Low Back Pain: Prediction of Short-term Outcome of Facet Joint Injection with Bone Scintigraphy[1]

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Purpose: To prospectively evaluate use of bone scintigraphy with single photon emission computed tomography (SPECT) for identification of patients with low back pain who would benefit from facet joint injections.

Materials and Methods: The protocol was reviewed and approved by the institutional review board. All patients provided informed consent. Forty-seven patients (23 men and 24 women) with low back pain, who were scheduled for facet joint injections, were prospectively enrolled and randomized into groups A and B (mean ages, 43.3 and 44.2 years, respectively) with a group A–group B ratio of 2:1. Group A patients underwent bone scintigraphy with SPECT prior to injection. Group A patients with bone scans positive for facet joint abnormalities received injections at the levels where abnormalities were identified on the scan (group A1). Group A patients with negative scans (group A2) received injections at the levels that were decided as in group B. Group B patients received injections at the levels indicated by the referring physician and did not undergo bone scintigraphy. All patients completed a pain and function questionnaire before injection and at 1, 3, and 6 months afterward. The change in the American Academy of Orthopaedic Surgeons pain scores after 1, 3, and 6 months compared with baseline scores was analyzed with analysis of variance and post hoc Bonferroni multiple-comparison tests between groups. Cost analysis was performed.

Results: The change in the pain score at 1 month was significantly higher ($P < .004$) in group A1 than it was in the other two groups. In group A1, 13 of 15 patients had improvement in pain score of greater than 1 standard deviation at 1 month, whereas improvement occurred in only two of 16 patients in group A2 and five of 16 patients in group B. In patients with positive scans, the number of facets treated with injection was decreased from 60, which was the number originally indicated by the referring physician, to 27. The Medicare cost was reduced from $2191 per patient to $1865 with the use of SPECT.

Conclusion: Bone scintigraphy with SPECT can help identify patients with low back pain who would benefit from facet joint injections.

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Degenerative changes of the spine are a common cause of low back pain. Although the spectrum of the degenerative changes is wide, the facet joint has long been considered a common source of low back pain (1–4). When one evaluates a patient, however, frequently there is limited direct evidence of the role of the facet joint in low back pain. Facet joint injections are commonly used for alleviation of back pain and/or to help determine whether the facet joint is a source of pain, but the results of these injections can be inconclusive. In addition, computed tomography (CT) has been proved to be unreliable in the identification of painful facet joints (5), and magnetic resonance (MR) imaging has not been investigated in regard to that matter. Therefore, a diagnostic method that can reliably be used to identify the areas of the spine responsible for low back pain, and to rule out the facet joint in particular, would be of great benefit in the assessment of these patients.

Radionuclide bone scintigraphy (bone scanning) is a known diagnostic technique that can be used to detect bone areas with increased osteoblastic activity or to detect synovial changes caused by inflammation or hyperemia. Bone scintigraphy can also depict degenerative changes, particularly those that demonstrate a high degree of remodeling. Thus, the purpose of our study was to prospectively evaluate the use of bone scintigraphy with single photon emission computed tomography (SPECT) for the identification of patients with low back pain who would benefit from facet joint injections.

Materials and Methods

Patients

The protocol was reviewed and approved by the institutional review board at Baylor College of Medicine and St Luke's Episcopal Hospital, Houston, Tex, and all patients provided informed consent. The study was performed in a Health Insurance Portability and Accountability Act–compliant manner. We (S.G.P., S.N.C.) prospectively enrolled 47 consecutive adult patients (23 men and 24 women) with low back pain who had received a diagnosis of facet joint syndrome according to the referring physician, who were scheduled for facet joint injections, and who were referred to us. All patients met the following inclusion criteria: *(a)* They had low back pain without leg pain. *(b)* They had been symptomatic for longer than 6 months. *(c)* They had low back pain with extension of the lumbar spine. *(d)* They had imaging evidence (excluding bone scan evidence) of facet joint abnormalities, such as facet hypertrophy, subchondral sclerosis, and joint space narrowing. Patients were excluded from enrollment if they *(a)* had undergone prior spinal surgery or prior facet joint injections, *(b)* had other spinal abnormalities (benign or malignant tumors, congenital defects, spondylolysis, or spondylolisthesis), *(c)* were unable to tolerate SPECT, and/or *(d)* were pregnant. We did not exclude any of the patients who were referred to us.

