Arthroscopic and Endoscopic Spinal Surgery

Text and Atlas, Second Edition

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Diagnostic and Therapeutic Percutaneous Transpedicular Approaches to the Spine

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TRANSPEDICULAR BIOPSY

Historical Review and Rationale for the Procedure

Open biopsy advocates prefer transpedicular biopsy (TPB) because it maximizes tissue retrieval, thus providing the highest diagnostic success rate. Open biopsy is especially relied on after failed needle biopsy or in selected presumed primary bone or cartilaginous tumors *(1)*. However, the complications and morbidity associated with an open surgical procedure provided incentive for the development of closed needle biopsy techniques.

Historically, preference for closed biopsy of the spine developed because it was claimed to be less invasive, less morbid, and more cost-effective than open biopsy. Closed biopsy has also become increasingly accurate as techniques and image modalities have evolved. Local anesthesia and an outpatient setting contribute to enhanced cost-effectiveness. Local anesthesia also allows nerve root monitoring during biopsy. Consequently, percutaneous biopsy of spinal lesions has become the biopsy technique of choice, but not without potential complications, such as nerve injury, bleeding, pneumothorax, and inadequate amount of tissue retrieval for diagnosis *(2–5)*.

The reported diagnostic success rates of closed needle biopsy of the spine are variable and decrease significantly with primary bone tumors *(2,3,6,7)* and tumors with complex architecture and cell pleomorphism (such as giant cell tumors, aneurysmal bone cyst, osteoblastoma, osteosarcoma, or chondrosarcoma) *(8,9)*. Crush artifacts, one of the problems created by small needles *(3)*, predisposes conventional closed biopsy to an inferior success rate *(6,10)*. Fyfe et al. *(10)* reported a cadaveric study in which biopsy specimens with tissue core diameters ≥2 mm enhanced diagnostic accuracy. Because the pedicle accommodates biopsy instruments that retrieve tissue core diameters >2 mm, the diagnostic success rate of a percutaneous TPB should approach the success rate of an open procedure. Larger tissue core diameters also avoid the diagnostic problems created by crush artifacts. Therefore, there was room for improvement and a transpedicular approach was developed as an alternative to the other biopsy methods for vertebral lesions involving the sacrum and thoracic, lumbar, and seventh cervical vertebral *(11,12)*.

Enthusiasm regarding surgery involving the vertebral pedicle is reflected by the ever-increasing information regarding transpedicular fixation *(13)*, morphology *(14–21)*, biomechanics *(22)*, fracture management *(13,23)*, and hemiepiphysiodesis *(24)*.

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Transpedicular fixation techniques have continued to increase in popularity since their inception *(25,26)*. The pedicular channel also has been used for fracture reduction *(27,28)*, external skeletal fixation *(29)*, decompression *(30)*, thoracic discectomy *(31)*, bone grafting *(26)*, and methylmethacrylate insertion *(26)*.

Despite increasing knowledge of vertebral morphometry and experience with transpedicular fixation, it was a long time before the pedicle was popularized as a channel for percutaneous vertebral needle biopsy.

The use of the pedicular channel for open biopsy is not a new idea. In 1928, von Lackum (as reported by Duncan and Ferguson *(32)* in 1936) performed a transpedicular curettage of a vertebral body giant cell tumor in an 8-yr-old girl. In 1933, Capener *(33)* described an anterolateral decompression in which the pedicle was removed to access lesions in the vertebral body. In 1949, Michele and Krueger *(34)* described a transpedicular approach as one of four posterior approaches to the vertebral body. It was not until 1979 that Travaglini *(35)* reintroduced this technique in the English literature.

The belated development of this technique may be attributed to three explanations. First, the proximity of the pedicle to neural elements deterred closed biopsy attempts because of fears of injuring these vital structures. Second, appreciation of the biopsy potential of vertebral body lesions through the pedicle has been limited *(36)*. Third, the larger tissue samples retrievable with open biopsy made open procedure (with radiographic guidance when indicated) the "gold standard" to which all other biopsy procedures had to be compared.

In 1983, Roy-Camille et al. *(13)* first described an open (TPB) technique used in a series of 47 patients. In 1990, Rengachary described a transpedicular technique that included a hemilaminectomy, a partial facetectomy, and a partial pediculectomy *(19)*. Also in 1990, Fidler and Niers *(37)* reported one case of an open TPB. In 1991, Renfrew *(7)* reported percutaneous TPBs in six patients using computed tomography (CT). We have reported the technique of TPB as an efficacious, safe, and cost-effective method *(12,38–43)*. In most cases, it can be performed under local anesthesia, with fluoroscopic guidance.

The Percutaneous Transpedicular Biopsy Technique

The percutaneous procedure requires a high-resolution image intensifier and a radiolucent operating table that can be precisely tilted. The transverse pedicle width and the pedicle angle in the axial plane are determined from preoperative CT images. The operating table is canted until the pedicular angle in the axial plane is perpendicular to the floor and the X-ray beam is collinear with the sagittal pedicular angle determined from lateral views of the vertebral body. A "bull's-eye" view of the pedicle should be obtained. This procedure is analogous to obtaining perfect circles during distal interlocking procedures of intramedullary femoral nail. Local anesthesia is obtained by injecting plain 1% lidocaine hydrochloride along the intended biopsy tract and infiltrating the posterior primary ramus as it emerges from the junction of the transverse process and superior facet of the corresponding joint and adjacent superior and inferior facet joints. After insertion of the guide pin, the physician makes a small stab wound incision about 1 cm long to allow the passage of a modified Kambin dilator *(44)* (5.35-mm diameter; Smith & Nephew) over the guide pin until it reaches bone (Fig. 1). Following this, a cannulated modified Kambin sleeve (6.4-mm diameter; Smith & Nephew) is passed over the dilator and guide pin until it abuts the cortical margins of the pedicle (Fig. 2). The use of a cannulated sleeve prevents clogging of the bone biopsy instrument with

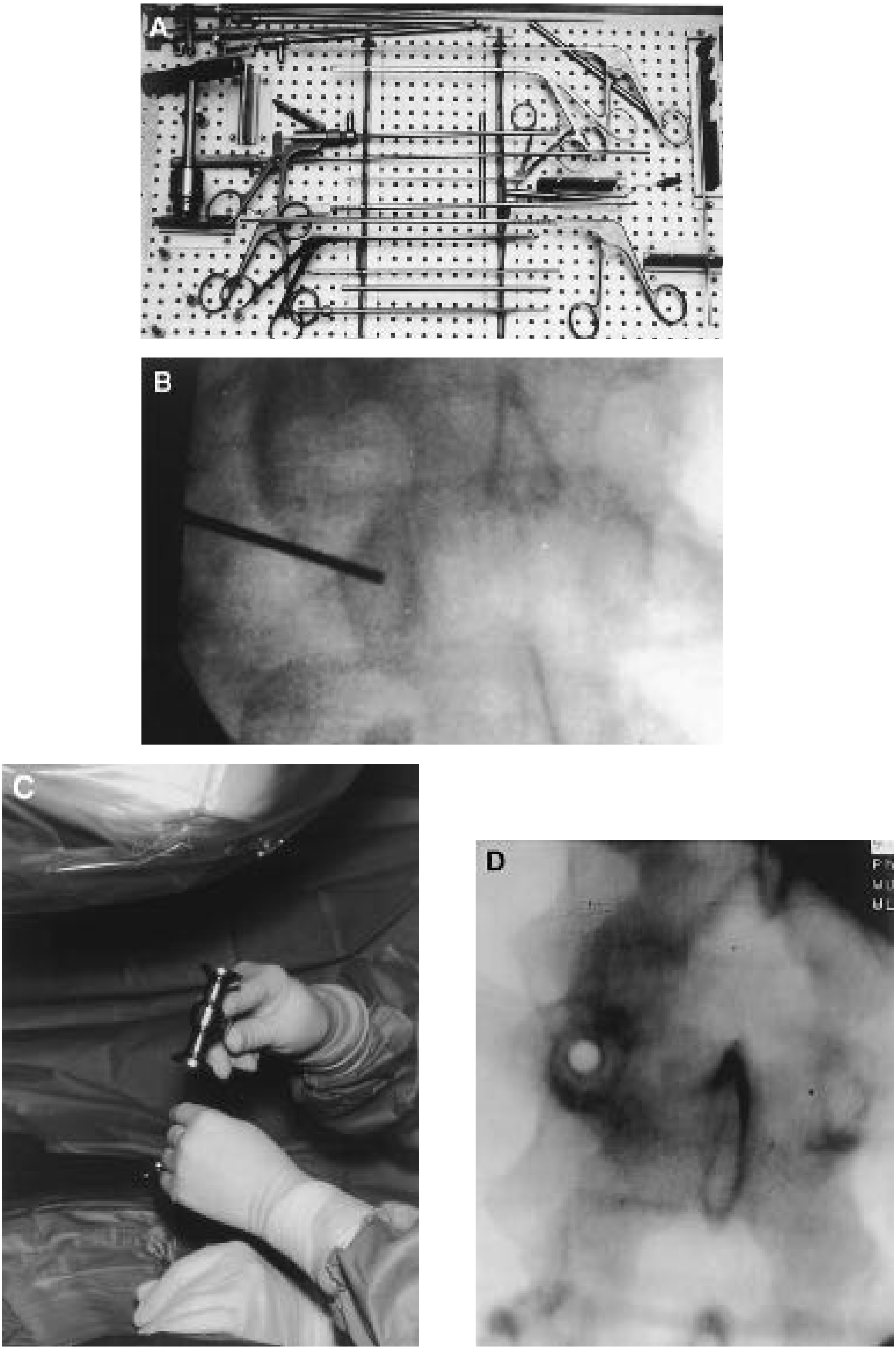


Fig. 1. **(A)** Modified Kambin-Craig instrumentation (manufactured by Smith & Nephew). Under image intensification, a guide pin is inserted **(B)** by tapping it gently **(C)**; **(D)** "bull's-eye" view into the pedicle.

