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ORIGINAL RESEARCH

Short-Term Outcomes of Intraarticular Corticosteroid Injection into the Lumbar Facet Joint According to the Findings of Single-Photon Emission Computed Tomography Imaging

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Objective: Bone single-photon emission computed tomography (SPECT) preferentially localizes areas exhibiting greater bone remodeling and enhanced perfusion, which helps identify areas of pain and inflammation in the lumbar facet joints (LFJs). Herein, we investigated the treatment outcome of intraarticular (IA) corticosteroid injection in patients with LFJ-origin lower back pain (LBP) depending on the presence of increased LFJ uptake on bone SPECT.

Methods: We retrospectively recruited 38 patients with LFJ-origin LBP. Of the 38 patients, 22 patients showed increased uptake on bone SPECT (SPECT+ group), and 16 patients did not show increased uptake on bone SPECT (SPECT- group). A numeric rating scale (NRS) was used to assess pain reduction 1 month after treatment with a corticosteroid injection. Treatment was considered successful when the posttreatment NRS score was ≥50% lower than the pretreatment NRS score.

Results: The NRS scores of the SPECT+ group at the 1-month follow-up were significantly lower than those of the SPECT- group. Additionally, the degree of change in the NRS scores was larger in the SPECT+ group than that in the SPECT- group. In addition, 18 of the 22 patients (81.8%) in the SPECT+ group underwent successful treatment. Eight of the 16 patients (50%) in the SPECT- group underwent successful treatment. The ratio of successful treatment was significantly higher in the SPECT+ group than in the SPECT- group.

Discussion: Bone SPECT could help predict the therapeutic outcome after IA LFJ corticosteroid injection and determine the treatment plan for patients with LFJ-origin LBP.

Keywords: facet joint, lumbar spine, corticosteroid, injection, single-photon emission computed tomography, pain

Introduction

Chronic lower back pain (LBP) is commonly observed in patients visiting clinics or hospitals and is a leading cause of disability.[1] The lumbar facet joint (LFJ) is commonly involved in persistent LBP. LFJ-origin LBP has a prevalence of 15–45%.[2,3] Repeated mechanical and chemical irritation on the LFJ can induce inflammation and stretching of the LFJ capsule, resulting in axial LBP.[4,5] Several therapeutic methods, including oral medication, hot pack, electrotherapy, ultrasound, extracorporeal shock wave therapy, and manual therapy, are applied for treating LFJ-origin LBP.[6,7] Of these methods, intraarticular (IA) LFJ corticosteroid injection is one of the most commonly used procedures. Its efficacy has been reported in previous studies.[8,9]

The knowledge on predicting the therapeutic outcome after IA corticosteroid injection in patients with LFJ-origin LBP can help determine an appropriate therapeutic method. Corticosteroids have a strong antiinflammatory effect.[10] Therefore, it is believed that the therapeutic outcome would be better in cases with evident inflammation within or around the LFJ than in cases without significant inflammation.

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Anatomic imaging modalities, including radiographs, computed tomography (CT), or magnetic resonance imaging, can identify the sites wherein degenerative changes and other anatomical abnormalities occur; however, they are limited in localizing the exact sites causing pain.[11] In contrast, bone single-photon emission CT (SPECT) imaging allows accurate localization of the metabolically active sites.[11] Bone tracer preferentially localizes the sites that have undergone significant bone remodeling and increased perfusion, which can identify the sites causing pain and inflammation in the LFJ.[12,13] Therefore, we believe that bone SPECT can help predict the therapeutic outcome of IA corticosteroid injection in patients with LFJ-origin LBP by assessing the presence of inflammation within or around the LFJ.

Herein, we evaluated the treatment outcome of IA LFJ corticosteroid injection in patients with LFJ-origin LBP based on the presence of increased LFJ uptake on bone SPECT.

