Skeletal Radiol (1988) 17:123–126

Skeletal Radiology

Subacute osteoporotic compression fracture: misleading magnetic resonance appearance

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Abstract. Three patients with benign subacute osteoporotic vertebral compression fractures are presented. T_1 weighted magnetic resonance (MR) images (SE 500/30) showed decreased vertebral signal. Because the results of the MR examination were thought to indicate malignant disease, extensive medical workups, including one biopsy, were pursued in all three patients. Routine (SE 500/30) spin-echo pulse sequences cannot definitively distinguish between benign and malignant vertebral compression fractures.

Key words: Spine, compression fracture – MR, T_1, low signal, nonspecific

Although most vertebral compression fractures are due to senile osteoporosis, the radiologist is often consulted by his colleagues to identify pathologic fracture due to an underlying malignancy. Several investigators have predicted that magnetic resonance (MR) will become the chief modality for imaging and diagnosing spinal-epidural metastatic disease [1, 3, 12]. A recent text has in fact stated that, with MR, "pathologic fracture can usually be distinguished from osteoporotic compression fracture. In the latter, the normal signal intensity of the vertebral body is maintained (bright on T_1 weighting), although vertebral body height is reduced" [10].

In contrast, the three patients presented in this paper had osteoporotic compression fractures studied by MR 12 to 93 days following the original injury. In all three cases, the fractured vertebral bodies exhibited decreased signal intensity on T_1 weighted images. Because the MR examination suggested an underlying neoplasm, extensive evaluation to exclude primary malignancy or multiple myeloma was undertaken in all three cases. These cases demonstrate that MR cannot definitively distinguish between benign and malignant vertebral compression fractures.

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Case reports

Case 1

ST, a 64-year-old woman with longstanding osteoporosis, fell on 30 November 1986 and developed severe back pain with a mild neurologic deficit. MR examination was performed on 12 December 1986 and revealed loss of height and decreased signal of the L_1 vertebra on SE 500/30 sequences (Fig. 1A). Slight cord compression was noted. All MR studies were performed on a Technicare 0.6 Tesla superconducting unit. Slice thickness was 0.75 cm on body coil images and 0.5 cm on surface coil images. The matrix was 256 × 128. The standard spin-echo, short TR, short TE pulse sequence used a TR of 500 milliseconds (ms) and a TE ranging from 30 to 38 milliseconds (ms) {SE 500/30–38}.

The decreased signal intensity on the SE 500/30 (T_1 weighted) image suggested a pathological fracture. Serum protein electrophoresis (SPEP), chest X-ray, and breast examinations were normal. A computed tomography (CT) examination of the lumbar spine performed on 16 December demonstrated the vertebral fracture without any lytic or blastic changes (Fig. 1B). Because the clinical and CT studies indicated a simple acute osteoporotic compression fracture, the diagnostic workup ceased. After 11 months of conservative treatment, the back pain and neurologic deficit have resolved.

Case 2

RI, a diabetic 84-year-old man presented with a 30 pound weight loss over a 2 months period and severe anemia. Skeletal survey demonstrated a severe compression fracture of L_1, with generalized osteopenia. MR examination of the spine (technique as described in case 1) showed the L_1 fracture with decreased signal on SE 500/30 (T_1 weighted) images. Because malignancy was of primary concern in this patient, an extensive diagnostic workup ensued. Bone marrow biopsy showed mega-