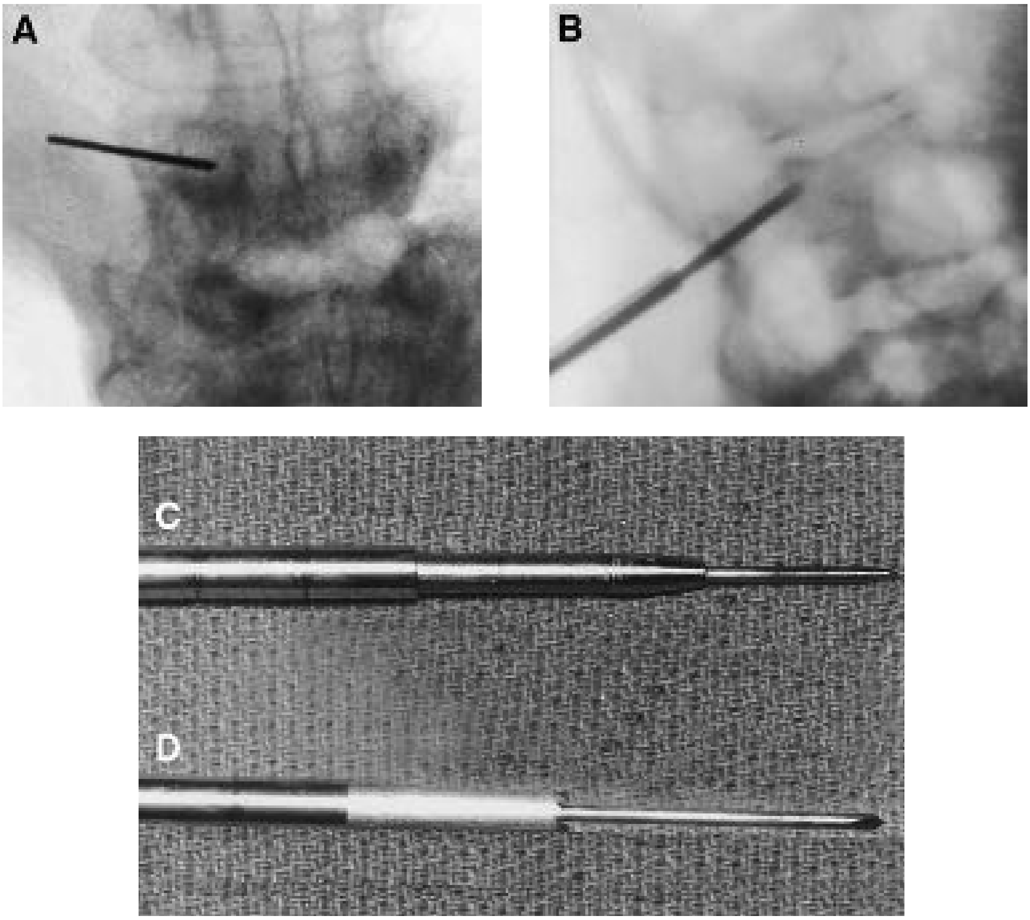


Fig. 2. **(A,B)** The pin is angled to the lesion intended for biopsy. Next a dilator **(C)** is passed over the guide pin to dissect the soft tissues, and a cannulated sleeve is inserted over the dilator until it reaches the pedicle. The dilator is then removed, and the toothed cutting biopsy tool **(D)** is inserted into the sleeve over the guide pin. (Partially reproduced with permission from ref. *40*.)

subcutaneous tissue or muscle fibers and also facilitates the insertion of the instrument for discectomy. Next, the physician removes the dilator and advances a toothed, modified Craig biopsy tool (3.2- or 5.15-mm diameter; Smith & Nephew) over the guide pin into the target. This tool has a larger diameter than the conventional Craig needle biopsy and a knob to attach a torque device that will facilitate manual introduction of the biopsy tool. The larger lumen allows passage of various instruments through the biopsy tool. It is important that the surgeon remove simultaneously the Steinmann pin and the biopsy tool. This method allows the successful removal of a core of bone or pathological tissue, because the specimen is impacted between the guide pin and the bone biopsy instrument *(12,40)* (Fig. 3).

We have demonstrated in the laboratory and in the clinical setting that retrieval of osteopenic bone and pathological soft tissue is enhanced as tissue is impacted between the biopsy cutting core tool and the guide pin. This expedience holds securely the biopsy specimen within the cutting core tool. Sufficient space also exists for insertion of instruments at various angles and directions to increase tissue sampling and access any vertebral

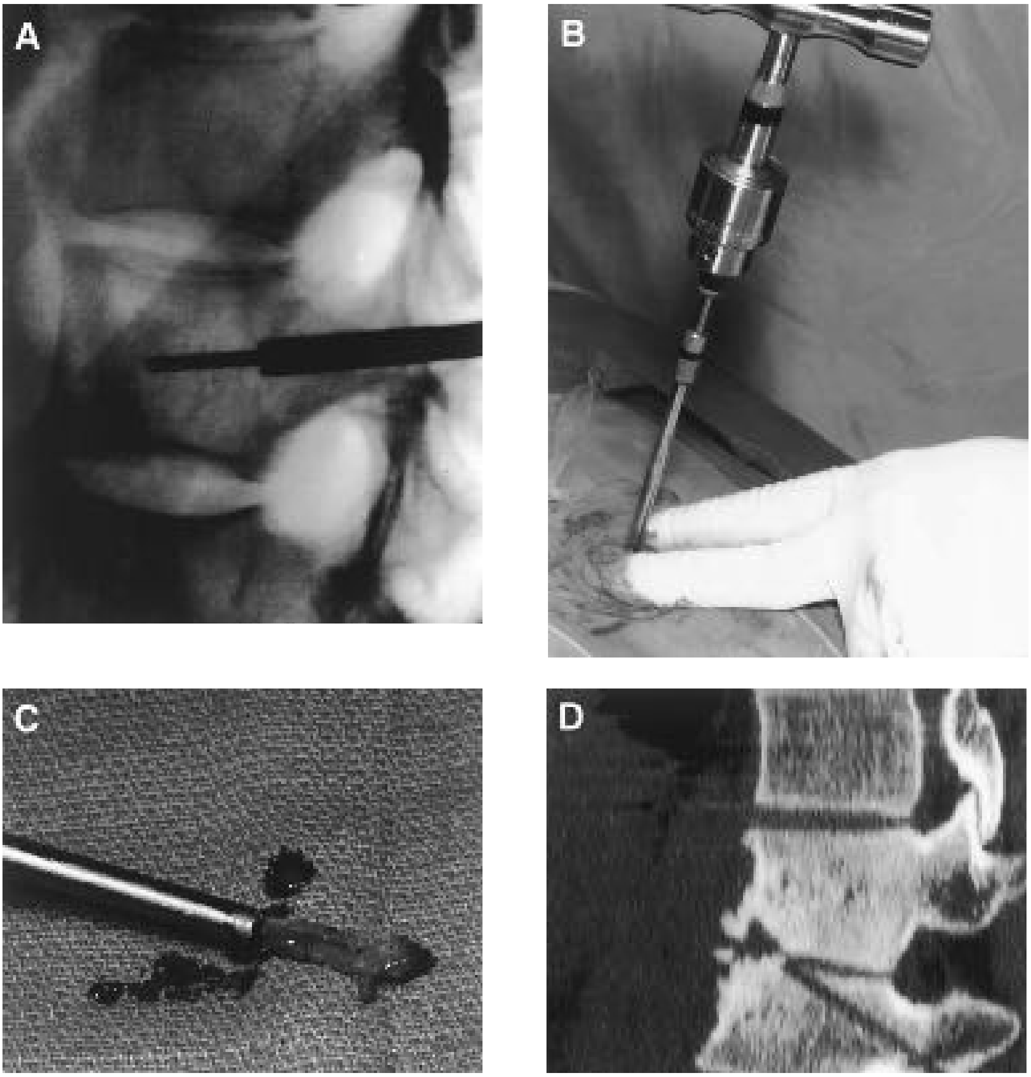


Fig. 3. Lateral radiograph demonstrating toothed biopsy cutting tool as it is inserted into vertebral body over guide pin **(A)** using a T-handle torque device **(B)**. As the cutting biopsy tool is being inserted, tissue is impacted between the guide pin and the biopsy tool and held firmly inside the tool. This expedience facilitates retrieval of tissue **(C,D)**. (Partially reproduced with permission from ref. *40*.)

body lesion. The integrity of the inferior and the medial cortical walls of the pedicle must be preserved in order to prevent any spread of hematoma, infection, or tumor inside the spinal canal. Additional tissue can be retrieved using curettes or biopsy forceps through the cannulated sleeve after removal of the guide pin (Fig. 4). The cannulated sleeve also facilitates insertion of hemostatic agents such as Surgicel (Johnson & Johnson Medical) or methylmethacrylate bone cement. The use of bone wax for hemostasis is not recommended because it does not pack well within the pedicle via the cannulated sleeve. Drains for 24 h are used only in cases of infection or benign conditions. If a drain is inserted, the patient must return on the first postoperative day for removal of the drain. We do not advocate drainage in the presence of malignancy.