Methods

Patients

This retrospective study was conducted in a single university hospital. We recruited consecutive Patients who received IA LFJ corticosteroid injections for LBP in the rehabilitation department between March 2010 and December 2013. The inclusion criteria were as follows: 1) patients aged between 20 and 80 years; 2) LFJ-origin pain was diagnosed using a diagnostic block with an IA injection of 0.5 mL 1% lidocaine (≥80% temporary pain relief); 3) patients who underwent bone SPECT prior to diagnostic block and IA LFJ corticosteroid injection for evaluating increased radiotracer uptake in the LFJ; 4) axial LBP sustained for at least 3 months prior to IA LFJ corticosteroid injection; 5) the degree of LFJ-origin LBP was at least 4 on the numeric rating scale (NRS, 0 indicating no pain and 10 indicating the worst pain imaginable) prior to IA corticosteroid injection; and 6) the follow-up evaluation was performed at 1 month after the injection. Patients with spinal infections, coagulopathy, allergy to iodinated contrast media, and rheumatic disorders were excluded from the current study. The Institutional Review Board of Yeungnam University Hospital approved this study, and the need for obtaining written informed consent was waived due to the retrospective design of the study.

IA Corticosteroid Injection

IA LFJ corticosteroid injection was performed using a posterior approach, wherein the patients were placed in the prone position for C-arm fluoroscopy (Siemens Healthineers). The C-arm tube was angled cephalad and rotated until it was at a tangent to the LFJ space. After confirming IA access by injecting 0.3 mL contrast into the LFJ space, 10 mg (0.25 mL) triamcinolone mixed with 0.25 mL 0.125% bupivacaine was injected using a 26-gauge and 90 mm spinal needle under C-arm fluoroscopy. In patients with increased LFJ radiotracer uptake on bone SPECT (SPECT+ group), IA LFJ corticosteroid injection was administered into the LFJs with increased radiotracer uptake. In patients without increased LFJ radiotracer uptake on bone SPECT (SPECT- group), LFJs for AI LFJ corticosteroid injection were selected based on the physical examination (local tenderness site) and degenerative LFJ pathological findings (osteophytes, bone sclerosis, or joint effusion) observed on radiographs or magnetic resonance images. During the follow-up period after the injection, no other procedures for managing pain were performed.

Bone SPECT

The included patients received 740 MBq of technetium-99m methylene diphosphonate and underwent SPECT imaging approximately 3 h after the radiopharmaceutical administration. A two-headed SPECT system (Hawkeye; GE Healthcare, Milwaukee, WI, USA) was used to obtain SPECT images under the following imaging conditions (Figure 1): low-energy high-resolution collimation, energy window peak at 140 KeV (20% windowing of 126–154 KeV), scatter window at 120 KeV (10% windowing of 115–125 KeV), step and shoot mode at 3° intervals over 180°, and a 30s dwell time per stop. An iterative ordered subset expectation maximization algorithm with two iterations and 10 subsets into a 64×64 matrix was used to reconstruct SPECT images. No scatter or attenuation correction was applied. A single nuclear medicine physician specialist with over 15 years of experience in the field evaluated the bone SPECT findings. Increased LFJ uptake was evaluated (Figure 1).

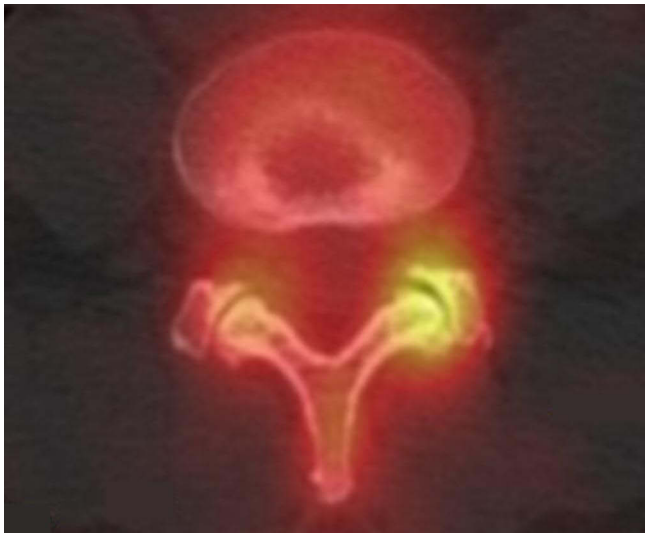

Figure 1 The bone single-photon emission computed tomography imaging findings of a 56-year-old woman with lumbar facet joint-origin lower back pain. Increased radiotracer uptake was observed in the left L4-L5 facet.

