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Case Report

Percutaneous Sacroplasty under Fluoroscopic Guidance Combined with Epidurogram for Sacral Insufficiency Fracture Resulting from Metastatic Tumor and Osteoporosis

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Sacral insufficiency fracture resulting from a metastatic tumor or an osteoporotic fracture causes severe low back pain and radiating pain mass effect on neural foramen and chemical irritants. Percutaneous sacroplasty is one of the effective treatment modalities for sacral insufficiency fracture and its pain. Because of the structural complexity of the sacrum, obtaining an epidurogram of the S1 and S2 nerve roots before the start of the procedure can be helpful to avoid nerve injury. We present 2 successful cases of percutaneous sacroplasty performed under fluoroscopic guidance. A 65-year-old man with sacral metastasis from stomach cancer and a 52-year-old man with sacral insufficiency fracture were suffering from severe buttock pain and radiating pain. After epidurography of the S1 and S2 nerve roots with steroid and contrast dye, percutaneous sacroplasty with fluoroscopy on the S1 or S2 body and alae was performed on both patients. There was no cement leakage or any other major complications. Both patients experienced significant reduction in pain.

Key words: Fluoroscopy-guided, sacral cementoplasty, sacral insufficiency fractures, sacral metastasis

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Sacral insufficiency fracture in patients with osteoporosis or sacral metastasis from malignant tumors may cause severe low back pain and radiating pain due to mass effect on neural foramen and chemical irritants. Aggravated by the sitting or supine position, sacral insufficiency fractures may prohibit normal activities of daily living and decrease the patient's quality of life. The classic treatment approach to sacral insufficiency fracture involved conservative therapy including bed rest and pain control (1). However, the immobility accompanying by these conservative modes of therapy could lead directly to deterioration of the general condition by increasing the risk for development of pulmonary embolism, deep vein thrombosis, and pressure sores, and commonly leads to skeletal muscle atrophy and the resultant need for rehabilitation therapy (1-3).

Recently, the consensus has arisen that vertebroplasty has a beneficial effect in bone-origin pain caused by compression fractures or metastatic cancer (4-7). Furthermore, positive results have been reported in the sacrum (1,3,8-10). However, because of the three-dimensional complexity of the sacrum, using only fluoroscopy can allow penetration of the anterior cortical bone of the sacrum and abdominal organ damage unless there is full awareness of the position of the needle tip. Lack of comprehension of the needle position can bring about direct sacral nerve damage and inappropriate cement deposition which can result in urinary or fecal incontinence or foot drop due to motor weakness of the sacral nerves. We present 2 cases of successfully completed sacroplasties on both the sacral bodies and alae under fluoroscopy combined with epidurogram and epidural block in order to reduce the complications described above.

Case Report

Case 1

A 65-year-old man presented to the pain clinic with buttock pain radiating down the left lower extremity. He had been diagnosed with stomach cancer with multiple metastases 7 months earlier and visited the pain clinic due to refractory pain despite radiation therapy to metastatic lesions in the bodies and alae of the first and second sacral vertebrae. Magnetic resonance imaging (MRI) revealed destruction of the sacrum with metastatic lesions compressing the first sacral nerve (Fig. 1). When the patient visited our department for the first time, he was unable to sit due to aggravation of buttock pain. He had a visual analogue scale (VAS) score of 9 in the sitting position. He also experienced severe radiating pain to the left posterior thigh in the dermatome of the first sacral nerve. Although we performed a transforaminal epidural steroid injection into the left first sacral neural foramen, the effect of the injection was maintained only for one day. Therefore we decided to perform sacroplasty.