The referring physician who evaluated the patients selected the levels for facet joint injection on the basis of standard diagnostic and clinical methods. After the referring physician completed the patient's evaluation, the patients were randomized by using a random number generator (Stata, version 8; Stata, College Station, Tex) into groups A and B, with a ratio of group A patients to group B patients of 2:1. The mean ages of patients in these groups were 43.3 and 44.2 years, respectively.

Group A.—These patients underwent bone scanning with SPECT prior to undergoing the facet joint injection. If the scan was positive for facet joint abnormalities (group A1), the patients received the injections at all the levels of the lumbar spine at which abnormalities were identified on the scan, and these levels were not necessarily the levels indicated by the referring physician. In the patients in whom no facet joint abnormalities were found on the scan (group A2), the levels for injection were those originally specified by the referring physician, as were those in group B.

Group B.—These patients underwent injection at the levels that were decided by the referring physician on the basis of the clinical symptoms, the physical examination findings, and findings on existing radiologic images, without performance of bone scanning with SPECT.

The demographic characteristics of the patients in the three groups are demonstrated in Table 1.

Facet Joint Injection and Questionnaire

Two pain specialists (with 7 and 10 years of experience) from our institution performed all the facet joint injections with fluoroscopic guidance. For each facet joint, a mixture of 2.5 mL of a local anesthetic (0.5% bupivacaine hydrochloride [Marcaine; Abbott Laboratories, North Chicago, Ill]) and 0.5 mL of a steroid (betamethasone sodium phosphate and betamethasone acetate injectable suspension [Celestone Soluspan; Schering-Plough, Kenilworth, NJ]) with a concentration of 6 mg/mL was injected. Approximately half of the dose was administered interarticularly (until resistance was encountered), and the remainder of the dose was administered around the posterior facet capsule after slight withdrawal of the needle.

The patients in groups A and B were asked to complete a validated pain and function questionnaire immediately before the facet joint injection (American Academy of Orthopaedic Surgeons

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[AAOS] MODEMS Lumbar Spine Baseline) and at 1, 3, and 6 months after the injection (AAOS MODEMS Lumbar Follow-up Survey) (6,7). The pain score was calculated by using published formulas of the AAOS available at their Web site (*www.aaos.org*). Pain scores were calculated at baseline and at 1, 3, and 6 months of follow-up. The scores at 1, 3, and 6 months of follow-up were obtained by means of mailed questionnaires. These scores were not included in the analysis if the patient had received additional injections or surgical treatment during the time between the injection and the pain assessment. Mean pain scores in the general population were reported to be 87 ± 17 (8).

Bone Scintigraphy and Interpretation of Results

The patients received 925–1110 MBq of technetium 99m–methylene diphosphonate intravenously. Whole-body anterior and posterior images were obtained with a dual-headed gamma camera (Vertex; Adac Laboratories; Milpitas, Calif) with a table motion speed of 12 cm/min at 3 hours after injection. Immediately after whole-body imaging, SPECT images of the lumbar spine were obtained (degrees of rotation, 360; number of images, 64; imaging time per image, 40 seconds). The raw data were processed by using a filtered backprojection technique and were displayed on a terminal in gray-scale values. The images were interpreted independently by two physicians (S.N.C. and W.H.M., with 9 and 23 years of experience in nuclear medicine, respectively) who were blinded to the clinical and imaging findings. In a facet joint, any tracer uptake that was higher than the uptake in the body of the adjacent vertebra was considered a positive finding. In two cases of disagreement, a third physician with 21 years of experience in nuclear medicine was asked to interpret the images, and the final interpretation was reached in consensus.

Cost of Procedures

The overall cost of each procedure was calculated by one author (J.A.H.) on the basis of the current Medicare reimbursement rates for our institution. For the facet joint injections, the hospital charges were added to the physician charges and cost of the contrast material used. The cost of steroids and that of the anesthetic administered were not included. For the bone scan with SPECT, the hospital charges for whole-body imaging and for SPECT were added to the physician charges and the cost of the radiopharmaceutical.