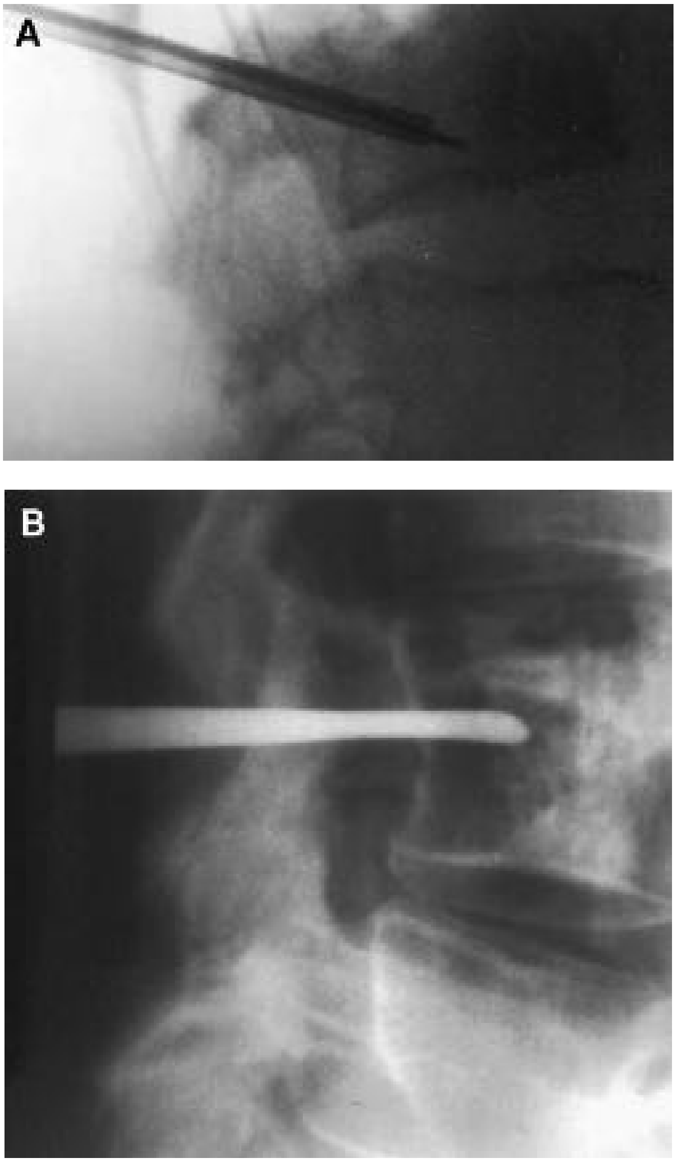


Fig. 4. The biopsy tool can be repositioned in different directions. **(A)** Further biopsy specimens can be removed by means of **(B)** curettage or **(C,D)** biopsy forceps.

Discussion

As graphed by Misenhimer et al. *(17)*, average cancellous pedicle width (transverse inside diameter) from T1 to L5, measured by sounding, ranges from slightly more than 1 mm at T4 to slightly less than 6 mm at L5. Because a biopsy needle that will retrieve a tissue core diameter larger than 2 mm has an outside diameter of nearly 3 mm, adequate space exists in most pedicles for transpedicular retrieval of substantial tissue specimen.

A transverse inner pedicle diameter that measures ≤3 mm is not a contraindication for percutaneous TPB. According to Zindrick et al. *(21)*, the average transverse outside

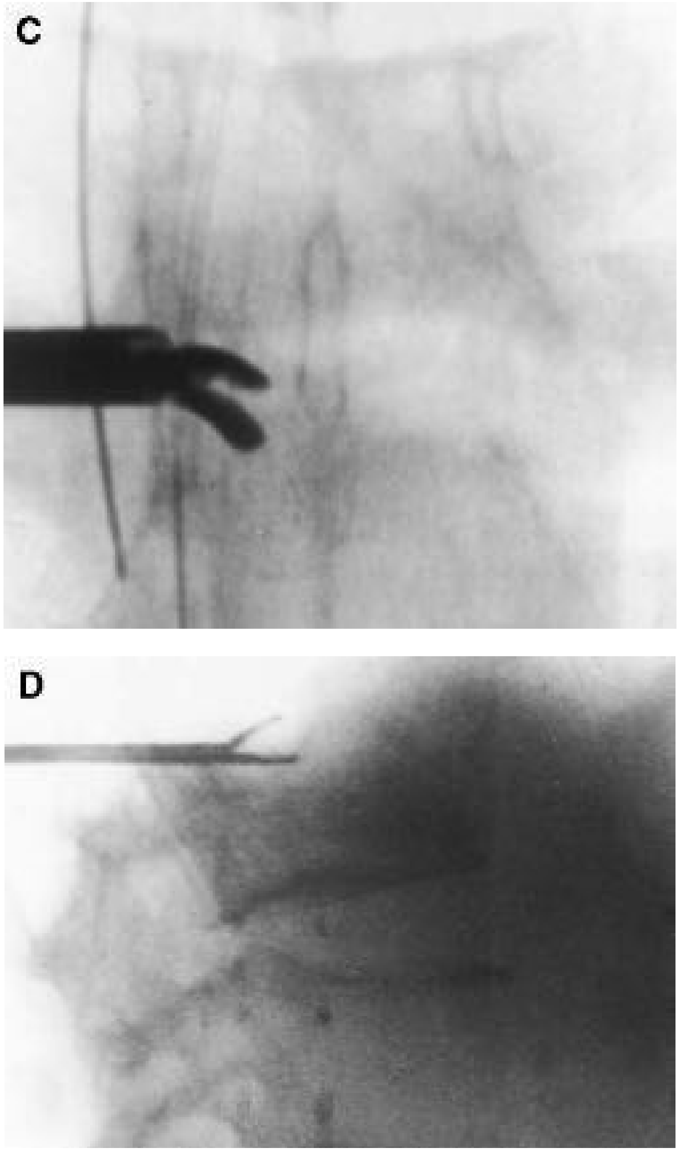


Fig. 4. *(Continued)*

diameters of the pedicular isthmus in the fifth thoracic vertebra is 4.5 mm and in the fifth lumbar vertebra is 18 mm. The narrowest pedicle diameter is 5 mm at T5 thoracic level, and the inside pedicle diameter measures <3 mm *(45)*. Band-saw cuts through the frontal plane of the vertebral pedicle demonstrated that this is neither circular nor elliptic but egg shaped, with the narrow end superior and the wider end inferior. Furthermore, we have confirmed that the pedicle is mostly cancellous bone with a thin shell of cortical bone *(12)*. Finally, the nerve root courses medial to the medial wall of the pedicle and inferior to the inferior wall of the pedicle, whereas the dural sacs lie immediately adjacent to the medial wall of the pedicle. Percutaneous TPB can safely be performed by cutting through the lateral wall extrapedicularly and avoiding

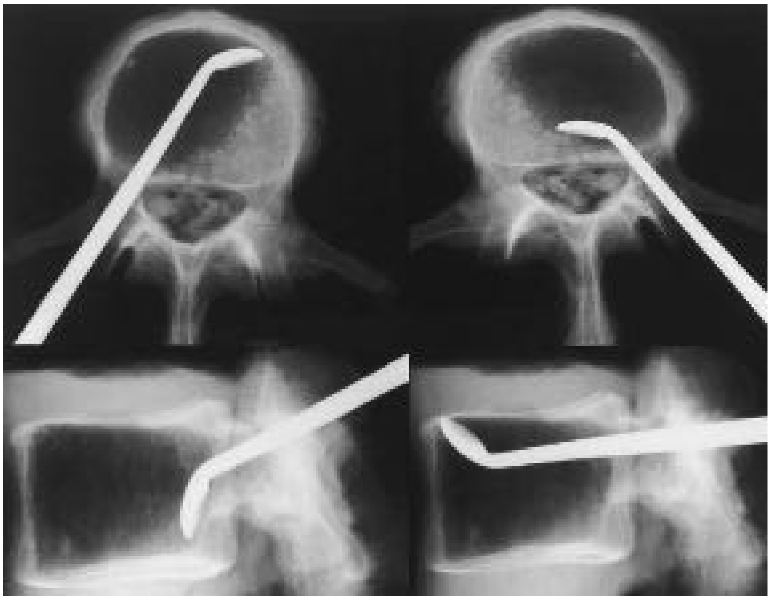


Fig. 5. In the laboratory, we have shown that through pedicular channels, bone can be retrieved from any region of the vertebral body. (Partially reproduced with permission from ref. *12*.)

violation of the medial pedicular wall. Inserting bone biopsy instruments through this area is minimally problematic. Caution should be taken not to violate the foramen, which provides nutrient vessels to vital nerve tissue structures.