Outcome Measurements

An NRS was used to assess pain intensity levels before IA corticosteroid injection and 1 month after treatment. A ≥50% reduction in the posttreatment NRS score compared with the pretreatment NRS score was considered a successful treatment.

Statistical Analysis

Statistical Package for the Social Sciences version 26.0 (IBM Corp., Armonk, NY) was used for data analysis. Data between the SPECT+ and SPECT- groups were compared. The Mann–Whitney *U*-test and chi-square test were used to compare demographic data, the NRS scores, and ratios of the successful treatments. The Wilcoxon signed-rank test was used to compare intragroup differences between the initial and 1-month follow-up NRS. Statistical significance was set at $P < 0.05$.

Results

We reviewed the charts of 71 patients who received IA LFJ corticosteroid injections. Of these patients, 33 patients were excluded (13 patients, no bone SPECT; 6 patients, no positive response on administering a diagnostic block; 5 patients, <3 months of pain onset; 4 patients, an initial pain NRS score of <4; and 5 patients, no 1-month follow-up data). Finally, 38 patients were recruited. Of the 38 patients, 22 patients had increased LFJ radiotracer uptake on bone SPECT (SPECT+ group), and 16 patients did not demonstrate increased uptake on bone SPECT (SPECT- group).

Significant differences were not observed with respect to all demographic data between the SPECT+ and SPECT- groups (Mann–Whitney *U*-test and chi-square test, $P > 0.05$) (Table 1). The initial NRS scores were not significantly different between the two groups (Mann–Whitney *U*-test, $P > 0.05$). Also, the numbers of treated LFJs in SPECT+ and SPECT-groups were 2.4 ± 1.0 and 2.3 ± 1.1, respectively, and no significant difference was observed between the groups (Mann–Whitney *U*-test, $P > 0.05$). In the intragroup comparison, the NRS scores at the 1-month follow-up significantly decreased in both groups compared with the initial scores (Wilcoxon signed-rank test, SPECT+ group: $P < 0.001$, SPECT- group: $P = 0.001$). However, the NRS scores at the 1-month follow-up in the SPECT+ group were significantly lower than those in the SPECT- group (Mann–Whitney *U*-test, $P = 0.029$). Furthermore, significant changes were observed in the NRS scores in the SPECT+ group than in the SPECT− group (Mann–Whitney *U*-test, $P = 0.029$). In addition, 18 of the 22 patients (81.8%) in the SPECT+ group underwent successful treatment. Eight of the 16 patients (50.0%) in the SPECT- group underwent successful treatment. The ratio of successful treatment was significantly higher in the SPECT+ group than in the SPECT- group (chi-square test, $P = 0.037$) (Table 1).

Table 1 The Demographic Data, Numeric Rating Scale Scores, and Ratios of Successful Treatment of SPECT+ and SPECT- Groups

	SPECT+ group	SPECT- group	P value
Number of patients, n (Male: Female)	22 (8:14)	16 (6:10)	0.943
Number of treated LFJs	2.4 ± 1.0	2.3 ± 1.1	0.804
Age, yr	55.3 ± 9.7	50.9 ± 10.4	0.223
Duration of pain, month	13.2 ± 8.0	13.8 ± 8.4	0.804
Initial NRS score	5.6 ± 0.7	5.6 ± 0.6	0.872
NRS score at 1 month follow-up	2.1 ± 1.2	3.1 ± 1.5	**0.029**
Change of NRS score	−3.5 ± 1.3	−2.5 ± 1.5	**0.029**
Successful treatment, n (%)	18 (81.8%)	8 (50.0%)	**0.037**

Note: P values in bold indicate P < 0.05.
Abbreviations: NRS, numeric rating scale; LFJ, lumbar facet joint; SPECT, single-photon emission computed tomography.

Discussion

Herein, we observed that the pain reduction in patients with increased LFJ uptake on bone SPECT was significantly larger than in those without increased LFJ uptake on bone SPECT. Furthermore, the rate of successful treatment (≥50% of pain reduction) was significantly higher in LFJs with increased uptake than in those without increased uptake.