Statistical Analysis

Outcome data were analyzed by one author (J.A.H.) with analysis of variance and post hoc multiple-comparison tests between groups (Stata, version 8; Stata). One-way analysis of variance with Bonferroni multiple comparisons was used to calculate the change in the AAOS pain scores at 1, 3, and 6 months after treatment compared with scores at baseline. A positive change in the AAOS pain score was defined as a change greater than the standard deviation of 17 of the scores as published by the AAOS. Intergroup comparisons also were performed with analysis of variance and post hoc comparisons. A difference with a P value of less than .05 was considered statistically significant for all analyses. Continuous variables were expressed as the mean ± standard deviation.

Results

The 6-month follow-up data were not available for two patients in group B.

Pain Scores

The average baseline AAOS pain score was 46, and there were no significant differences between groups ($P = .33$). The change in the AAOS pain score at 1 month after treatment (Table 2) was significantly higher ($P < .008$) in group A1 than it was in the other two groups (Fig 1). The AAOS pain scores at 1-month follow-up were not significantly different compared with baseline scores in group A2 ($P = .32$) and group B ($P = .09$). In group A1, 13 (87%) of 15 patients had an improvement in the pain score at the 1-month follow-up. In contrast, only two (13%) of 16 patients in group A2 had a positive response. In group B, five (31%) of 16 patients had a positive response. Overall, 20 (43%) of 47 patients had a positive response to the facet joint injection. The change in pain scores at 3 months after treatment was significantly higher in group A1 ($P < .001$) than it was in the other two groups; in addition, the change in pain scores in group B was significantly higher ($P = .015$) than it was in group A2 (Fig 1). The difference in the pain scores between groups was not significant after 6 months ($P = .067$) (Fig 1).

Number of Joints Treated with Injection

In the patients in group A1, the number of facet joints treated with an injection was reduced from 60, the number requested by the referring physicians, to 27, the number of facet joints that were abnormal on the bone scan (Fig 2). In six patients, the facet joints that were

Table 1

Demographic Data for Groups A1, A2, and B

Data	Group A1	Group A2	Group B
Sex			
No. of men	7	8	8
No. of women	8	8	8
All	15	16	16
Age (y)*			
Men	47.1 ± 17.1	43.2 ± 9.7	43.9 ± 6.3
Women	46.1 ± 11.9	37.2 ± 9.9	44.5 ± 14.7
All	46.6 ± 14.0	40.3 ± 10.0	44.2 ± 11.0

Note.—The differences among the groups were not statistically significant.

* Values are the mean ± standard deviation.

treated with injection were completely different from the ones initially requested by the referring physicians. In the other nine patients, the facet joints treated with injection were included in the number of those that the referring physicians initially thought were abnormal.

Costs

On average, for those patients who eventually received a facet joint injection, four different facet joints were treated. On the basis of data from Baylor College of Medicine, where SPECT and many of the facet joint injections were performed, the Medicare reimbursement for the facet joint injections (four facet joints) was $2257, and the reimbursement included two charges for a facet block injection with an additional facet, contrast material, and physician charges for the initial facet and three additional facets. The Medicare reimbursement for the bone scan with SPECT was $797 for the technical fees, the radiopharmaceutical, and the physician's fee. On the basis of these costs, and data from this study, if 100 Medicare patients were treated without bone scanning with SPECT, the total cost to the health care system would be $225 678, with the assumption that an average of four facet joints would be treated per patient. If SPECT and bone scanning were used, the total cost to Medicare would be $188 887, including $79 688 for the scanning and $109 199 for the injections.

Discussion

The evidence-based medicine review of the literature of the Cochrane Collaboration concluded that "convincing evidence is lacking on the effects of injection therapies for low back pain" (8). In 1976, Mooney and Robertson (9) found that 62 of 100 patients with chronic low back pain had initial pain relief when the facet joints were treated with an injection of a local anesthetic and 20% had complete relief at the 6-month follow-up. In 1977, however, Ogsbury et al (4) showed that, although 44 of 95 patients had temporary relief, only six patients had long-term relief. In 1984, Lippitt (10) showed that of 117 patients, 20 patients had an excellent response, 30 patients had a good response, 11 patients had a fair response, five patients had a mediocre response, and 51 patients had no change. In these earlier studies, the percentage of all patients with a positive response is generally consistent with the percentage of patients (who had directly received the injections without having undergone bone SPECT) with a positive response that we found in the present study.