Not only will the pedicle accommodate a variety of biopsy instruments, but the pedicle also will provide access to any vertebral body lesion. In our laboratory study, we have shown that instruments passed through one vertebral pedicle can access more than 50% of the volume of the vertebral body, including tissue directly anterior to the spinal canal (Fig. 5). Furthermore, this volume is accessible without performing a laminectomy, facetectomy, or pediculectomy, as described by others *(46)*. Additional tissue can be obtained by performing multiple passes at various angles. Greater latitude for angling instruments exists in the sagittal plane than in the axial plane, because sagittal pedicle diameter is greater than transverse diameter. The volume of tissue retrievable through the pedicle supports use of the percutaneous transpedicular technique for routine biopsy of vertebral body lesions. In cadaveric specimens, an experimental study showed that a 2-mm trephine does not obtain suitable bone core for histological examination, whereas the amount of samples obtained with a 3.5-mm trephine is adequate for histopathological examination *(47)*.

Fidler and Niers *(37)* recommended an open transpedicular approach over a percutaneous procedure. They claim that the open approach facilitates block excision of tissue and prevents dissection of hematoma and damage to the pedicular wall. Violation of the pedicular wall may potentially contaminate the epidural space or the paravertebral structures. However, using the percutaneous technique as we have described, these potential complications can be avoided and the patient can be spared the morbidity and cost associated with an open surgical procedure *(12)*.

Renfrew et al. *(48)* recommended CT-guided percutaneous TPB of the spine. This was based on the fact that the proximity of neural elements to the pedicle makes transpedicular biopsy under fluoroscopy a hazardous procedure. However, high-resolution image intensifiers display sufficient details of vertebral elements so as to allow protection of the medial and inferior walls of the pedicle during biopsy, thus avoiding injury to the neural elements. In our series, there were no advantages of CT guidance over image intensification *(12)*. Cost-effectiveness is an advantage of image intensification over CT. Moreover, in the presence of spinal deformities, image intensification is easier to maneuver.

Negative results can be encountered as a consequence of technical errors. We believe that pitfalls owing to faulty biopsy instrumentation retrieval techniques can be avoided.

Failures can be encountered when the guide pin technique is not used while retrieving the biopsy tool (Fig. 6). We encountered no diagnostic problems with crush artifact despite crowding the biopsy tool with a guide pin. Impaction of tissue between the needle and guide pin facilitates tissue retrieval in osteopenic bone and friable soft-tissue lesions. Another pitfall can be encountered when the pedicle is sclerotic and the lesion in the vertebral body is lytic. In this situation, dense bone from the pedicle is packed into the biopsy cannulated instrument and clogs the cutting tool, which makes almost impossible any further retrieval of pathological soft tissue from the vertebral body. This problem prompted us to modify the technique by removing vertebral tissue in sequence. The surgeon first creates an empty tunnel in the pedicle by removing a core of bone. Then the surgeon reinserts the empty biopsy tool through the empty pedicle into the pathological friable tissue, and, thus, the tool can retrieve a specimen for biopsy unimpeded (Fig. 7).

The reported complications of this procedure were minor and the incidence ranged from 0 to 5.6% *(40,42,49–53)*. In our series *(40)*, we had one technical complication—a retained piece of drainage tube in the pedicle—which was easily retrieved via the percutaneous transpedicular tract, previously created, using a biopsy forceps under local anesthesia. Serious bleeding, which can be encountered in hypervascular tumors, is easily manageable by plugging the pedicle with either methylmethacrylate bone cement or Surgicel *(40)*. To avoid spillage of malignant tumor tissues into the surrounding area, we also advocate the use of methylmethacrylate cement to plug the pedicular entrance (Fig. 8). In cases of infection, drainage for suction irrigation can be left *in situ*. The reported diagnostic accuracy of PTB ranges from 89 to 99% *(40,49,51–55)*. In our series of 86 procedures, the diagnostic accuracy was 95%. All diagnostic failures (four cases) occurred in the first 54 patients of our series *(40)*. In the subsequent patients, our success rate was 100% *(42)*. When technical pitfalls are avoided, the diagnostic success rate of TPB is equivalent to that of open biopsy techniques and with significantly less morbidity (Figs. 9–18).

In conclusion, we recommend the percutaneous TPB technique over open biopsy or closed posterolateral biopsy for its safety, minimal morbidity, simplicity, diagnostic accuracy, and cost-effectiveness. The caliber of the pedicle accommodates biopsy instruments that are able to access any vertebral body lesion and retrieve sufficient tissue for diagnosis. In addition, the use of local anesthesia provides a reliable monitor of nerve root function. Bleeding is also easily controlled. Furthermore, the technique can extend to the upper thoracic levels including the C7 vertebra, provided a high-resolution image intensifier is available.

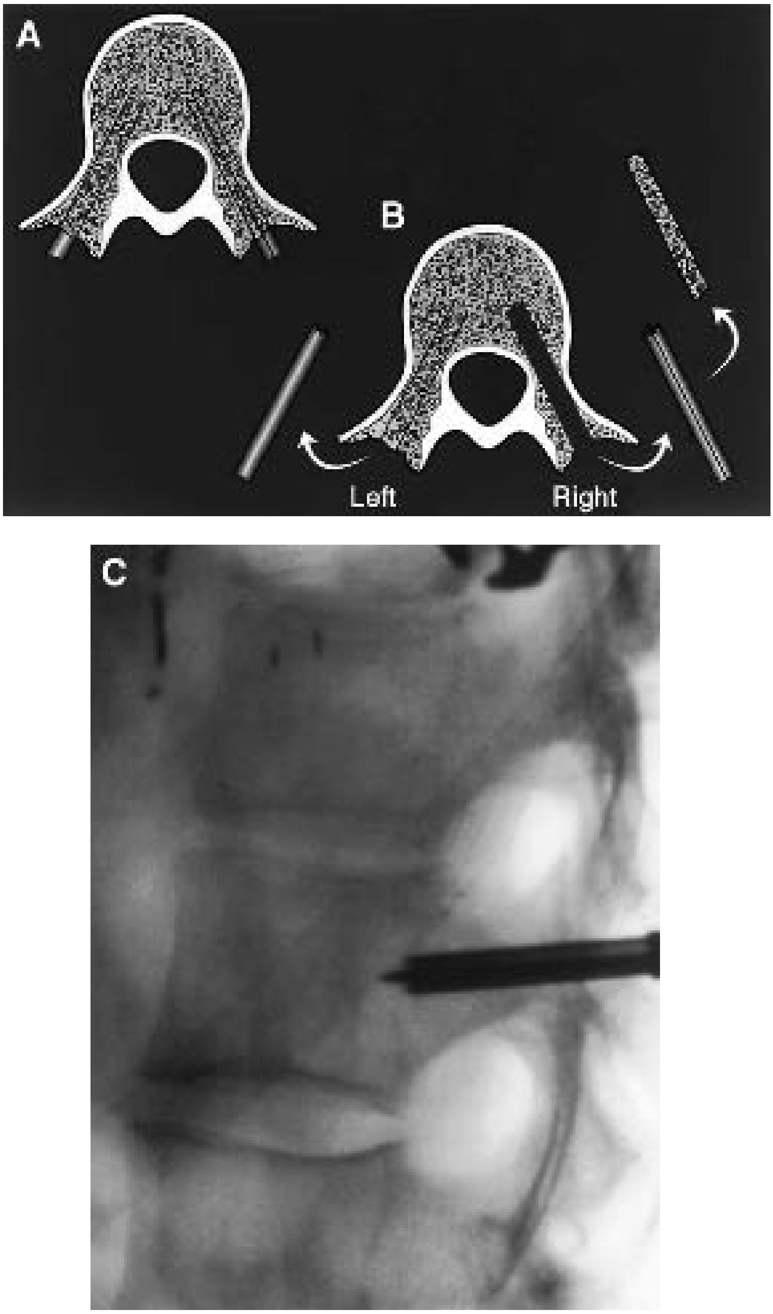


Fig. 6. (A,B) This drawing demonstrates that removal of biopsy specimens through the right pedicle is greatly facilitated by removing the guide pin of the biopsy cutting tool and the guide pin simultaneously. **(B,** right**)** Tissue is packed between the biopsy cutting tool and the guide pin. Using this technique, we have never failed to retrieve vertebral tissue, neither in the laboratory nor in the clinical setting **(C)**. However, if the guide pin technique is not used, the core, cut by the biopsy tool, might not remain inside the biopsy instrument (especially if the tissue is osteopenic or friable) when the instrumentation is removed (see left pedicle). (Partially reproduced with permission from ref. *40*.)