The procedure was performed under sterile conditions. After preparing and draping the operation site, transforaminal epidural steroid injections to the left first and second sacral nerves were performed before the start of the sacroplasty. The injected drug contained 2 mL of iopamidol (Pamiray Inejction 300TM, DongKook Pharm. Co., Ltd., Gwanghaewon-myeon, Korea) as contrast dye, 0.5 mL of dexamethasone sodium phosphate 5mg/mL and 0.5 mL of 2% lidocaine, so that the total volume of the injected drugs became 3 mL of 0.33% lidocaine, which was given to each neural foramen (Fig. 2A). C-arm anterior-posterior (AP) fluoroscopic imaging was performed and optimized by rotating the apparatus cephalad until the endplates of the L5 and S1 vertebral bodies were visualized as parallel lines and by rotating left or right until the spinous process was at the midline in the image. A bone access needle was inserted at the left superior articular process of the first sacral vertebra. The needle was positioned at an angle of 20 degrees to the sacral body and advanced forward, avoiding spinal canal or nerve injury with assistance from the epidurogram and intermittent checking of the lateral fluoroscopic image. The needle was stopped when its tip approached the anterior third of the AP diameter of the S1 body on the lateral image. At this time, the location of the needle tip was slightly lateral to midline which was appropriate for a lesion on the left side of the S1 body. A second bone access needle was inserted at the sacral ala lateral to the S1 neural foramen. The needle was angled 20 degrees lateral and 10 degrees cephalad and advanced forward assuring that the needle tip did not breech the anterior cortex of the sacral ala on the lateral fluoroscopic image. A third bone access needle was inserted at the sacral ala lateral to the S2 neural

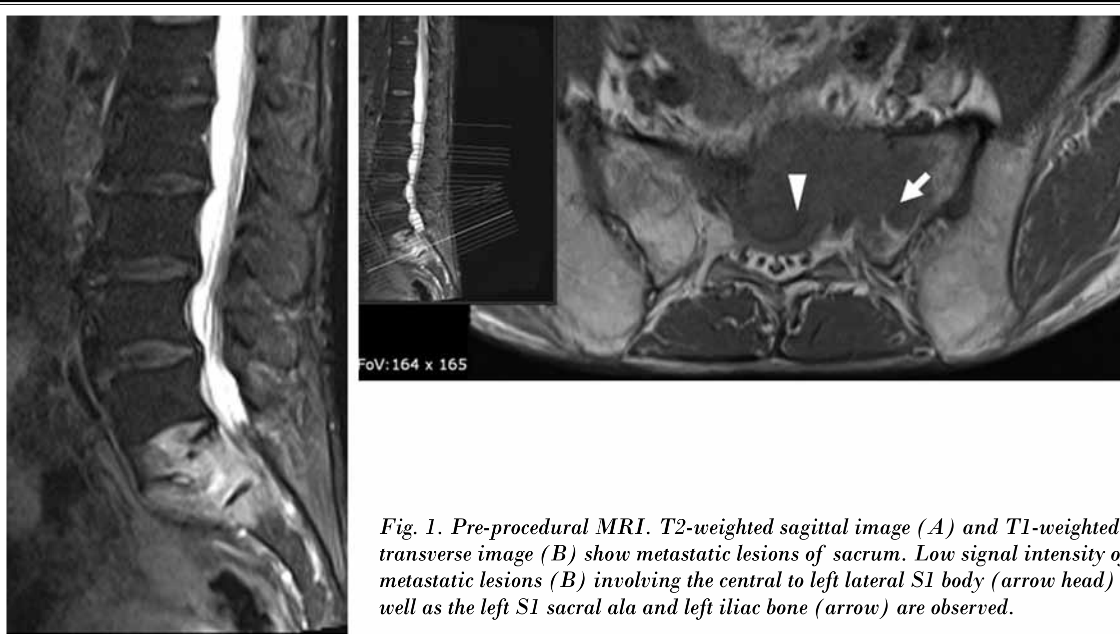

Fig. 1. Pre-procedural MRI. T2-weighted sagittal image (A) and T1-weighted transverse image (B) show metastatic lesions of sacrum. Low signal intensity of metastatic lesions (B) involving the central to left lateral S1 body (arrow head) as well as the left S1 sacral ala and left iliac bone (arrow) are observed.

