≥3-month history of symptomatic lumbar radicular pain of at least 3 on the numeric rating scale (NRS, 0 = no pain, 10 = the worst pain), despite oral medications (meloxicam and tramadol/acetaminophen); (4) MRI findings of foraminal stenosis in an IS level compatible with pain symptoms; (5) ≥80% temporary pain relief following a diagnostic radicular nerve block with 1 mL of 2% lidocaine. The exclusion criteria were as follows: (1) presence of other pathologies that can cause lumbar radicular pain, such as lateral recess or central stenosis and herniation of the lumbar disc, (2) bilateral symptoms or involvement of more than one segment, (3) myelopathy, (4) infection of the spine, (5) previous history of spinal surgery, such as lumbar fusion or laminectomy, and (6) coagulation disorders. When patients were using oral anticoagulants, the medications were discontinued 4–5 days prior to TFESI. The Institutional Review Board of Yeungnam University Hospital approved the study, and written informed consent to participate in the study was obtained from all included patients. This study adhered to the Declaration of Helsinki.

Severity of Isthmic Spondylolisthesis

The included patients were classified according to IS severity on lateral lumbar spine radiographs. IS severity was determined by the slippage of the involved lumbar spine (Figure 1).[11] Grades I, II, III, and IV were < 25%, 25%–50%, 50%–75%, and 75%–100%, respectively. Of the 40 patients, 24 and 16 were classified as grade I and II, respectively. No patients had grade III or IV IS. Patients with grades I and II were allocated to Groups 1 and 2, respectively.

TFESI Procedures

The injections were administered by a single specialized interventional physiatrist who focused on spinal injections. A strict aseptic technique was applied during the TFESI procedures. Patients were placed in the prone position, and C-arm fluoroscopy (Siemens, Erlangen, Germany) was used for level identification and needle guidance. Lidocaine 1% was administered at the needle insertion site. A 25-gauge, 90-mm spinal needle with a bent tip was positioned between the lateral vertebral body and the 6 o'clock position below the pedicle, as visualized through lateral fluoroscopic imaging. The needle tip was observed between the spinal laminar and posterior vertebral bodies. Additionally, under anteroposterior (AP) fluoroscopy, 0.3 mL of non-ionic contrast material was injected to confirm the absence of vascular uptake and ensure that the contrast did not spread into the foramen. Following confirmation, 20 mg (40 mg/mL) of triamcinolone with bupivacaine hydrochloride (0.5 mL) was administered. Physical or manual therapy was not administered after TFESI to any of the enrolled patients.

Outcome Measures

A single investigator conducted the assessments during the pre-treatment and follow-up periods. The investigator was blinded to the group allocation of the patients and was not involved in any treatment. Pain intensity was evaluated using the NRS. NRS