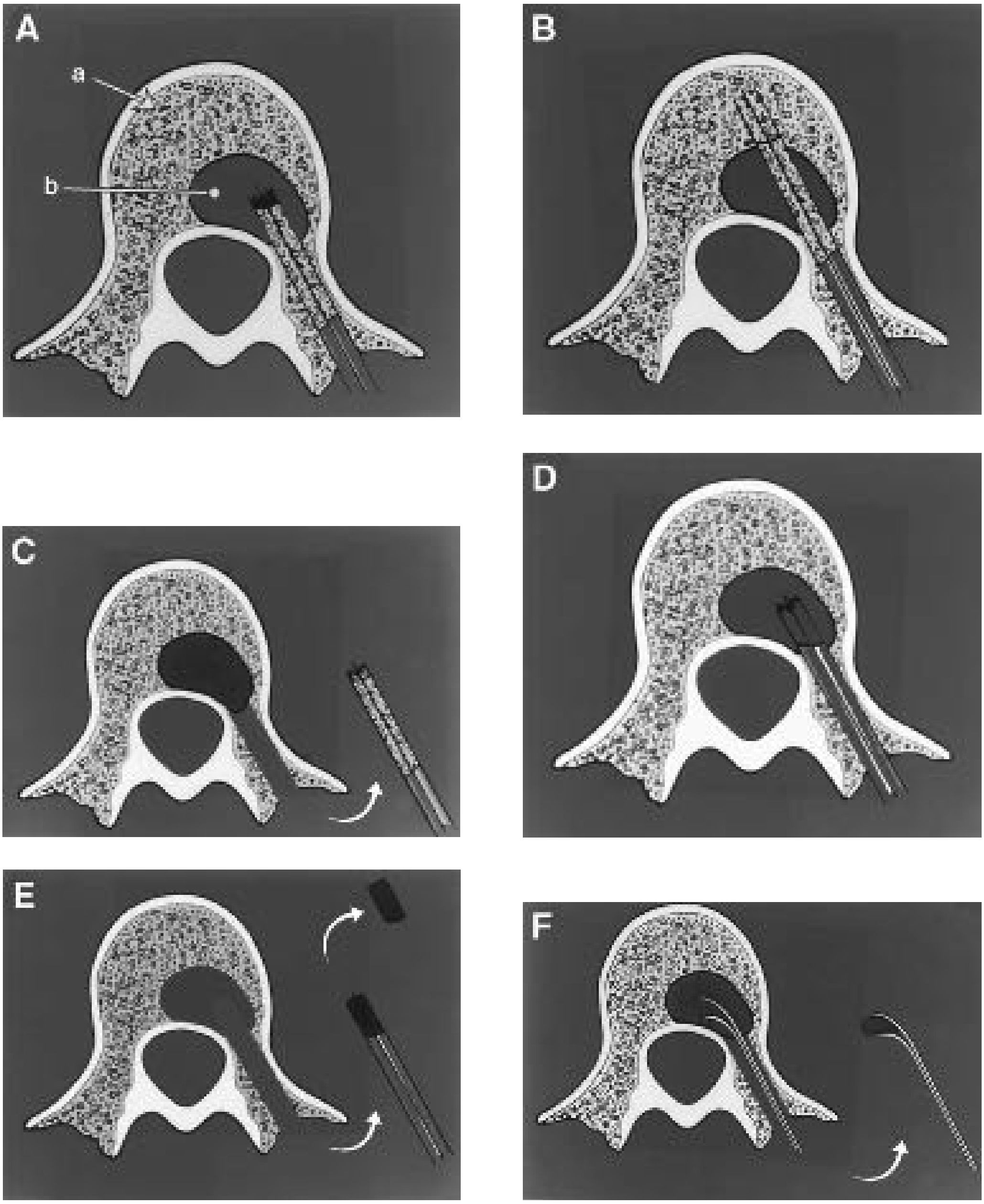
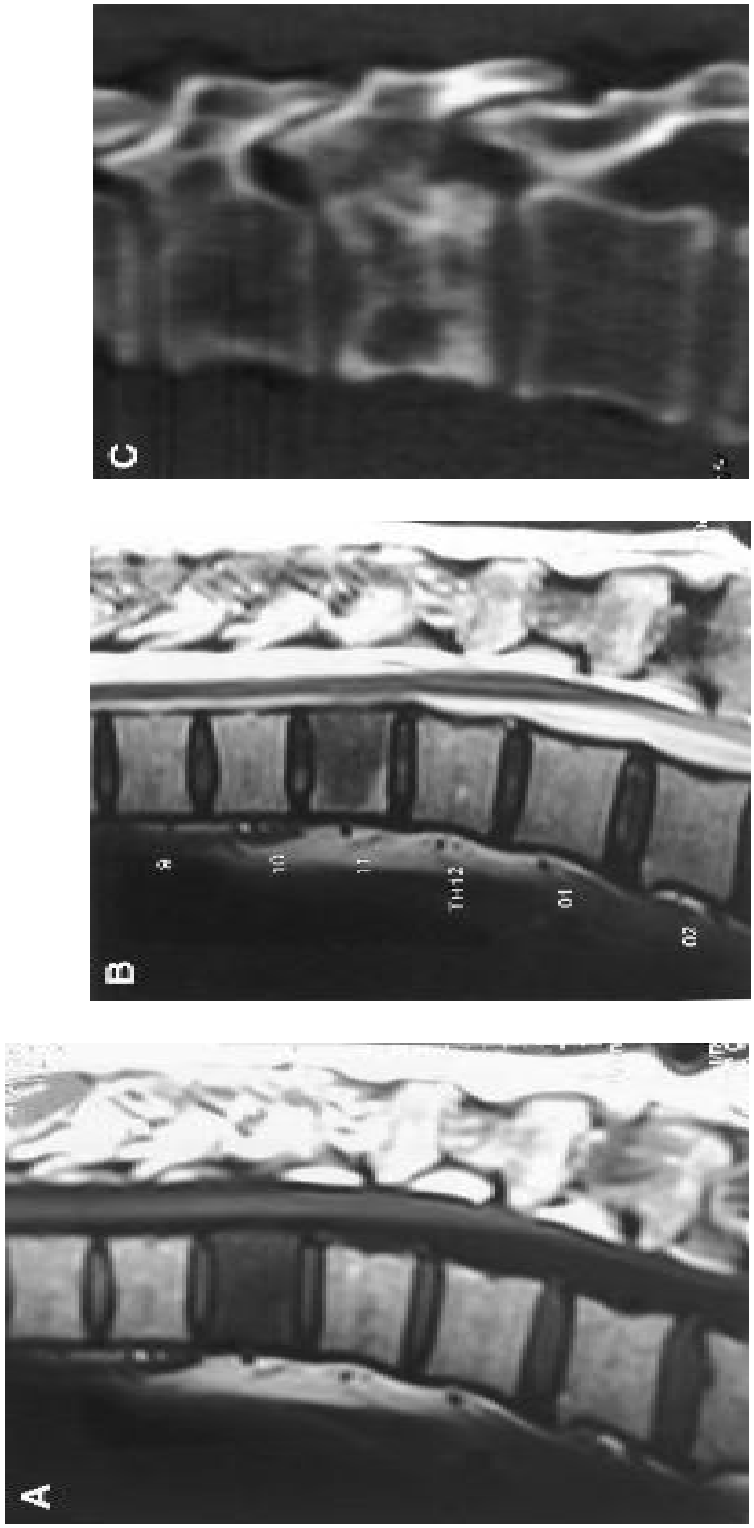


Fig. 7. **(A)** Bone from the pedicle can clog the tip of the biopsy cutting tool and, thus, may not allow friable tissue from a lytic lesion (b) to enter the biopsy tool. **(B)** Further insertion of the biopsy cutting tool may even crush a soft-tissue lesion against hard bone. **(C)** First a core of bone is removed from the pedicle. **(D)** Then the empty biopsy cutting tool should be reinserted through the open pedicular channel, to retrieve soft tissue unimpeded **(E)**. **(F)** Further specimens of friable soft tissue can be removed by mean of biceps forceps. (Modified with permission from ref. *40*.)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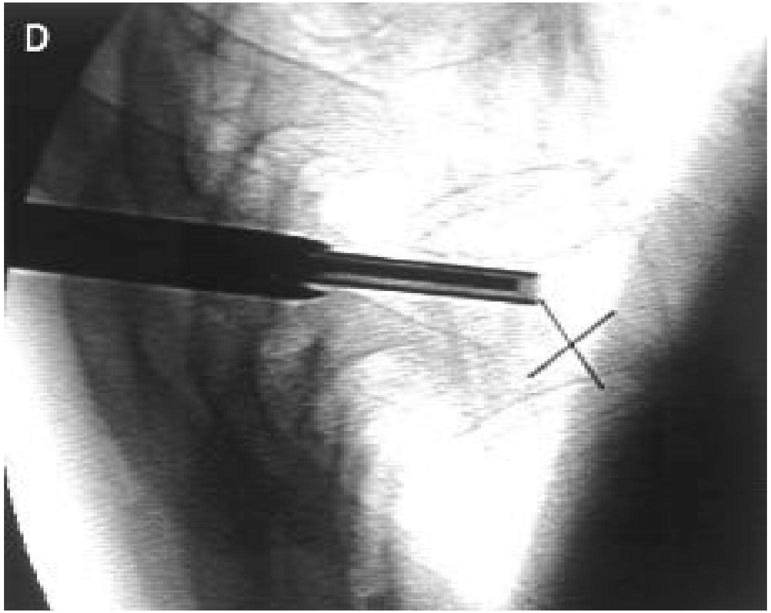


Fig. 8. (A) T1 A-weighted image shows a low signal intensity, and **(B)** T2-weighted image shows a high signal intensity of a metastatic mixed lesion as seen on CT scan (lateral reformat). **(D,E)** After transpedicular biopsy, some bleeding was encountered, and this was controlled by inserting PMMA bone cement into the lytic component of the tumor and the pedicle. Postoperatively the patient was pain free.