Because the results of treatment for low back pain with facet joint injection remain inconsistent (11), investigators have tried to identify the subgroups of

Figure 1

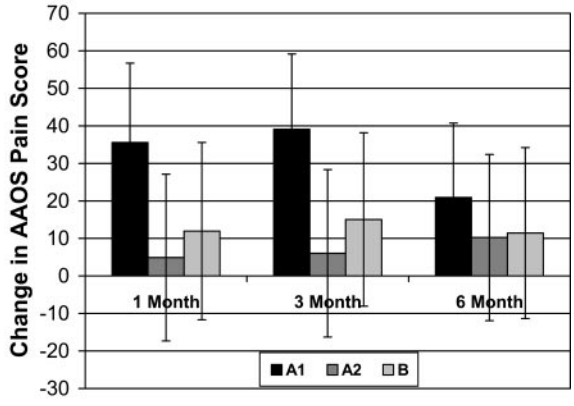

Figure 1: Graph shows change in the AAOS pain score at 1, 3, and 6 months after injection compared with baseline scores for groups A1, A2, and B. The change in the AAOS pain score of group A1 was significantly greater than it was in the other two groups at 1 and 3 months after treatment. At 6 months after treatment, the change was similar in all three groups. Error bars represent the statistical error.

Figure 2

Figure 2: Transverse bone SPECT image in 40-year-old woman shows an abnormal left facet joint (arrow) and a normal right facet joint at the level L5-S1. This patient was originally scheduled for bilateral L5-S1 facet joint injections.

Table 2

Pain Status at Follow-up

	1 Month			3 Months			6 Months		
Pain Status	Group A1	Group A2	Group B	Group A1	Group A2	Group B	Group A1	Group A2	Group B*
Better	13	2	5	12	2	5	8	4	5
Same	2	14	11	3	14	11	7	11	8
Worse	0	0	0	0	0	0	0	1	1

* Two patients in this group were lost to follow-up at 6 months.

patients who would benefit from the facet joint injection. In 1981, Fairbank et al (12) showed that patients with a wider than normal spinal canal and patients with pain in both the back and the thigh have a better response to facet joint injections than do patients with a narrow spinal canal and patients with pain in the low back and lower part of the leg. These data suggest that the inconsistent response to facet joint injections in large numbers of patients may be caused by the inconsistent selection of patients.

Radionuclide bone scintigraphy can depict bone areas with increased function, and it can depict synovial changes caused by inflammation or hyperemia. Bone scintigraphy also can depict degenerative changes, particularly those that demonstrate a high degree of remodeling. The induced radiopharmaceutical uptake can vary from subtle to pronounced, depending on the metabolic activity and size of the lesions. Osteophytes that are in the process of growing exhibit a high uptake, whereas mature osteophytes tend to have a normal or slightly increased uptake (13). Abnormalities can be detected sooner with bone scintigraphy than they can be with radiographic methods, and joints observed as abnormal at scintigraphy eventually show the most progressive radiographic changes (14). Joints that are radiographically abnormal but normal at bone scintigraphy do not show additional deterioration (14). In addition, with SPECT, the sensitivity of the scan for depiction of bone lesions is increased.

The use of bone scintigraphy for the evaluation of patients who have received facet joint injections has been investigated before and was found to help in the prediction of the clinical response of the patients (15,16). Findings in our prospective study indicated that patients with a positive bone scan have an excellent response to facet joint injections when they are administered at the levels where the abnormalities are seen on the bone scan, whereas patients with a negative bone scan have a much poorer chance for improvement in symptoms. It is important to emphasize that patients with a negative bone scan (more than 50% of the patients in the series included in the current study) can be spared from an invasive procedure such as facet joint injection, which carries risks such as hypersensitivity reactions to the contrast material or the anesthetic and infection, both of which can lead to morbidity.