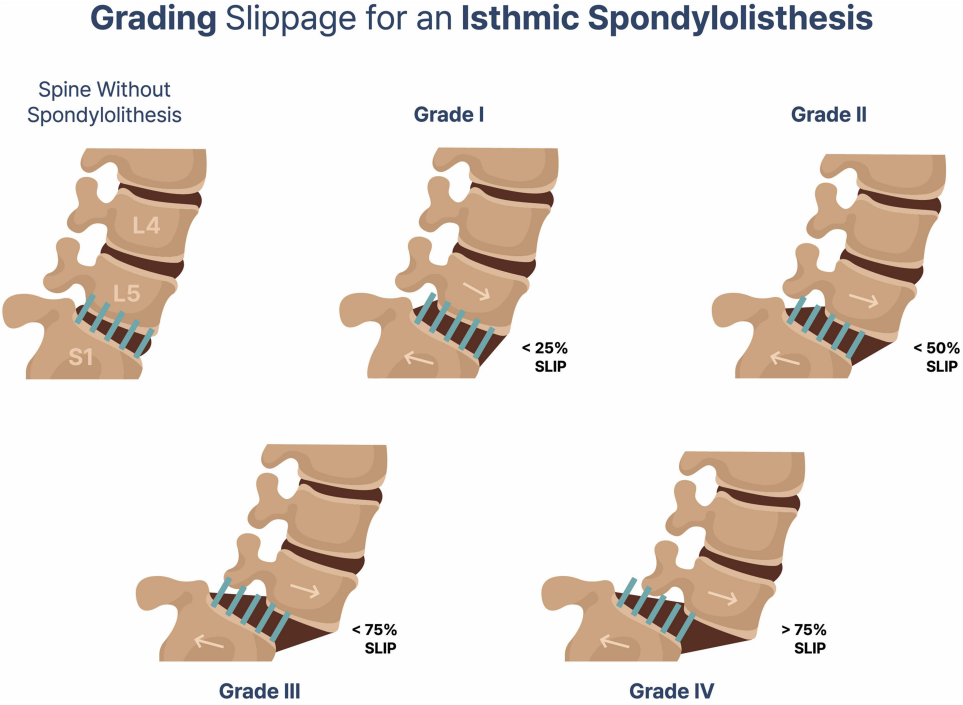

Figure 1 The grading of isthmic spondylolisthesis based on the degree of slippage of one vertebral body on the adjacent vertebral body (Grade I <25%; Grade II: 25–50%; Grade III: 50–75%; Grade IV: 75–100%).

scores were recorded before TFESI and at one and two months after TFESI. Successful treatment was defined as a reduction of ≥50% in the NRS score at the 2-month follow-up compared to the pre-treatment NRS score. To validate the change in pain reduction, the change in NRS scores was calculated by comparing the pre-treatment NRS scores with the scores at the 2-month follow-up (change in NRS [%] = (pre-treatment score - score at two months after treatment) / pre-treatment score × 100).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, v. 22.0, IBM Corporation, Armonk, NY, USA). Demographic data and successful treatment rates were compared between the two Groups using the Mann–Whitney U and chi-square tests. The changes in NRS scores in all included patients, regardless of Group allocation, and the patients in Groups 1 and 2 were evaluated using repeated measures of one-factor analysis. Repeated-measures two-factor analysis was used to compare changes between the Groups over time. Multiple comparisons were obtained following contrast using the Bonferroni correction. The level of statistical significance was set at $p < 0.05$.

Results

One patient in Group 1 and one patient in Group 2 were lost to follow-up, resulting in 23 patients in Group 1 and 15 patients in Group 2 who completed the study. No adverse events were observed in either group. There were no significant intergroup differences in demographic data ($p > 0.05$) (Table 1).

In all included patients, the mean NRS score decreased after treatment. The NRS at pre-treatment was 4.9 ± 1.2. At one month, the mean NRS was 2.5 ± 1.7; at two months, the NRS was 2.7 ± 1.7 (Figure 2A). Notably, the NRS scores differed significantly over time ($p < 0.001$) (Figure 2A). Moreover, the scores at one and two months after TFESI were significantly lower than the pretreatment scores (one month: $p < 0.001$, two months: $p < 0.001$). At the two-month follow-up, 19 out of 38 patients (50.0%) achieved successful treatment outcomes with pain relief of ≥ 50%.

In the group analysis, Group 1 showed a decrease in mean NRS after treatment. The pretreatment NRS was 4.8 ± 1.1. At one month, the mean NRS was 2.0 ± 1.6, and at two months, it was 2.2 ± 1.7 (Figure 2B). In Group 2, the mean NRS decreased from 5.1 ± 1.3 before treatment to 3.2 ± 1.5 at one month, and 3.5 ± 1.5 at two months.

Table 1 Demographic Characteristics of Patients in Group 1 and Group 2

	Group 1	Group 2	P-value
Number (n)	23	15	
Age (yrs)	62.7 ± 12.9	59.9 ± 14.7	0.595
Male: Female	14:9	5:10	0.097
NRS (pre-treatment)	4.8 ± 1.1	5.1 ± 1.3	0.791
Pain duration (months)	28.1 ± 32.7	22.0 ± 30.1	0.344
Site of Pain (right/left)	13:10	6:9	0.319
Nerve root Injection level (L4/L5)	3:20	1:14	0.531

Abbreviation: NRS, numeric rating scale.

The NRS scores for each group differed significantly over time ($P < 0.001$) (Figure 2B). In both groups, scores at one and two months after TFESI were significantly decreased compared to the pretreatment scores (Group 1 - one month: $p < 0.001$, two months: $p < 0.001$; Group 2 - one month: $p < 0.001$, two months: $p = 0.002$). Reductions in NRS scores over time were significantly larger in Group 1 than in Group 2 ($p = 0.039$) (Figure 2B). In addition, the scores from pretreatment to one month after TFESI were significantly lower in Group 1 than in Group 2 ($p = 0.049$). However, two months after TFESI, no significant intragroup differences in the reduction of NRS scores were observed ($p = 0.076$).

