Bone SPECT in Patients with Persistent Back Pain After Lumbar Spine Surgery

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Twenty-five patients with persistent pain after lumbar spine surgery for pain were evaluated by single photon emission computed tomography (SPECT) bone scanning. The patients were divided into three groups, depending on the type of surgery performed. The data obtained indicates that lumbar spine SPECT is most useful in conditions where there is the greatest likelihood of instability. The study shows that the improved contrast and better three-dimensional patient information gained through lumbar spine SPECT permits more accurate delineation of the level of maximum instability and stress on the vertebra.

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With the introduction in 1911 of spinal fusion by Albee (*1*) and Hibbs (*2*), and the report in 1934 by Mixter and Barr (*3*) of laminectomy for removal of herniated intervertebral disk, lumbar surgery for the relief of low back pain has become one of the most frequently performed procedures in medicine. Surgery for low back pain is successful 80–90% of the time (*4*). The remainder of the patients continue to have pain and constitute a population frequently referred to as "failed back syndrome" (*5*). A number of diagnostic modalities including conventional x-rays, lumbar computed tomography (CT), and myelography, have been used to evaluate patients to determine the cause of persistence of back pain. Planar bone scanning has been of restricted usefulness because of superimposition of the individual structures of the vertebra over each other. However, with the introduction of single photon emission computed tomography (SPECT) scanning of the spine this problem has been eliminated and image contrast has been improved. The present study was designed to evaluate lumbar spine SPECT in the "failed back syndrome".

MATERIAL AND METHODS

Twenty-five consecutive patients with persistent back pain after either one or more lumbar surgical procedures for relief of pain were evaluated by lumbar SPECT scan. Conventional transaxial CT and x-rays were also performed.

For the purpose of SPECT scanning, the patient was injected with 20 mCi of technetium-99m methylene diphosphonate (MDTP). Sixty-four images were collected over a 360° elliptical orbit, using a low-energy, parallel hole collimator. Each image was collected for 20 sec. The images were reconstructed on 64×64 matrix. A 0.8 Hanning filter was used for

TABLE 1
Results of Bone SPECT in Patients with Postlaminectomy Back Pain: Group 1—One Spinal Level Involved

Patient	Age (yr)	Surgery (Type of laminectomy and year)	SPECT
1	42	L5-S1 right unilateral, 1984	Positive L5-S1 facet on right
2	36	L5-S1 right unilateral, 1981	Positive L5-S1 facet on right
3	42	L5-S1 bilateral, 1979	Negative
4	25	L4-L5 left unilateral, 1983	Negative
5	62	L5-S1 bilateral, 1981	Negative
6	36	L5-S1 bilateral, 1980	Negative
7	45	L5-S1 bilateral, 1983	Negative
8	45	L4-L5 bilateral, 1978	Negative
9	38	L5-S1 right unilateral, 1981	Negative
10	27	L5-S1 right unilateral, 1983	Negative
11	43	L5-S1 left unilateral, 1979	Negative