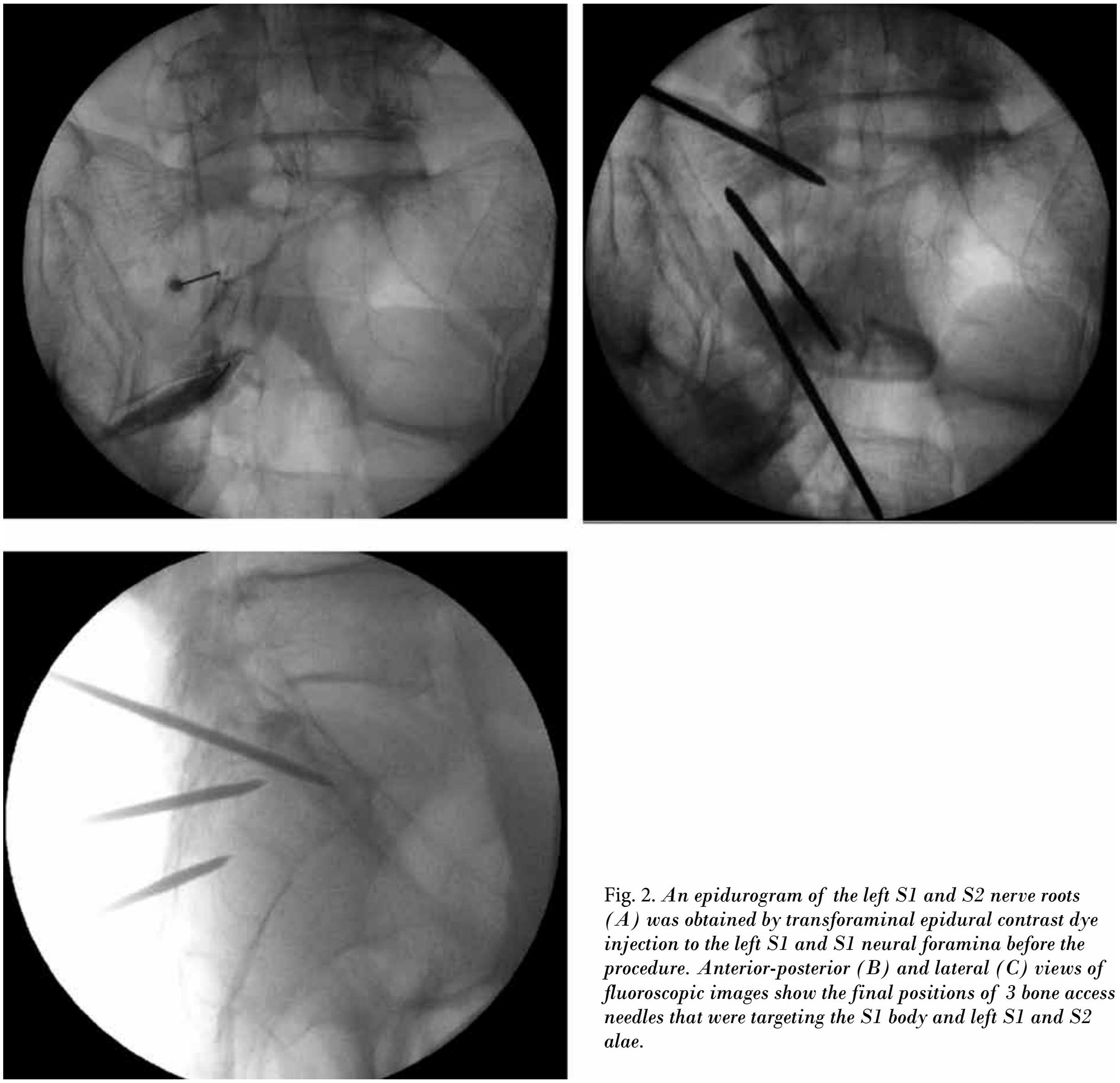

Fig. 2. *An epidurogram of the left S1 and S2 nerve roots (A) was obtained by transforaminal epidural contrast dye injection to the left S1 and S1 neural foramina before the procedure. Anterior-posterior (B) and lateral (C) views of fluoroscopic images show the final positions of 3 bone access needles that were targeting the S1 body and left S1 and S2 alae.*

foramen. This needle was also angled 20 degrees lateral and 10 degrees cephalad and advanced forward under fluoroscopic guidance assuring that the anterior cortex was not breeched on the lateral fluoroscopic image. After confirmation of the positions of the 3 needles on the AP and lateral fluoroscopic images (Fig. 2B, C), 2 mL of polymethylmethacrylate (PMMA) bone cement was injected via each needle. During the bone cement injection, real-time fluoroscopy was performed to ensure that there was no leakage of cement to the spinal canal, neural foramina, or abdominal cavity (Fig. 3A, B). There was no major vessel bleeding, no nerve-stimulating symptoms, and no motor weakness on intermittent leg movement testing. On postoperative abdominal-pelvic computed tomography (CT), the cement was observed to be placed appropriately in relation to the lesions. There was no extravasation (Fig. 4 A, B).