Two months after TFESI, 15 patients (65.2%) in Group 1 and 4 patients (26.7%) in Group 2 reported successful treatment outcomes (pain relief of ≥ 50%). The rate of successful treatment two months after TFESI was significantly higher in Group 1 than in Group 2 ($p = 0.020$).

Discussion

TFESI is primarily aimed at achieving efficacy by utilizing steroid injections to decrease the production and release of inflammation-related substances.[4,12] Compression of the nerve root triggers the release of various cytokines and inflammation-mediated cells, thereby contributing to radicular pain following LFSS.[13] Furthermore, steroids possess anti-inflammatory properties that help reduce inflammation-related substances, inhibiting processes that lead to radicular pain,[14,15] and a reduction in inflammation can alleviate edema in the nerve root or surrounding tissues caused by inflammation. By reducing edema, space is formed between the bony exit and the nerve root, decreasing nerve root compression, venous engorgement, and arterial insufficiency.[4,12] In addition to their anti-inflammatory effects, corticosteroids can inhibit neural transmission within nociceptive C-fibers.[16,17] These actions of corticosteroids contributed to pain reduction in our patients after TFESI.

Regarding the different effects of TFESI according to IS severity, more severe IS induces a higher degree of intervertebral disc degeneration, which diminishes the height of the neural foramen.[18] Moreover, it induces severe hypertrophy of the facet joints and ligaments within or near the spinal foramen.[19] Notably, these anatomical changes can narrow the area of the spinal foramen to a high degree.[18,19] Repeated mechanical stimulation and inflammation could continuously irritate the nerve root within a severely narrowed spinal foramen. The NRS scores significantly decreased after TFESI regardless of IS severity. However, the NRS score reduction one month after TFESI was more significant when the slippage of the involved spine was below 25% compared to that in patients with 25–50% slippage. In addition, the successful treatment rate after TFESI was 65.2% and 26.7% in the groups with <25% and 25–50% slippage, respectively. Our results indicate that TFESI could be an effective therapeutic method for controlling radicular pain due to IS-derived foraminal stenosis, and it is more effective when the IS-derived patient slippage is below 25%. We think that in patients with more severe IS, the spinal foramen is likely more significantly narrowed, resulting in heightened mechanical stimulation and inflammation on the nerve root. This could contribute to a relatively poorer therapeutic outcome in patients with 25–50% slippage.

To the best of our knowledge, only one study[20] has reported the effectiveness of TFESI in IS. They retrospectively included 32 patients with IS and compared the effectiveness of TFESI in 171 patients with degenerative spondylolisthesis (DS). In their study, patients with DS showed a higher success rate (66.1%) and longer duration of pain relief (181 days) than did those with IS (46.9% and 140 days, respectively). However, they did not evaluate the effect of TFESI according to IS severity, and pre-determined follow-ups for each patient were not conducted.