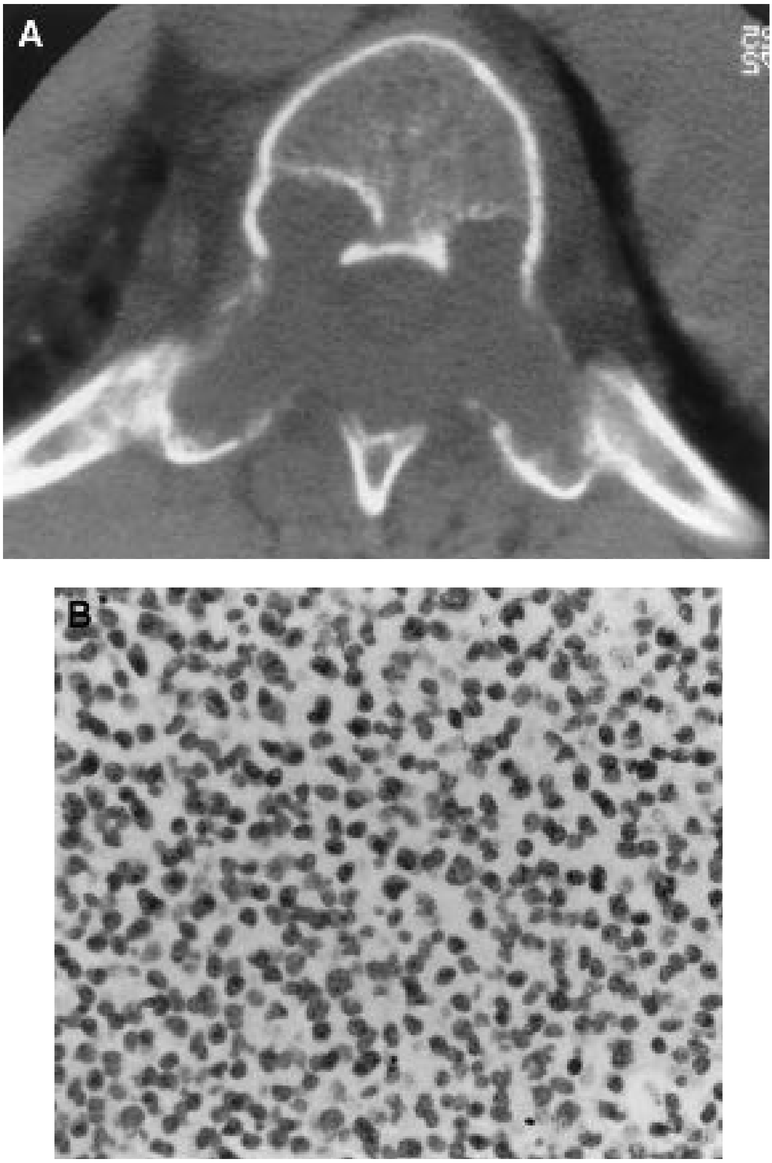


Fig. 9. An axial CT scan of the T12 vertebra shows that it is affected with **(A)** solitary myeloma and **(B)** its histology. A lateral radiograph demonstrates **(C)** pathological fracture of L3 vertebra and **(D)** biopsy-revealed lymphoma.

MANAGEMENT OF PYOGENIC SPONDYLODISCITIS

Historical Review and Rationale for the Procedure

Because MRI has shown that the pathological lesion involves the disc and the two adjacent vertebral bodies *(56)*, the term *spondylodiscitis* is preferred. The natural history of uncomplicated spondylodiscitis is self-limiting healing. However, a variable degree of bone destruction frequently takes place during the infectious process *(57)*. Depending on the degree of bone destruction, it is not uncommon for the spine to heal

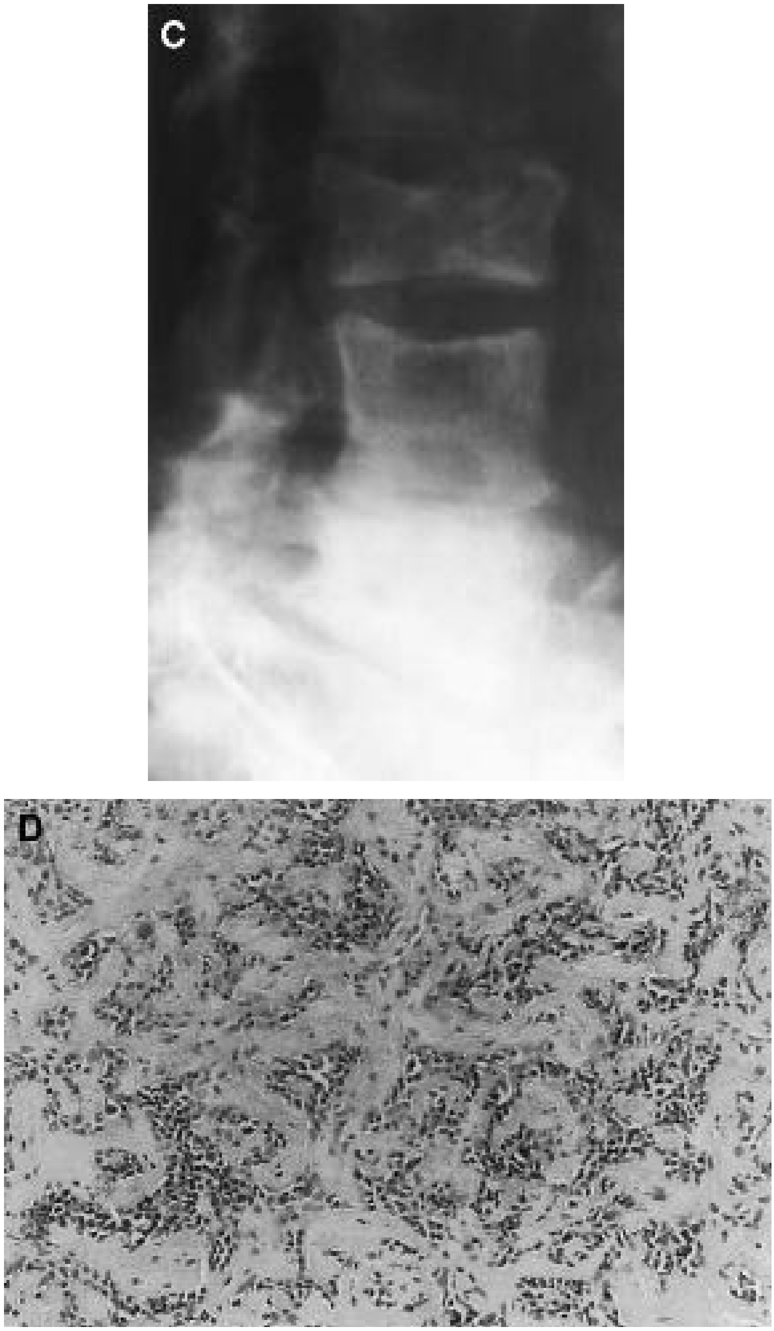


Fig. 9. *(Continued)*

in a kyphotic deformity, which, in turn, may predispose to mechanical low-back pain *(58)*. Reports have indicated that mechanical low-back pain is frequently associated with conservative treatment of vertebral osteomyelitis *(59)*. Early diagnosis is crucial for management of this condition *(60–62)*, because delayed treatment also may result in serious neurological complications *(63)*.

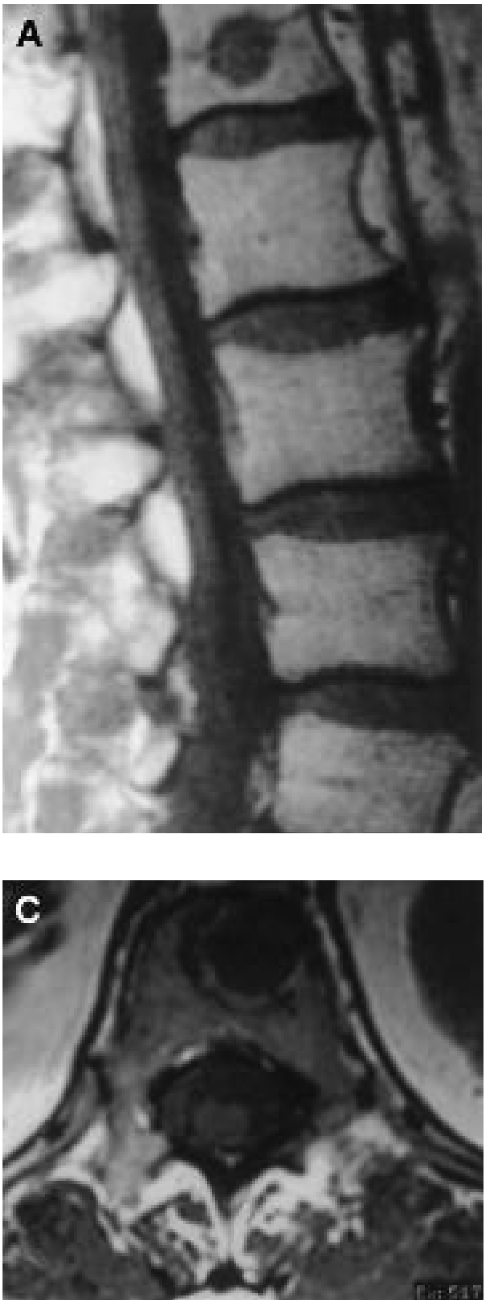


Fig. 10. **(A)** T1 A-weighted magnetic resonance imaging (MRI) image of a lytic lesion is shown. **(B)** TPB revealed renal cell carcinoma. **(C)** An axial T1-weighted MRI image of a blastic lesion is shown. **(D)** An axial CT scan shows the removed biopsy core. **(E)** Histological examination revealed osteoblastoma.