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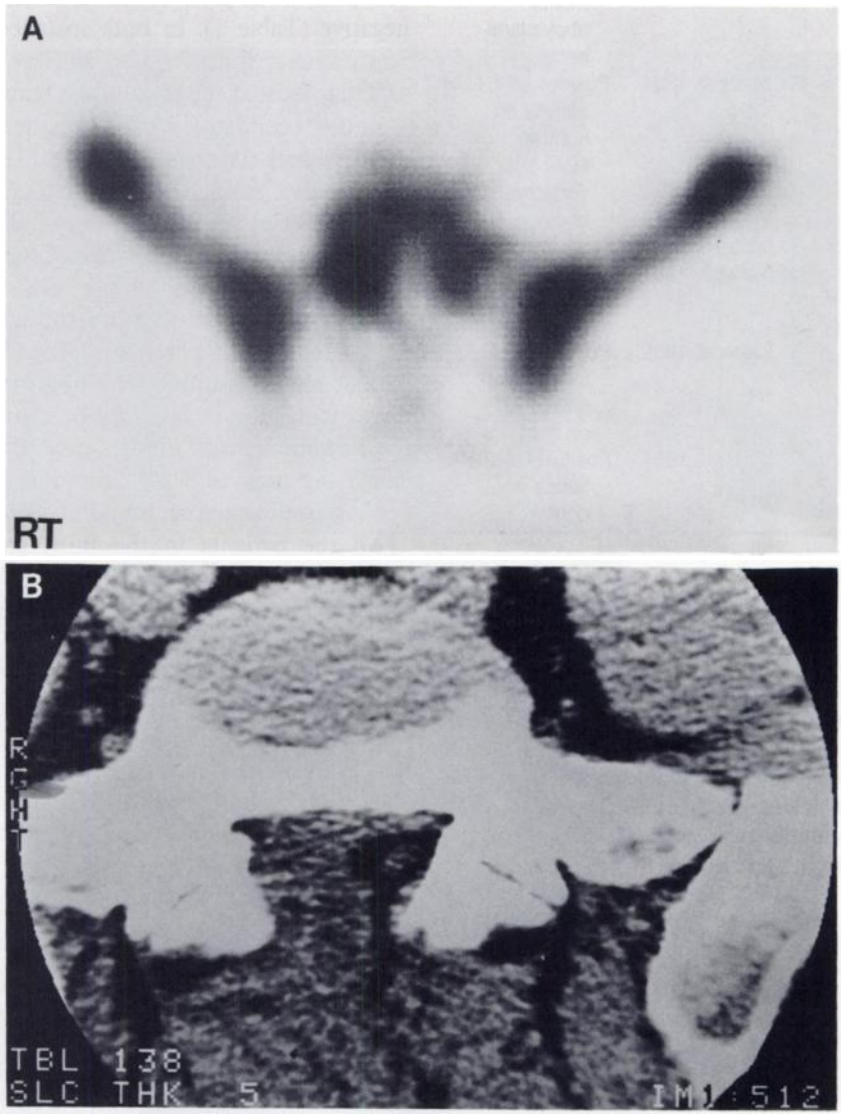

FIGURE 1
A 42-yr-old patient (Table 1) underwent a bilateral laminectomy at L5-S1 level in 1984. The transaxial SPECT scan at L5-S1 demonstrates (A) increased activity in the articular facet on the right at the level of the laminectomy. The laminectomy is also outlined. The CT scan (B) through the same level shows the facets to be symmetric in appearance.

TABLE 2
Results of Bone SPECT in Group 2—Multiple Spinal Levels Involved

Patient	Age (yr)	Surgery (Type of laminectomy and year)	SPECT
1	61	L4 to S1 bilateral, 1981	Positive L5-S1 facets bilateral
2	32	L4 to S1 bilateral, 1978	Negative
3	37	L3 to S1 bilateral, 1981	Positive L3-4 facets above laminectomy
4	45	L4 to S1 bilateral, 1981	Positive L5-S1 activity on right at facet and vertebral body
5	44	L4 to S1 bilateral, 1983	Negative
6	57	L4 to S1 bilateral, 1981	Positive L5-S1 facets, bilateral
7	56	L3 to S1 bilateral, 1982	Positive L3-4 facet on left and L5-S1 on right
8	45	L4 to S1 bilateral, 1984	Positive L4-L5 facets on right

reconstruction that was performed in a transverse plane. The sagittal and coronal images were generated from transverse reconstruction.

The patients ranged in age from 27 to 62 yr. The 25 patients were divided into three subgroups based on their surgical history. The first subgroup constituted those patients who had a laminectomy involving only one spinal level. There were 11 patients in this group. The second group was composed of patients with laminectomies over more than one level. In some of these patients, at least part of the articular facet at one or more levels was removed at the time of surgery. This group consisted of eight patients. The third group included six patients who previously had a fusion, as well as a laminectomy. In most instances, the fusion was performed after an initial laminectomy. Fusion was performed in order to control persistent back pain.

RESULTS

In the first group of 11 patients, there were two who had positive SPECT scans. The remaining nine were negative (Table 1). In both instances where the scan was positive, the increased activity was noted in the articular facet at the level of the laminectomy (Fig. 1).

In the second group of eight patients, there were two negative and six positive studies (Table 2). In four of the positive cases, the increased activity was at the lowest level of the laminectomy predominantly in the articular facets. In another one of these six patients, the increased activity was at the level above the highest segment of the laminectomy and again was predominantly in the articular facets (Fig. 2). The remaining patient with a positive scan had increased activity in the articular facets, both above and below the level of the decompressive laminectomy (Fig. 3). In all eight cases, the area of wide decompressive laminectomy could be delineated on the SPECT coronal views.