The patient reported 50% reduction of pain at 3 hours after the procedure and the following day, the pain had decreased by 80%. Both eating and sleeping in sitting and lying positions were now possible. From the second day after the procedure, the patient no

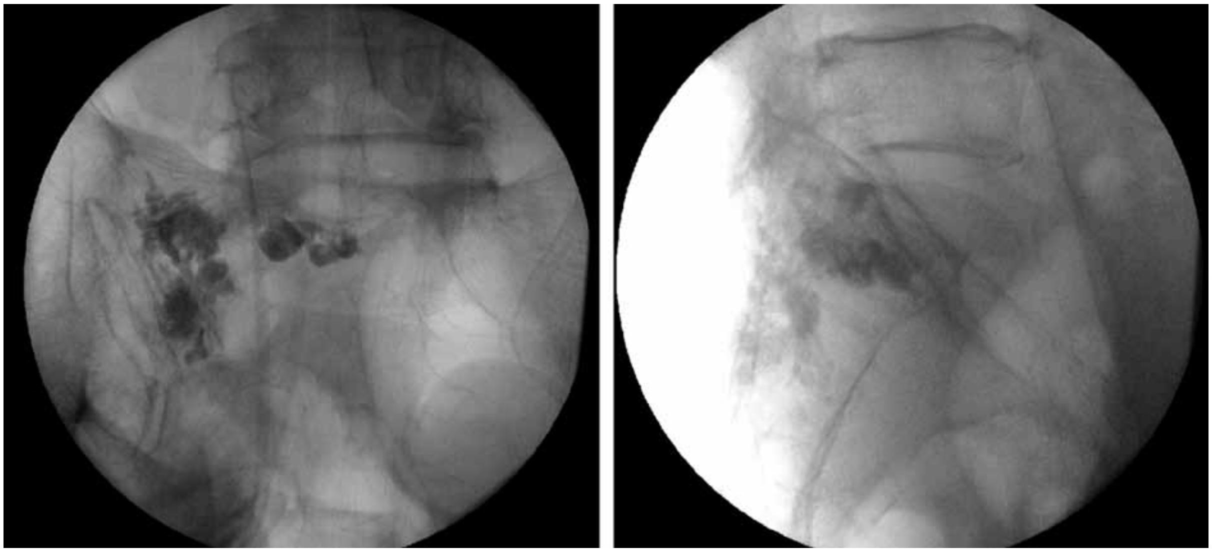

Fig. 3. *Anterior-posterior (A) and lateral (B) fluoroscopic views show introduction of cement into the sacrum and confirm lack of cement leakage.*