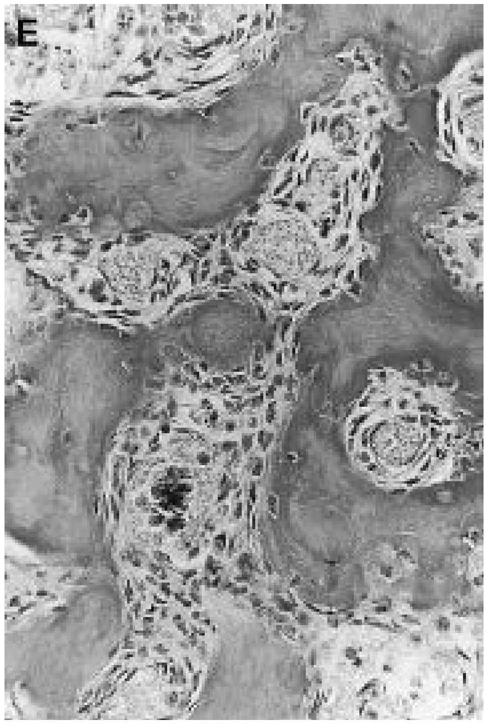


Fig. 10. *(Continued)*

The treatment of joint infections typically includes surgical debridement, irrigation, and prolonged antibiotic therapy *(64–69)*. Gradually, the percutaneous arthroscopic approach has superseded open arthrotomy *(70,71)*. A similar concept has been applied successfully to the treatment of pyogenic spondylodiscitis. Percutaneous discectomy, by means of a nucleotome, can evacuate infected disc material as an alternative to open surgery *(72–74)*. However, reports are scanty and only two or three patients are referred to in each report.

Fraser et al. *(75)* showed experimentally that during the natural course of discitis, granulation tissue from the subchondral bone would invade the intervertebral disc, resorb the disc space, and heal the infection. Intradiscal invasion of vascular granulation tissue was present in our histopathological studies *(76)*. Successful treatment of discitis entails spontaneous fusion. However, the spine very often may either fail to fuse, developing pseudoarthrosis, or fail to heal in good alignment, resulting in kyphotic deformity. Both conditions may predispose to chronic low-back pain. Spontaneous interbody fibrous or bony fusion occurs in 6–24 mo *(77,78)*. However, according to Frederickson et al. *(79)*, spontaneous ankylosis occurs in only 35% of patients. Therefore, it seems reasonable to assume that any medical manipulation that accelerates the natural healing process may prevent these complications *(38,41)*. Although the published data are not from prospective randomized studies, there is good evidence in the studies to support this concept. Transpedicular drainage of Pot’s abscess, as an adjunct to posterior stabilization, was performed successfully to speed up the process of healing *(80)*.

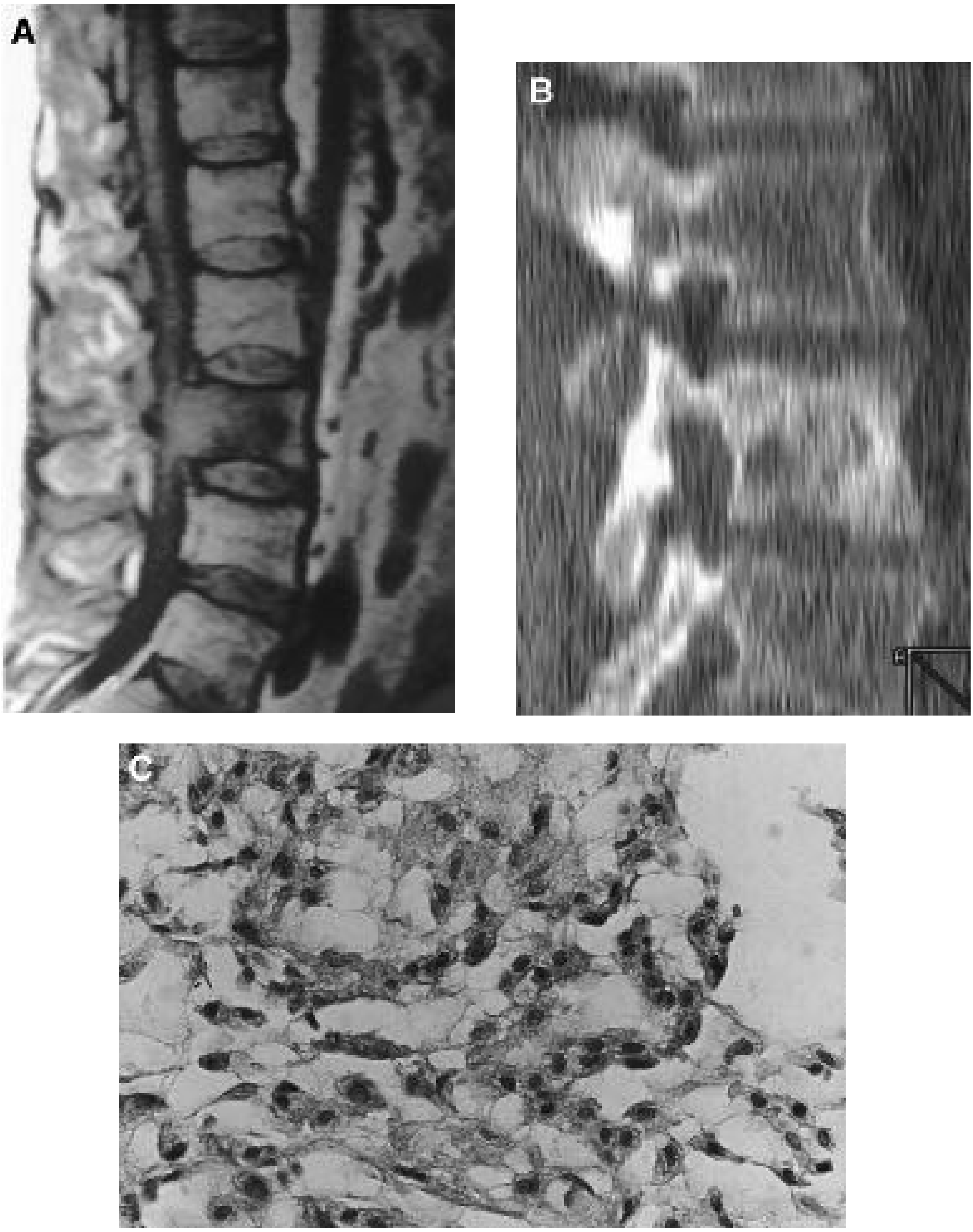


Fig. 11. Sagittal T1-weighted MRI image of a lytic lesion **(A)** better demonstrated on lateral reformated CT scan. **(B)** An adequate amount of tissue was retrieved to allow different histopathological staining techniques in order to enhance the diagnostic accuracy. The diagnosis was chordoma. **(C)** Typical physalipherous cells; **(D)** cluster epithelioid cells; **(E)** S1 100 protein stain; **(F)** Vimentin stain.