LFJ-origin LBP occurs due to continuous excessive joint movement and loading of the LFJs.[4] Persistent LFJ-origin LBP could result in continued mechanical irritation of the nociceptive nerves and inflammation within or around the LFJ.[4,5,14] When blood flow increases locally due to inflammation, the radiotracer delivery increases and accumulates in the inflamed area.[11] Additionally, a constant mechanical load on the LFJ induces mechanical destruction. Increased radiotracer uptake on bone SPECT occurs in proportion to the osteoblastic activity observed at sites undergoing bone remodeling.[15] Increased osteoblastic activity following bony destruction around the LFJ would result in increased uptake as observed on bone SPECT in our patients.

In our study, 38 patients were diagnosed with LFJ-origin LBP based on physical examination and imaging studies. However, in 16 patients, the bone SPECT did not reveal increased uptake. In these LFJs, the inflammation or joint destruction was not severe enough to be observed on bone SPECT. Additionally, the cases could have been misdiagnosed. We believe that bone SPECT in patients with LFJ-origin LBP can help evaluate the LFJ's severity of inflammation or damage and in the accurate diagnosis of LFJ-origin LBP. Furthermore, our results revealed that the effect of IA LFJ corticosteroid injection was significantly greater in LFJs showing increased uptake on bone SPECT than in those without increased uptake, indicating that bone SPECT can be used to predict the therapeutic outcome in patients with LFJ-origin LBP before administering the IA corticosteroid injection.

By far, several studies have reported that bone SPECT can help identify joints that cause pain.[16–19] However, to the best of our knowledge, two previous studies compared the efficacy of IA LFJ corticosteroid injection based on the presence of increased LFJ uptake on bone SPECT.[20,21] In 1996, Dolan et al recruited 22 patients having increased LFJ uptake on bone SPECT and 36 patients without increased LFJ uptake.[20] While the patients with increased LFJ uptake demonstrated a significant reduction in the pain 1 month after IA LFJ corticosteroid injection administration (NRS, from 6.3 to 3.3), no significant reduction was observed in the pain of patients without increased LFJ uptake after the injection (NRS, from 5.8 to 5.3). In 2006, Pneumaticos et al evaluated the efficacy of IA LFJ corticosteroid injection based on the bone SPECT findings.[21] Of the 15 patients with increased LFJ uptake, 13 had an improved pain score at the 1-month follow-up. Additionally, of the 16 patients without increased uptake, only 2 patients had a positive therapeutic effect after the injection. In the previous two studies, when the patients did not reveal an increased LFJ uptake on bone SPECT, the pain reduction after IA LFJ corticosteroid injection was poor. No significant reduction was observed in the average NRS score, and only a small percentage of patients exhibited a reduction in pain after the procedure. In contrast, although not many patients demonstrated an increased LFJ uptake (NRS, from 5.6 to 2.1), our study patients who did not demonstrate an increased LFJ uptake also experienced significant pain reduction (NRS, from 5.6 to 3.1). The previous studies

diagnosed LFJ-origin LBP and recruited patients for IA LFJ injection based on the pain characteristics or imaging studies.[20,21] However, the standard method for diagnosing LFJ-origin LBP is image-guided medial branch blocks or IA injections.[22] Therefore, we believe that the pain origin of some patients who were recruited in the previous studies might not have been LFJ but could be discogenic or muscle-origin LBP.

Conclusion

In conclusion, we demonstrated that the therapeutic outcome of IA LFJ corticosteroid injection for controlling LFJ-origin LBP was more favorable in patients with increased LFJ uptake on bone SPECT compared with patients without increased LFJ uptake. We believe that bone SPECT can help determine the therapeutic method for treating LFJ-origin LBP and accurately diagnose LFJ-origin LBP. Our study had certain limitations. First, we included a small number of patients and followed up on the therapeutic outcome only a month after the IA corticosteroid injection. Second, our study had a retrospective design. Third, the data used for this study was somewhat outdated. Fourth, the measurement of functional status was not performed. Fifth, the age range of the patients included in our study was too wide, ranging from 20 to 80 years. Further studies compensating these limitations are warranted.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The institutional review board of Yeungnam University Hospital approved the retrospective review of patient data for this study and waived the need for individual informed consent. In accordance with privacy regulations, only the study manager and collaborators had access to patients' data to maintain confidentiality. The data were stored anonymously, using assigned alphanumeric codes to ensure that patient identities were protected.

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Disclosure

The authors declare no conflicts of interest in this work.

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