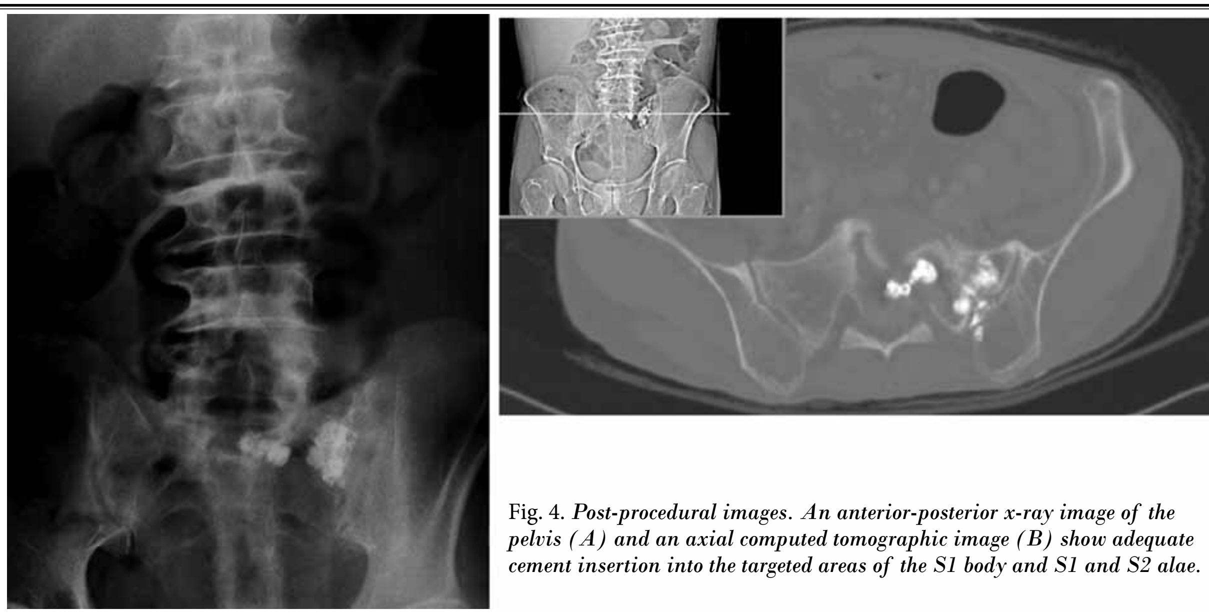

Fig. 4. *Post-procedural images. An anterior-posterior x-ray image of the pelvis (A) and an axial computed tomographic image (B) show adequate cement insertion into the targeted areas of the S1 body and S1 and S2 alae.*

longer complained of pain with activities of daily living (VAS < 2).

Case 2

A 52-year-old man with alcoholic liver cirrhosis was suffering from radiating pain in the right posterior leg and was diagnosed with an osteoporotic sacral insufficiency fracture and spondylolisthesis at S1 on S2. His T-score on a bone mineral density examination was – 3.1. We performed a transforaminal epidural block of the right S1 nerve due to right S1 nerve root compression accompanied by severe (VAS 8) radiating pain. However, the pain relief achieved by the block lasted no longer than one day. The spine surgery department then performed a right S1 laminectomy to decompress the nerve. Despite the surgery, there was no pain relief. The

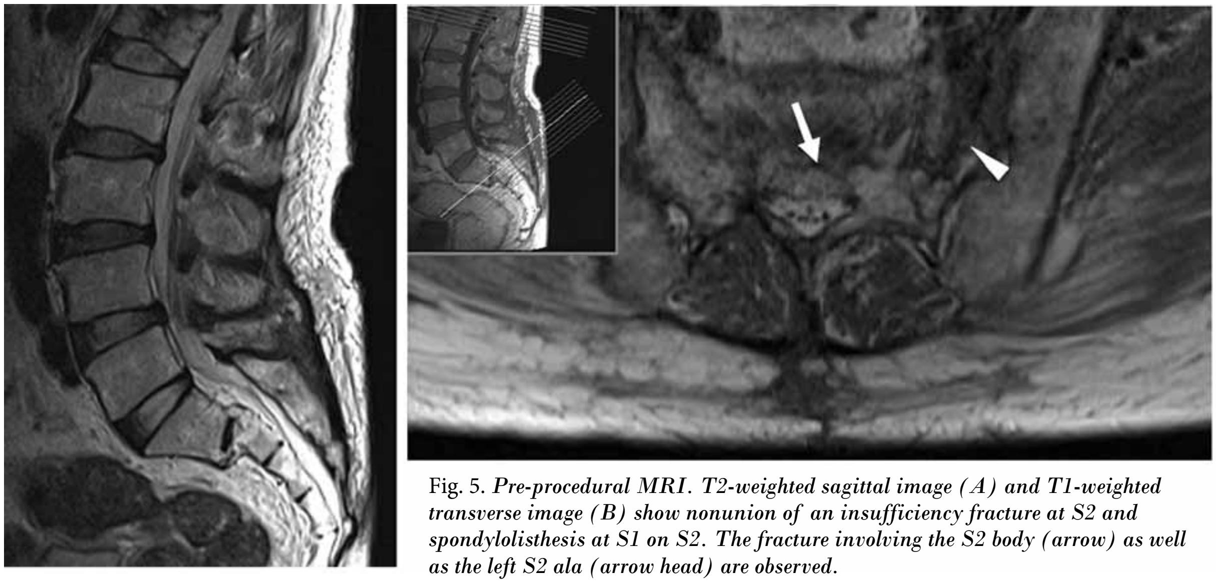

Fig. 5. *Pre-procedural MRI. T2-weighted sagittal image (A) and T1-weighted transverse image (B) show nonunion of an insufficiency fracture at S2 and spondylolisthesis at S1 on S2. The fracture involving the S2 body (arrow) as well as the left S2 ala (arrow head) are observed.*

patient was treated with conservative methods such as medications and bed rest. When the patient revisited the pain clinic after 7 months, he reported that the pain was worsening (VAS 9) and he could not ambulate even indoors. MRI showed progression of the spondylolisthesis and continued high signal intensity of the body and ala of S2 that suggested non-union of the insufficiency fracture (Figure 5A, B). In addition, the radiating pain was not only on the right but was now also on the left. The pain on the left side was even more severe than what he had been experiencing on the right. Accordingly, we planned a sacroplasty on the S2 vertebra. The patient preparation was the same as that in Case 1. The transforaminal epidural block and epidurography were performed following the same method (Fig. 6A, B).