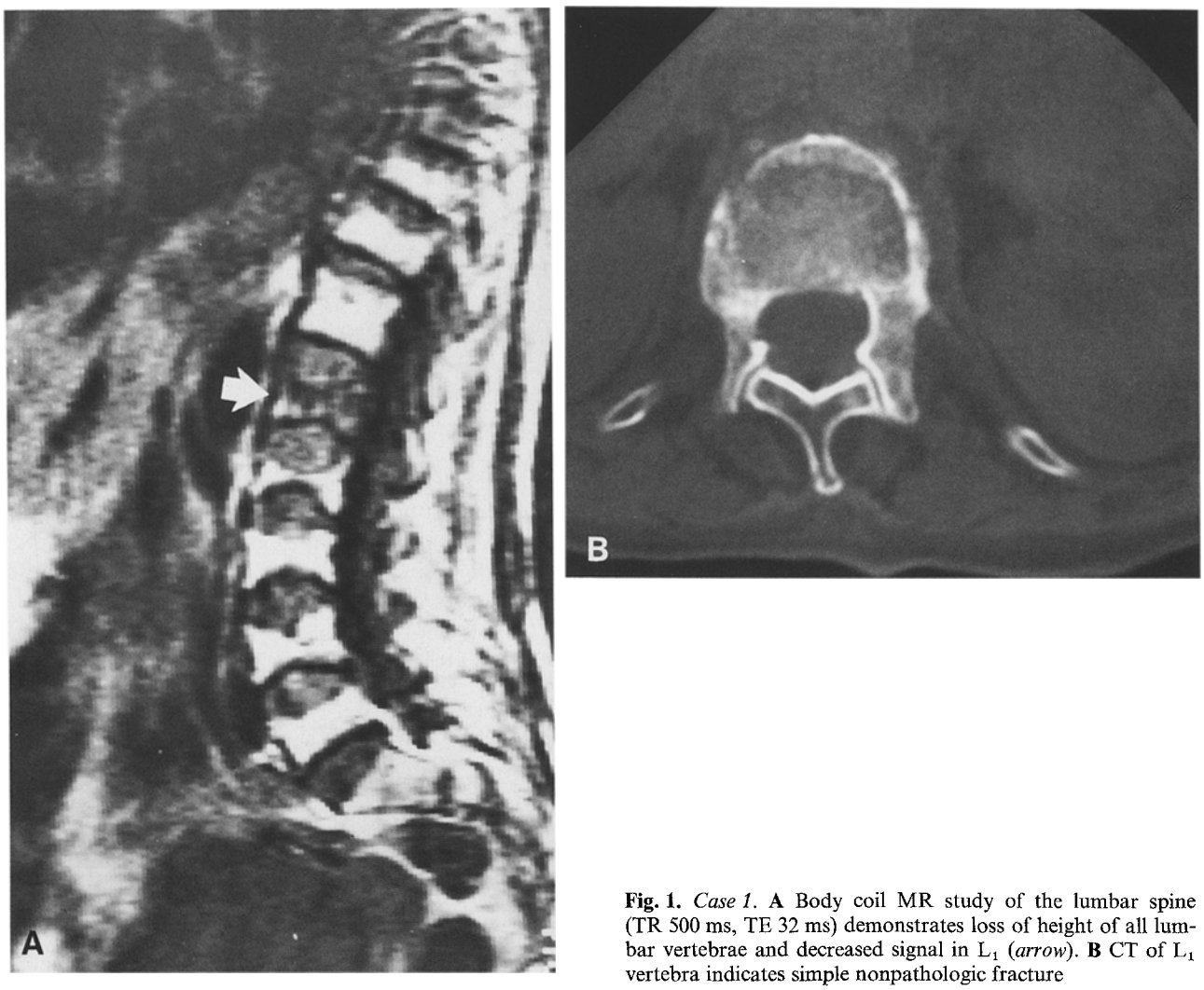

Fig. 1. *Case 1.* **A** Body coil MR study of the lumbar spine (TR 500 ms, TE 32 ms) demonstrates loss of height of all lumbar vertebrae and decreased signal in L_1 (*arrow*). **B** CT of L_1 vertebra indicates simple nonpathologic fracture

loblastic changes and mild iron deficiency. Intravenous pyelogram, abdominal CT, chest X-ray, barium enema, UGI series and small bowel series, upper and lower gastrointestinal endoscopy, SPEP, and urine electrophoresis were all negative. A Schilling test was positive for pernicious anemia. Radionuclide bone scan showed increased activity at L_1, but no other lesion was identified. Despite the fact that the patient had fallen two months prior to admission, trephine biopsy of L_1 under CT guidance was performed because of the MR appearance of the vertebra. Pathologic examination of the biopsy specimen revealed reactive new bone and no neoplasm. The patient was then discharged from the hospital and advised to wear a corset. He continues to improve 8 months after discharge.