All the patients in the third group had positive SPECT scans (Table 3). In two of the six cases, there was increased activity in the fusion mass bilaterally (Fig. 4). Both these cases showed CT evidence of poor integration of the fusion mass with formation of pseudoarthrosis. In two of the remaining four cases, there was increased activity in the articular facets and vertebral body in the area of disk space at the level just above the fusion (Fig. 5). In the third of these four cases, there was increased activity noted in the articular facets at the level just below the fusion. In the remaining

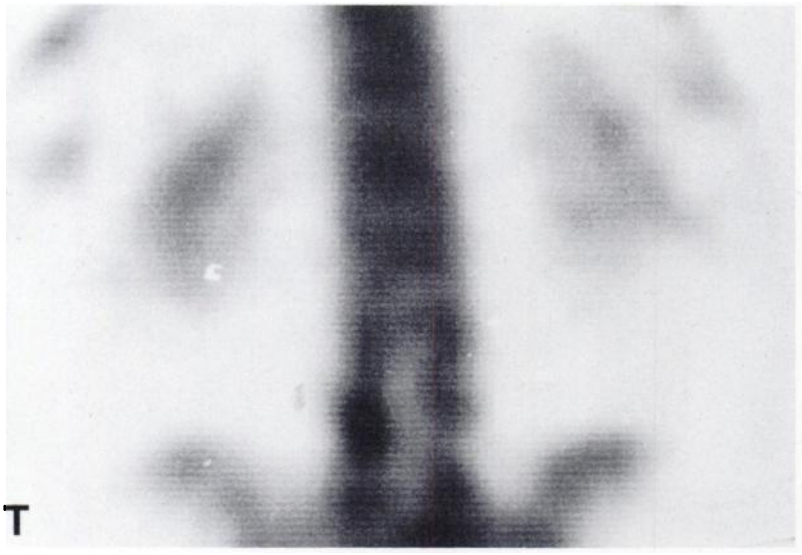

FIGURE 2
A 45-yr-old patient (Table 2) underwent bilateral laminectomy in 1984 from L4-S1. A coronal anterior view shows increased activity in the articular facet of L4-5 on the right, as well as the presence of midline laminectomy site from L4-S1.