C-arm AP fluoroscopic imaging was optimized by rotating the apparatus cephalad until the endplates of the L5 and S1 vertebral bodies were visualized as parallel lines and by rotating left or right until the spinous process was at the midline in the image. A bone access needle was inserted into the sacral ala between the S1 and S2 neural foramina. The needle was positioned at a 20 degree angle to the anterior border of the S2 body and advanced forward under fluoroscopic guidance, avoiding spinal canal or nerve injury with assistance from the epidurogram. The endpoint of the needle tip was the anterior third of the AP diameter of the S2 body on the lateral image. A second bone access needle was inserted into the sacral ala at a level between the S1 and S2 neural foramina. The needle was angled 20 degrees lateral and 10 degrees caudad and advanced forward assuring that the needle tip was not positioned beyond the anterior border of the sacral ala on the lateral fluoroscopic image. After confirmation of the positions of the 2 needles on the AP and lateral fluoroscopic images (Fig. 7A, B), 0.7 mL of PMMA were instilled into the S2 body and 1 mL of PMMA was instilled into the S2 sacral ala. During the bone cement injection, real-time fluoroscopy was performed to ensure that there was no leakage of cement to the spinal canal, neural foramina, or abdominal cavity (Fig. 8A, B). There was no major vessel bleeding, no nerve-stimulating symptoms, no motor weakness on intermittent leg movement testing, and no paralysis of the anal sphincter.

While the patient felt severe pain even with small movements while lying in bed before the procedure, he did not complain of pain during position change from supine to standing at 3 hours after the sacroplasty. From the second day after the procedure, the patient no longer complained of pain with activities of daily living (VAS < 2).

Discussion

Although the effects of sacroplasty of the sacral alae in pathologic fractures or insufficiency fractures have been reported in several studies, there has been a debate about the effects because the degree of pain relief obtained following sacroplasty was less than that obtained with vertebroplasty in thoracic or lumbar vertebral fractures (11-13). This might be because of per-

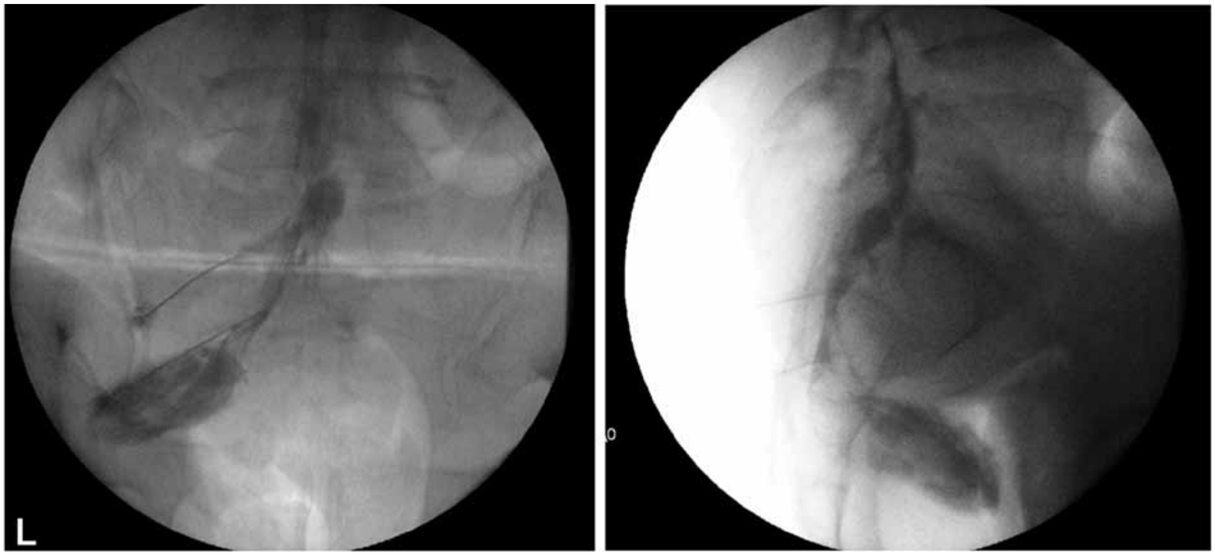

Fig. 6. *An anterior-posterior fluoroscopic view (A) and a lateral fluoroscopic view (B) of an epidurogram were obtained by transforaminal epidural contrast dye injection to left S1 and S2 neural foramina before the procedure.*