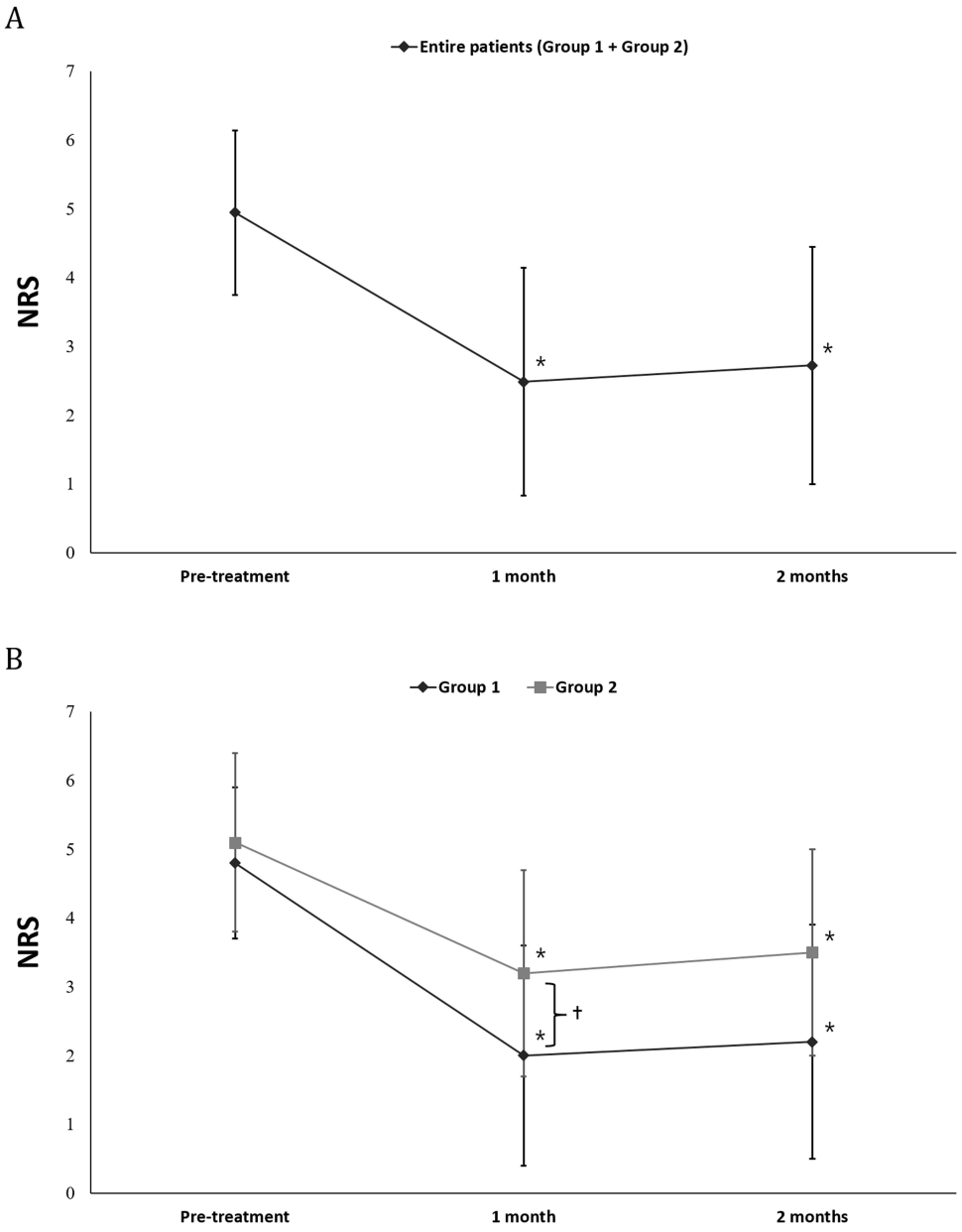

Figure 2 Change in NRS scores. (**A**) NRS scores in the entire cohort showed a significant decrease at 1 and 2 months after TFESI compared to pre-treatment. (**B**) NRS scores in Groups 1 and 2 revealed a significant decrease at 1 and 2 months after TFESI compared to pre-treatment. The intergroup changes over time were significantly different. One month after TFESI, the NRS scores were significantly lower in the Group 1 than in the Group 2. *p <0.05: intragroup comparison between 1 and 2 months post-treatment and pre-treatment (repeated measures one-factor analysis), †p <0.05: intergroup comparison at each time-point (repeated measures two-factor analysis).

In conclusion, we showed that TFESI could significantly alleviate chronic radicular pain from IS-induced foraminal stenosis, and its effect persisted for at least 2 months after TFESI. However, when the slippage of the vertebra is less than 25% in patients with IS, its effectiveness is superior to that in patients with a 25–50% slippage. Our study is the first to evaluate the effects of TFESI in controlling chronic radicular pain caused by IS according to its severity. We believe that our study can provide clinicians with useful information for establishing a plan to control radicular pain induced by IS. However, our study has some limitations. First, our study is limited by its small sample size. Second, the follow-up period was relatively short. Third, although 20–79-year-old patients were included in our study, the upper age limit was relatively high. In other words, the inclusion of older patients might potentially complicate the differentiation of the IS effects from those of other degenerative diseases. Also, the analysis was conducted without considering the impact of age on the therapeutic outcome. Fourth, we did not assess how TFESI affected patients with a severe-degree IS (Grade III and IV). Fifth, Satisfaction with the treatment was not assessed. Thus, further studies compensating these limitations are warranted in the future.

Funding

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NO.00219725).

Disclosure

The authors have no conflicts of interest to declare for this work.