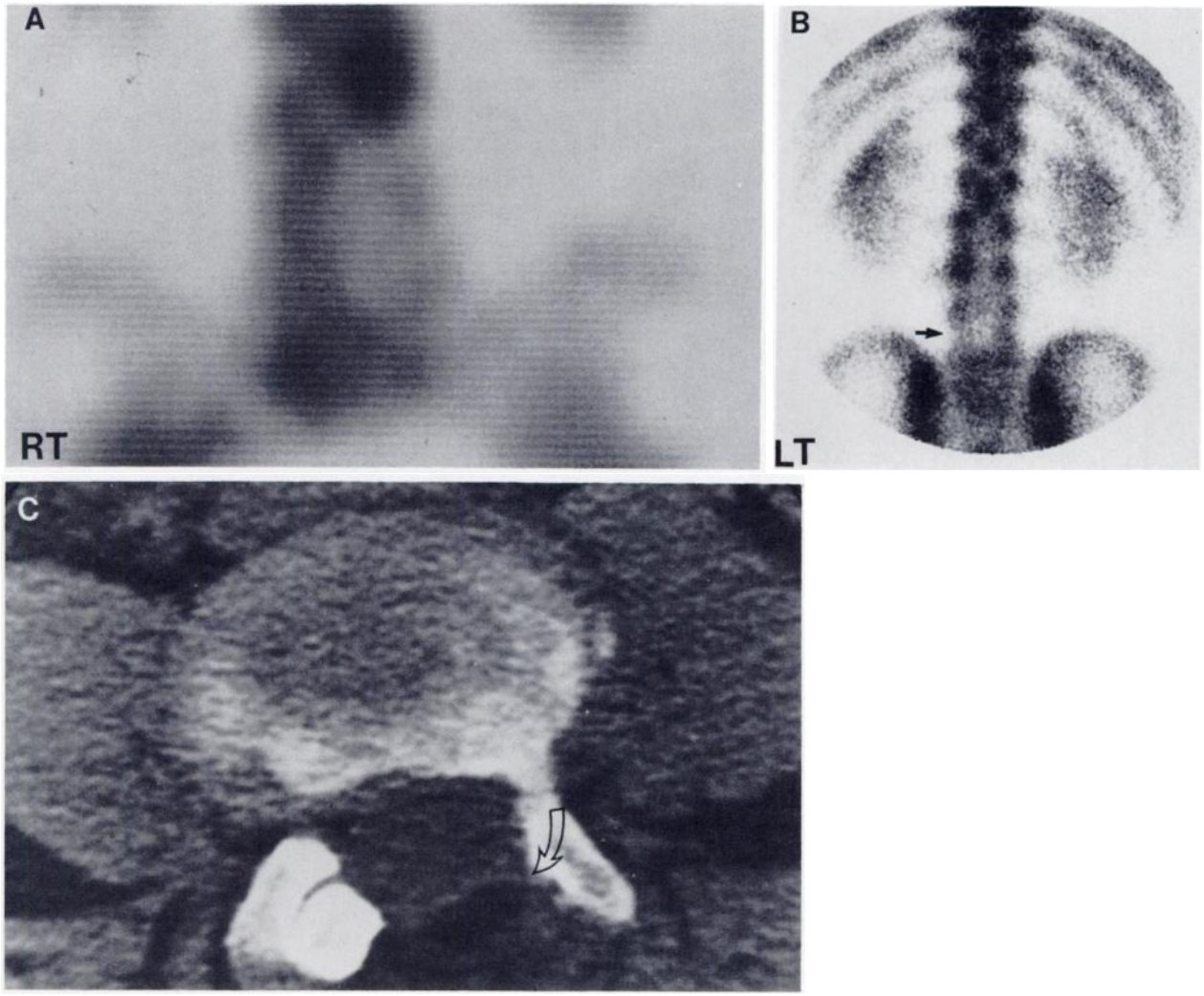

FIGURE 3
A 56-yr-old patient (Table 2) underwent a wide bilateral laminectomy of L3 to S1 in 1982. Activity is seen in the anterior coronal view (A) in the articular facet on the left at L3-4 and in the articular facet on the right at L5-S1. A wide laminectomy defect from L3 to S1 is present. A planar posterior view (B) demonstrates the midline laminar defect (arrow) but fails to demonstrate the localized increase in L3-4 and L5-S1 articular facets noted on the SPECT image. CT scan through L3-4 (C) shows the absence of a portion of the articular facet (arrow) in the area of the increased activity on the SPECT scan.

TABLE 3
Results of Bone SPECT in Group 3—Fusion and Laminectomy Performed

Patient	Age (yr)	Surgery (Type of laminectomy and year)	SPECT
1	30	L4-L5 bilateral laminectomy, 1978 L4-S1 bilateral fusion, 1986	Increased activity in fusion mass bilateral
2	47	L4-S1 bilateral laminectomy, 1976 L4-S1 bilateral fusion, 1979	Positive L3-4 bilateral facets and vertebral body
3	44	L4-S1 bilateral laminectomy, 1984 L4-S1 bilateral fusion, 1985	Increased activity at fusion mass bilateral
4	47	L3-S1 bilateral laminectomy, 1982 L3-S1 fusion, 1985	Positive L3-4 bilateral facets and L5-S1 on right at facets and vertebral body
5	40	L4-S1 bilateral laminectomy, 1984 L4-S1 bilateral fusion, 1986	Positive L5-S1 facets bilateral
6	56	L3-L5 bilateral laminectomy, 1974 L3-S1 bilateral fusion times two, 1979 and 1982	Positive L3-4 facets, bilateral

case, there was activity in the area of the articular facets and less so in the vertebral body both above and below the fusion.

DISCUSSION

A large volume of data has been collected regarding patient outcome after laminectomy and after laminectomy with fusion, since these procedures were popularized in the 1930s. In a large series, the results from center to center tend to be remarkably similar and indicate the overall failure rate varies from 20–30% (*4–6*). The initial short-term follow-up studies, as expected, tend to give a more optimistic as well as somewhat more varied success rate (*6*). In longer range studies, i.e., 10 years or greater, the percentages tend to become much more similar from study to study (*7*).