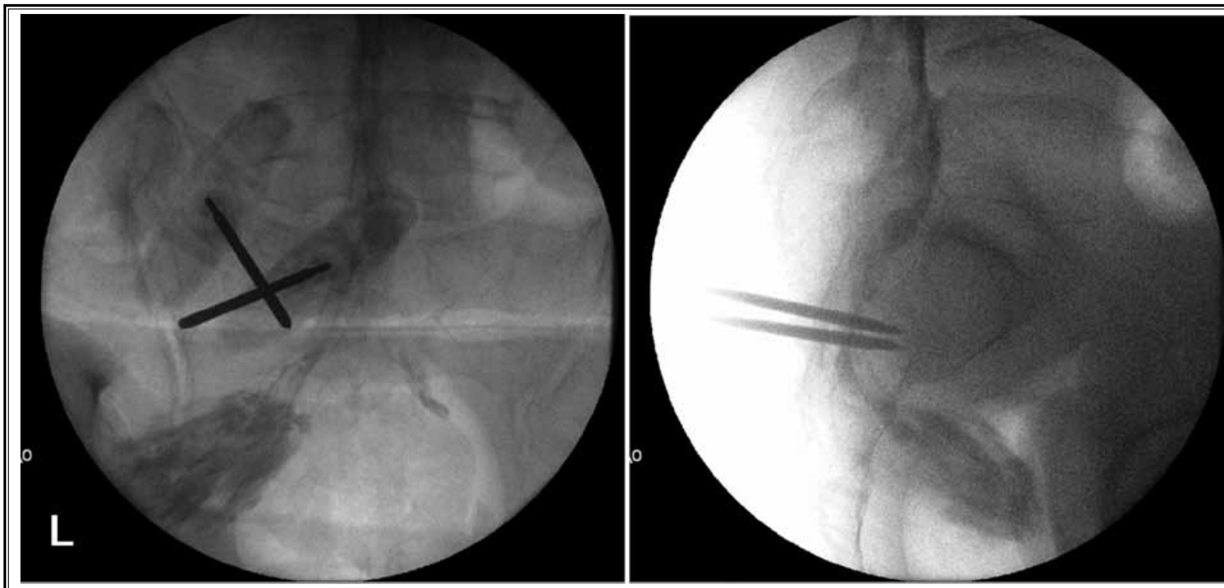

Fig. 7. *Anterior-posterior (A) and lateral (B) fluoroscopic views show the final positions of 2 bone access needles that were targeting the S2 body and left S2 ala.*

sistent sacral body pain in spite of the stability achieved by sacroplasty (13).

In Case 1, we assessed that the aggravating factor of the patient's pain was weakening of the inherent sacral osseous integrity due to diffuse metastatic lesions which produced sacral instability and pain when sitting or standing. Therefore we felt that the instillation of bone cement into the sacral body was necessary. In addition, the metastatic lesions had extended to the left S1 neural foramen on the preoperative MRI, which made the foramen narrower and induced compression and chemical-mediated neuroinflammation of the left S1 nerve (Fig. 1). In such a case, insertion of PMMA into the corresponding vertebra might be helpful because