Case 3

ER is a 74-year-old woman who suddenly developed severe radiating back pain on 8 December 1986. Spinal radiographs revealed a mild compression fracture of T_8 and a more severe compression fracture of L_1. Both fractures showed increased activity on radionuclide bone scan. Neurologic examination was unremarkable except for a left-sided Babinski. An MR examination of the spine (technique as described in case 1) performed on 11 March 1987 revealed hypointensity of T_8 and L_1 with loss of height on SE 500/30 (T_1 weighted) images (Fig. 2A, B). These findings were interpreted as consistent with the presence of metastatic neoplasm. The patient refused bone marrow biopsy or any invasive procedure. SPEP was within normal limits. There was no evidence of lung or breast mass. The patient remained stable with no treatment. A follow-up MR spinal examination performed on 4 June 1987 without surface coils revealed the T_8 signal to have completely returned to normal (Fig. 2C) and the L_1 signal to have increased somewhat.

Discussion

In the elderly patient, a decreased signal on SE 500/30 (T_1 weighted) spinal MR studies usually indicates the presence of metastatic disease or myeloma [3, 4, 10, 12]. When imaged on T_2 weighted sequences (SE 2000–2500/80–100), metastatic disease to the spine may produce contradictory signals, sometimes increased and sometimes decreased [11]. The three patients included in this