During the early experience with surgery for the relief of back pain, there was discussion regarding the value of laminectomy alone versus laminectomy and fusion. Individuals such as Caldwell and Shephard (*8*) took the position that at the time of laminectomy, fusion was not necessary. They based their opinion on the fact that 80% of their patients obtained good or excellent relief from pain after removal of intervertebral disk at laminectomy without the need for fusion. However, individuals such as Stinchfield and Cruss (*9*) took the position that the performance of laminectomy produced instability and that, therefore, back pain would result if the patients were not stabilized by fusion at the time of surgery. More recent long-term follow-up studies have demonstrated that there is not significant difference in outcome whether a patient has fusion or not (*10*). Presently fusion is not commonly carried out at the time of laminectomy, but rather reserved for those individuals who have had a laminectomy and continued to have pain (*11*).

The causes of failure of lumbar surgery are varied. Some are relatively straightforward, such as inadequate indications for surgery because of poor initial identification or localization of the back pain. Occasionally there is recurrence of disk extrusion. In certain individuals, recurrence of pain after surgery may be a result of a different cause than the one that produced the initial pain. It is recognized that laminectomy, particularly over multiple levels, may cause instability and therefore place stress on the articular facets. If instability persists, slippage of one vertebral body on another may occur. The facets are amply innervated by pain fibers and facet derived pain is well documented (*12*). Other causes are even less apparent and in many instances a definite cause cannot be established even after repeated multimodality evaluation.

The standard method of re-evaluating a patient with persistent pain has been to use conventional radiography followed by myelography or CT (*13*). The role of lumbar spine scintigraphy in evaluating the "failed back syndrome" has been relatively limited. On planar scintigraphy, increased activity arising from the posterior arch is superimposed on activity from the vertebral body, therefore making the study relatively nonspecific (*14*). However, multiplanar SPECT studies have overcome this problem of superimpostion (*15*). In our present study we could, through the use of multiple planes, demonstrate with confidence the various components of the vertebral body as well as the site of the laminectomy.

In reviewing our data, it appears that the SPECT study is the most useful in those instances where there is the greatest likelihood for stress on the articular facets. This situation occurs least often in single level laminectomies and increases as multiple levels are decompressed and the potential for instability increases. Therefore we noted that in Group I, which was comprised of patients having single level laminectomy there were only two positive studies, both of which had increased activity in the area of the articular facets. However, in the second group there were only two negative studies and the remaining six were positive.

Likewise, in cases where there had been fusion superimposed on the laminectomy for the purpose of