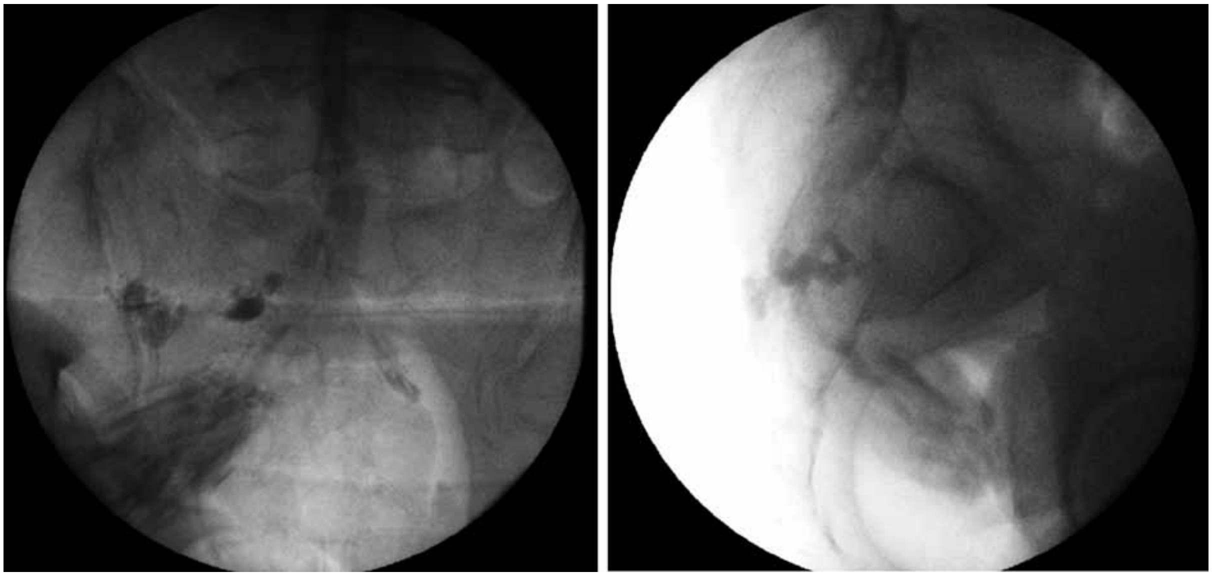

Fig. 8. *Anterior-posterior (A) and lateral (B) fluoroscopic views show the introduction of cement into the sacrum and confirm lack of cement leakage.*

it destroys painful nerve endings within the vertebral body by an exothermic reaction during polymerization and it has tumoricidal effect by inducing tumor necrosis. As such, we believe that PMMA could have a pain-reducing effect in this patient (13-16).

The patient of Case 2 had instability between S1 and S2, which likely caused continuous irritation of the bilateral S1 spinal nerves (Fig. 5A, B). Therefore, to reinforce the S2 body, we injected PMMA into both the S2 body and sacral ala for pain reduction.

The sacrum has three-dimensional complexity which makes it difficult to distinguish the structures on the fluoroscopic imaging. Even the sacral neural foramina are not visible on the lateral view. CT has an imaging advantage on these points and would be safer for sacroplasty because the position of the needle can be visualized accurately. On the other hand, there are also disadvantages to CT, such as difficulty with real-time monitoring of cement delivery and exposure to a higher radiation dose (3,13,17). Therefore, combining the 2 modalities of CT and C-arm fluoroscopy is ideal, but this is not available in most clinics. Efforts have been made to overcome the disadvantages of fluoroscopy and to increase the safety and reliability of fluoroscopic imaging (2,13).

The mixture of contrast agent, lidocaine, and dexamethasone were given to perform the transforaminal epidural injection. This mixture made it possible to observe the course of nerve roots running in the epidural space. This epidurogram helped avoid needle induced injury to the nerve roots and duramater during needle insertion and advancement. Furthermore this epidural admixture can reduce neuroinflammation and relieve post-operative pain through the use of an epidural steroid in the injectate. As our clinical protocol, 0.33% lidocaine and dexamethasone were used to do the transforaminal epidural steroid injection. Although its concentration is much lower than for a complete sensory blocking dose, it could provide some pain relief without either complete sensory block or motor block. Patients would still be able to react if a bone access needle came close to a nerve. Indeed, during our 2 procedures, there were no neuropathic symptoms and we also intermittently checked leg movements and anal tightness to ensure the absence of paralysis. Adding dexamethasone decreased the neural and perineural inflammation caused by prolonged compression and released chemical mediators from the tumors. We thought this epidural block would have been helpful to decrease the pain during and after the procedure.

Lateral fluoroscopic imaging should be performed throughout the sacroplasty to avoid spinal canal, neural foramen, and abdominal organ damage if the procedure is performed under only fluoroscopic guidance. In addition, real-time fluoroscopic observation is necessary during the cement delivery to monitor for extravasation. Safe sacroplasty can be possible if there is careful planning of needle insertion and cement delivery based on MRI or CT conducted before the procedure. Assisted pain control by tranforaminal epidural block and epidurogram would be helpful. Further investigation of long-term effects of sacroplasty on both the sacral bodies and sacral ala under fluoroscopy will be needed for broader clinical applications.

Disclaimer

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Conflict of interest

Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

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