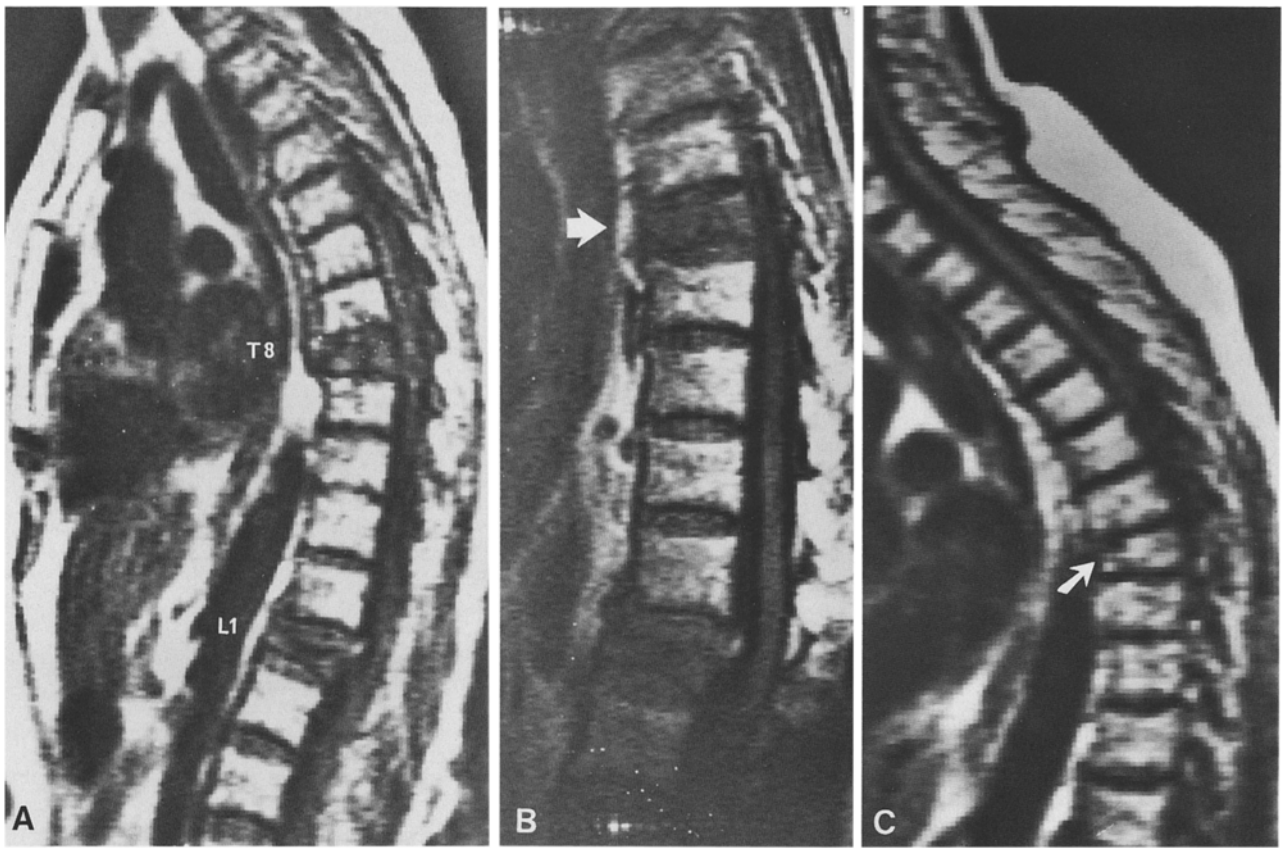

Fig. 2. *Case 3.* **A** Body coil (TR 500 ms, TE 38 ms) and surface coil **B** (TR 500 ms, TE 30 ms) images reveal loss of height and decreased signal in T_8 (*arrow*) and L_1 (*arrow*). This MR study was performed 3 months after onset of symptoms. **C** Follow-up MR study done 3 months after first study (6 months after onset of symptoms) shows return of normal signal in T_8 on T_1 weighted image (*arrow*)

article demonstrate, however, that a low signal intensity may be produced by a simple, benign, vertebral fracture. This observation is important because as many as 1/3 of vertebral compression fractures in patients with known primary malignancies are benign [6]. The need to distinguish between benign and pathologic fracture is obvious. Further diagnostic evaluation and treatment depend upon it.

According to Modic et al., a subacute fracture will show increased T_1 and T_2 signals because of hemorrhage. Chronic fractures will produce a decreased or isointense signal on T_1 weighted images and an increased signal on T_2 weighted images [9]. McCardle et al. state that on T_1 weighted images a vertebral fracture will have a normal signal from day 1 through day 4 and an increased signal after the sixth day [7].

Despite such contradictory statements, it should not be surprising that a healing fracture of any bone should produce a decreased MR signal on an SE 500/30 pulse sequence (T_1 weighted image). Hematoma forms at the fracture site together with extensive edema, inflammatory infiltrate, and bone necrosis. Thus the fatty marrow which normally produces a bright signal on SE 500/30 (T_1 weighted) sequences is disrupted. Subsequent resolution of the hematoma with fibrosis and formation of cartilage and new bone eventually progress to complete remodelling [2]. Except for the hematoma, which is eventually resorbed, most of these changes will cause decreased signal on SE 500/30 (T_1 weighted) or similar sequences. These changes include osteomyelitis [5], edema, and ischemic necrosis of bone [8]. The same nonspecificity and the resulting misleading appearance in the spine has also been described with fractures of the long bones [13]. In this report, Stafford et al. described three cases of stress fracture where T_1 marrow signals were markedly decreased. One of these fractures was biopsied to exclude a tumor. Since fracture healing and bone remodelling can go on for months and even years [2], many benign fractures will be misinterpreted as malignant on MR studies.

On the other hand, CT may provide more information and permit a more reliable distinction

between benign and malignant fractures. If no areas of permeation, lytic or blastic changes, or adjacent masses are seen, then the fracture is presumed to be benign. If the clinician, however, strongly suspects an underlying malignancy, then one must resort to a percutaneous or open biopsy to make a definitive diagnosis.

Conclusion

A decreased vertebral signal on SE 500/30 (T_1 weighted) MR images of a compression fracture is a nonspecific finding. Both benign and malignant fractures can produce the same result. The MR findings should not be the only indication for an extensive and invasive diagnostic workup.

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