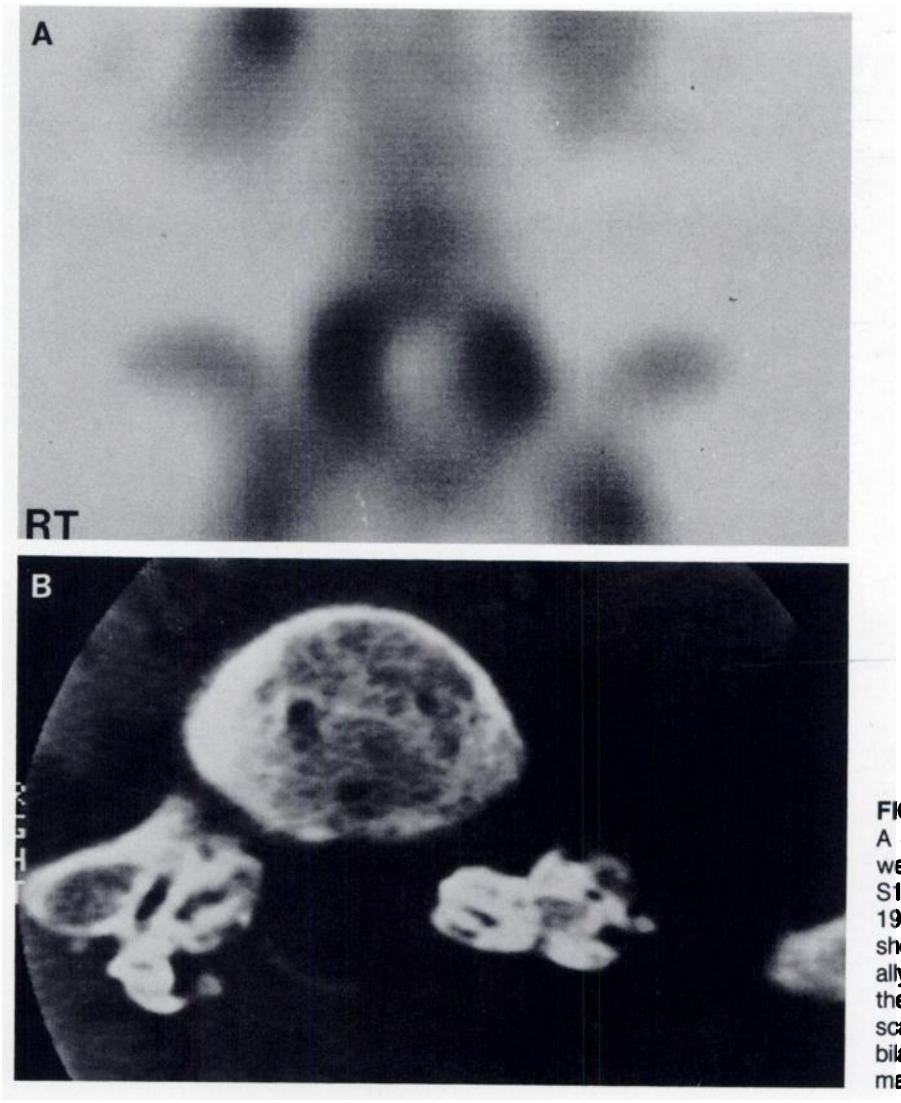

FIGURE 4
A 44-yr-old patient (Table 3) underwent bilateral laminectomy from L4-S1 in 1984 and bilateral function in 1985. The coronal SPECT scan shows (A) increased activity bilaterally in the fusion masses as well as the presence of a laminar defect. CT scan (B) through L4-5 shows partial bilateral reabsorption of the fusion mass.

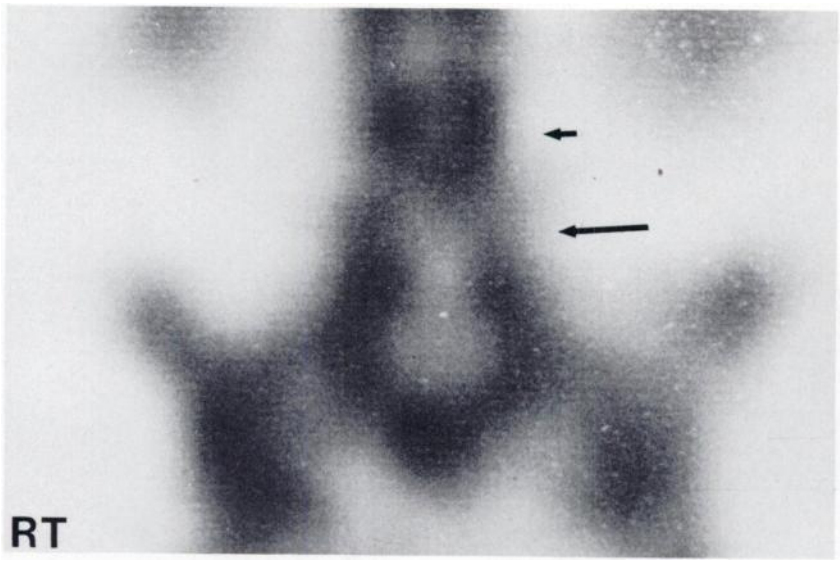

FIGURE 5
A 47-yr-old patient (Table 3) underwent bilateral laminectomy from L4-S1 in 1976 and bilateral fusion in 1979. The study shows on anterior coronal view a wide midline defect and increased activity at L3-4 (large arrow). The activity in the bilateral fusion masses is minimal (short arrow).

increased stabilization, uptake was nevertheless still present in the area of the articular facets in a number of cases. This most likely occurs because with fusion immobilization is carried out over multiple lumbar segments and the forces of flexion/extension are then disproportionately transferred to the segments above and below the fusion mass causing increased load on the facets at these levels.

As noted above, chronic facet stress as a result of instability arising from multi-level laminectomy has previously been proposed as a cause of persistent post-surgical back pain. However, the new dimension that has been added by SPECT scanning of the spine is that a more accurate delineation can be made of the level of involvement than could be previously by conventional x-ray or CT scan.

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