References

1. Randall RM, Silverstein M, Goodwin R. Review of pediatric spondylolysis and spondylolisthesis. *Sports Med Arthrosc Rev*. 2016;24:184–187. doi:10.1097/JSA.0000000000000127
2. Alomari S, Judy B, Sacino AN, et al. Isthmic spondylolisthesis in adults… A review of the current literature. *J Clin Neurosci*. 2022;101:124–130. doi:10.1016/j.jocn.2022.04.042
3. Burton MR, Dowling TJ, Mesfin FB. Isthmic Spondylolisthesis. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441846/. Accessed January 31, 2024.
4. Chang MC, Lee DG. Outcome of transforaminal epidural steroid injection according to the severity of lumbar foraminal spinal stenosis. *Pain Physician*. 2018;21:67–72. doi:10.36076/ppj.1.2018.67
5. Gunzburg R, Szpalski M. The conservative surgical treatment of lumbar spinal stenosis in the elderly. *Eur Spine J*. 2003;12:S176–180. doi:10.1007/s00586-003-0611-2
6. Kalff R, Ewald C, Waschke A, Gobisch L, Hopf C.Degenerative lumbar spinal stenosis in older people: current treatment options. *Dtsch Arztebl Int*.2013;110:613–623. doi:10.3238/arztebl.2013.0613
7. Coutinho AE, Chapman KE. The anti-inflammatory and immunosuppressive effects of glucocorticoids, recent developments and mechanistic insights. *Mol Cell Endocrinol*. 2011;335:2–13. doi:10.1016/j.mce.2010.04.005
8. Davis N, Hourigan P, Clarke A. Transforaminal epidural steroid injection in lumbar spinal stenosis: an observational study with two-year follow-up. *Br J Neurosurg*. 2017;31:205–208. doi:10.1080/02688697.2016.1206188
9. Park Y, Lee WY, Ahn JK, Nam HS, Lee KH. Percutaneous adhesiolysis versus transforaminal epidural steroid injection for the treatment of chronic radicular pain caused by lumbar foraminal spinal stenosis: a retrospective comparative study. *Ann Rehabil Med*. 2015;39:941–949. doi:10.5535/arm.2015.39.6.941
10. Ploumis A, Christodoulou P, Wood KB, Varvarousis D, Sarni JL, Beris A. Caudal vs transforaminal epidural steroid injections as short-term (6 months) pain relief in lumbar spinal stenosis patients with sciatica. *Pain Med*. 2014;15:379–385. doi:10.1111/pme.12318
11. Meyerding HW. Low backache and sciatic pain associated with spondylolisthesis and protruded intervertebral disc: incidence, significance, and treatment. *J Bone Joint Surg Am*. 1941;23:461–470.
12. Kim JK, Wang MX, Chang MC. Deep learning algorithm trained on lumbar magnetic resonance imaging to predict outcomes of transforaminal epidural steroid injection for chronic lumbosacral radicular pain. *Pain Physician*. 2022;25:587–592.
13. Akuthota V, Lento P, Sowa G. Pathogenesis of lumbar spinal stenosis pain: why does an asymptomatic stenotic patient flare? *Phys Med Rehabil Clin N Am*. 2003;14:17–28, v. doi:10.1016/S1047-9651(02)00078-5
14. Greaves MW. Anti-inflammatory action of corticosteroids. *Postgrad Med J*. 1976;52:631–633. doi:10.1136/pgmj.52.612.631
15. Narouze SN, Vydyanathan A, Kapural L, Sessler DI, Mekhail N. Ultrasound-guided cervical selective nerve root block: a fluoroscopy-controlled feasibility study. *Reg Anesth Pain Med*. 2009;34:343–348. doi:10.1097/AAP.0b013e3181ac7e5c
16. Johansson A, Hao J, Sjölund B. Local corticosteroid application blocks transmission in normal nociceptive C-fibres. *Acta Anaesthesiol Scand*. 1990;34:335–338. doi:10.1111/j.1399-6576.1990.tb03097.x
17. Li JY, Xie W, Strong JA, Guo QL, Zhang JM. Mechanical hypersensitivity, sympathetic sprouting, and glial activation are attenuated by local injection of corticosteroid near the lumbar ganglion in a rat model of neuropathic pain. *Reg Anesth Pain Med*. 2011;36:56–62. doi:10.1097/AAP.0b013e318203087f
18. Sohn HM, You JW, Lee JY. The relationship between disc degeneration and morphologic changes in the intervertebral foramen of the cervical spine: a cadaveric MRI and CT study. *J Korean Med Sci*. 2004;19:101–106. doi:10.3346/jkms.2004.19.1.101
19. Choi YK. Lumbar foraminal neuropathy: an update on non-surgical management. *Korean J Pain*. 2019;32:147–159. doi:10.3344/kjp.2019.32.3.147
20. Sencan S, Ozcan-Eksi EE, Cil H, et al. The effect of transforaminal epidural steroid injections in patients with spondylolisthesis. *J Back Musculoskelet Rehabil*. 2017;30:841–846. doi:10.3233/BMR-160543