On the other hand, the patients who were randomized into the group of those who did not undergo bone SPECT prior to the facet joint injection had an approximately 30% likelihood of improvement. This likelihood, however, was significantly lower than that of patients with a positive bone SPECT scan and may be explained primarily by the fact that the group without bone scans included many patients who, in reality, would have had a negative bone SPECT scan and, therefore, would not have responded satisfactorily to the injections. In addition, in this group of patients who did not undergo bone scanning, the selection of the levels for injection was determined empirically by the referring physician. Thus, it is possible that even in the patients who would really benefit from the injection, wrong levels or fewer than the appropriate number of levels were treated with injection, and these discrepancies led to a decreased response.

In addition, it seems that the group of patients who did not undergo bone scanning had a better response than did those who had a negative bone scan, and this finding may have been caused by the fact that this group included patients who would have had a positive bone scan, if one had been obtained. The sample sizes of groups A2 and B, however, were not large enough to allow us to know, with confidence, whether their responses were really different. On the basis of the mean and standard deviations for the outcome data we collected, we would need approximately 150 subjects in group A2 and 140 in group B to determine with a power of 0.8 whether these groups were statistically different from each other.

Finally, we showed that use of bone scanning with SPECT not only contributed to a change in the levels to be treated with injection in some patients but also may have led to a better response after the injection and may have decreased the number of levels to be treated by one-half.

The benefit from the facet joint injection lasted for at least 3 months and subsided at 6 months. At 6 months, the pain response to facet injections was not statistically different among the three groups (this absence of difference would stand even if the two nonresponders from group B had had excellent improvement), partly because the effect of the facet injection lasts for only a few months and partly because there may have been some improvement in the pain in the other two groups at 6 months as a result of only the natural history of the disease.

With use of bone scintigraphy, in more than 50% of patients who received no benefit from the injection, the risks associated with the facet joint injections would have been avoided. The potential drawback of using bone SPECT for screening patients before facet joint injections is that there may be a small percentage of patients (13% in this study) with negative bone scans who benefit from the injections. The improvement in 13% of the patients possibly could be explained by the natural history of the disease or even a placebo effect.

At our institution, we demonstrated not only a clear clinical advantage in the use of bone scanning with SPECT in candidates for facet joint injection but also a clear economic advantage, on the basis of Medicare rates, in the use of additional imaging to identify those patients who would benefit from a facet joint injection. Given the wide range of charges and reimbursement rates for medical procedures, however, the economic benefit of screening patients referred for facet joint injections would have to be recalculated for individual sites. Nevertheless, the value of avoiding the risks and less favorable aspects of facet joint injections, as well as of determining the potential economic benefit, strongly argue for the use of bone SPECT in the identification of

patients who would benefit from facet joint injections.

This study represents a prospective randomized trial in which all the patients who were consecutively referred were enrolled. Because the patients were evaluated in physicians' clinics, it was not possible for the authors to know whether all patients who received a diagnosis of facet joint syndrome or only a percentage of those who received that diagnosis were referred for enrollment. Even if this may have introduced a referral bias, however, this bias would have affected all three groups of the study equally, since all referred patients were randomized, and the bias would not have affected the results.

It may be possible that those who underwent bone SPECT demonstrated a better response because of the placebo effect. It is clear from the study results, however, that those with positive SPECT scans demonstrated a better response than did those with negative SPECT scans.

The patients who were enrolled in the study had received a diagnosis of facet joint syndrome and had been referred for facet joint injection. The diagnosis was determined with results of a clinical evaluation and other diagnostic techniques, such as plain radiography, CT, and MR imaging. This work-up was not standard and probably varied, depending on the clinician's preference. We decided to use this group of patients, however, because it really represented the patients a clinician would see in everyday practice in a university hospital.

In conclusion, bone scanning with SPECT helps in the identification of patients who would benefit from a facet joint injection. Patients with positive scans have an excellent response to facet joint injections. In contrast, patients with negative scans and patients who undergo injection without having undergone bone scanning are less likely to have a beneficial response to the injections.

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