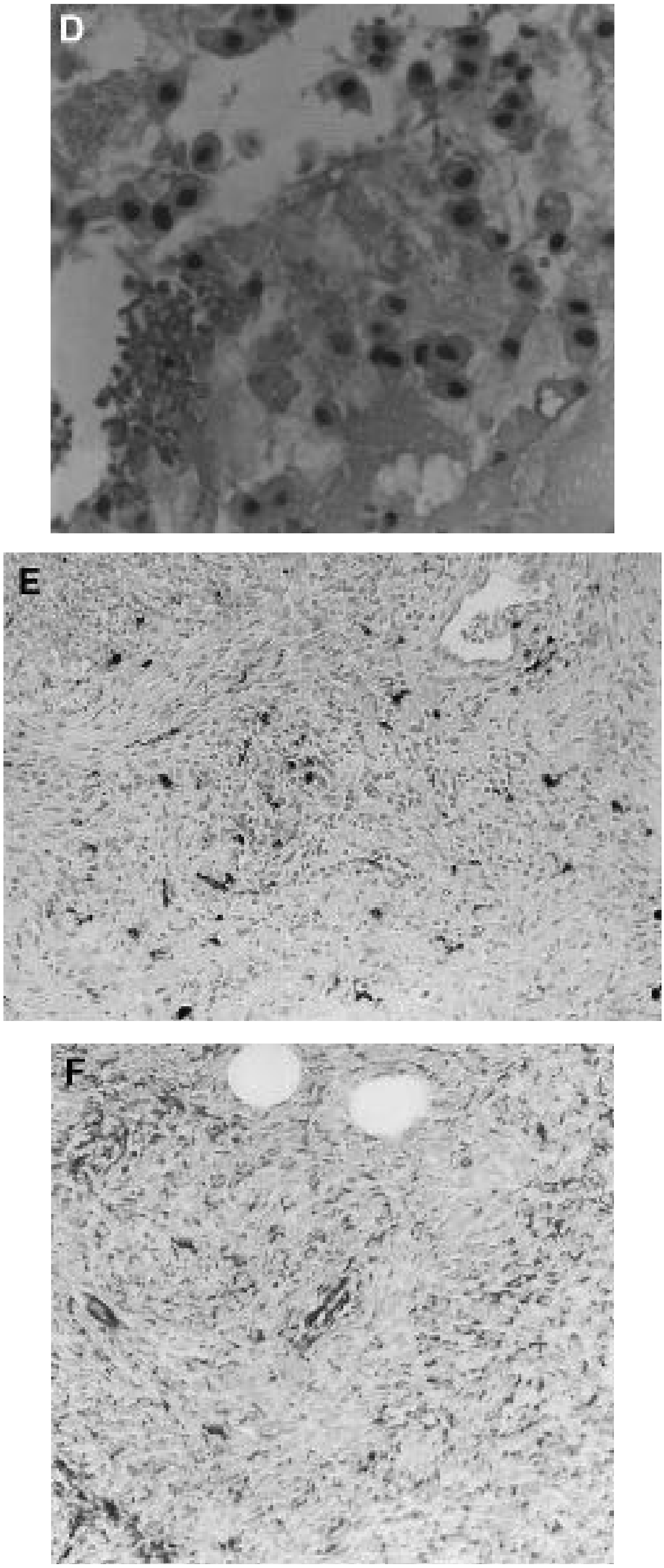
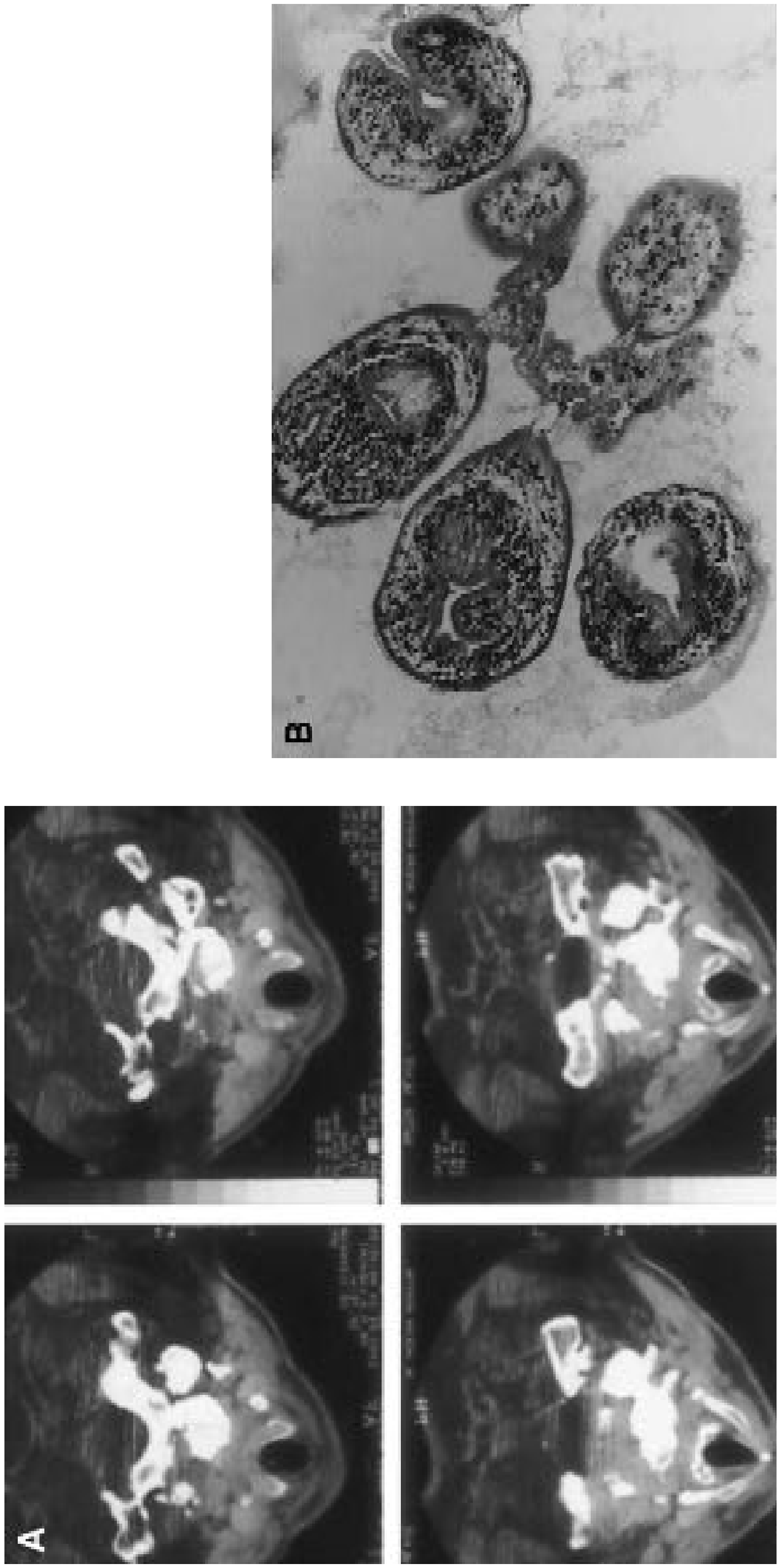


Fig. 11. *(Continued)*



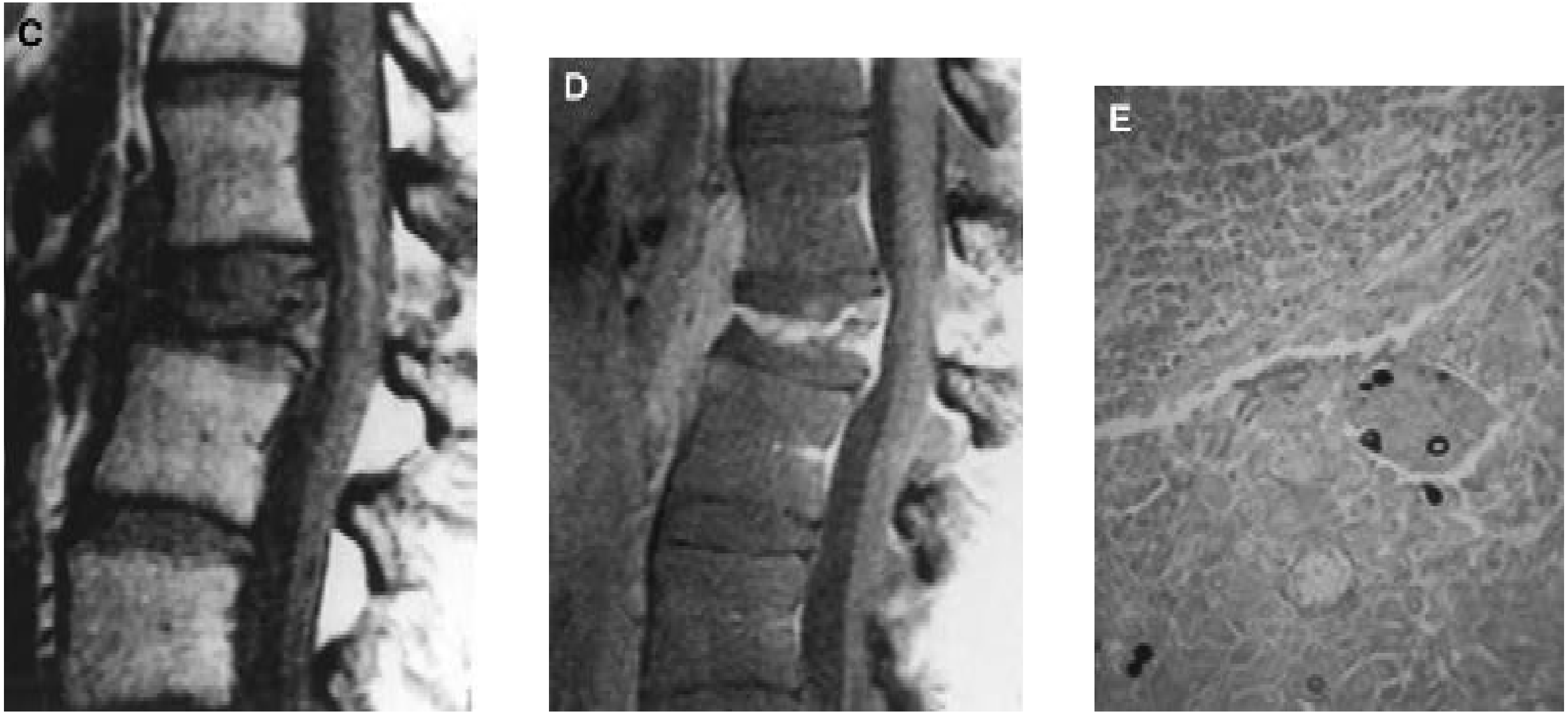


Fig. 12. Hydatid disease as seen on **(A)** axial CT scan and **(B)** its histology. T1- and T2-weighted MRI images demonstrating spondylodiscitis **(C, D)** caused by blastomycosis as seen on histology **(E)**.

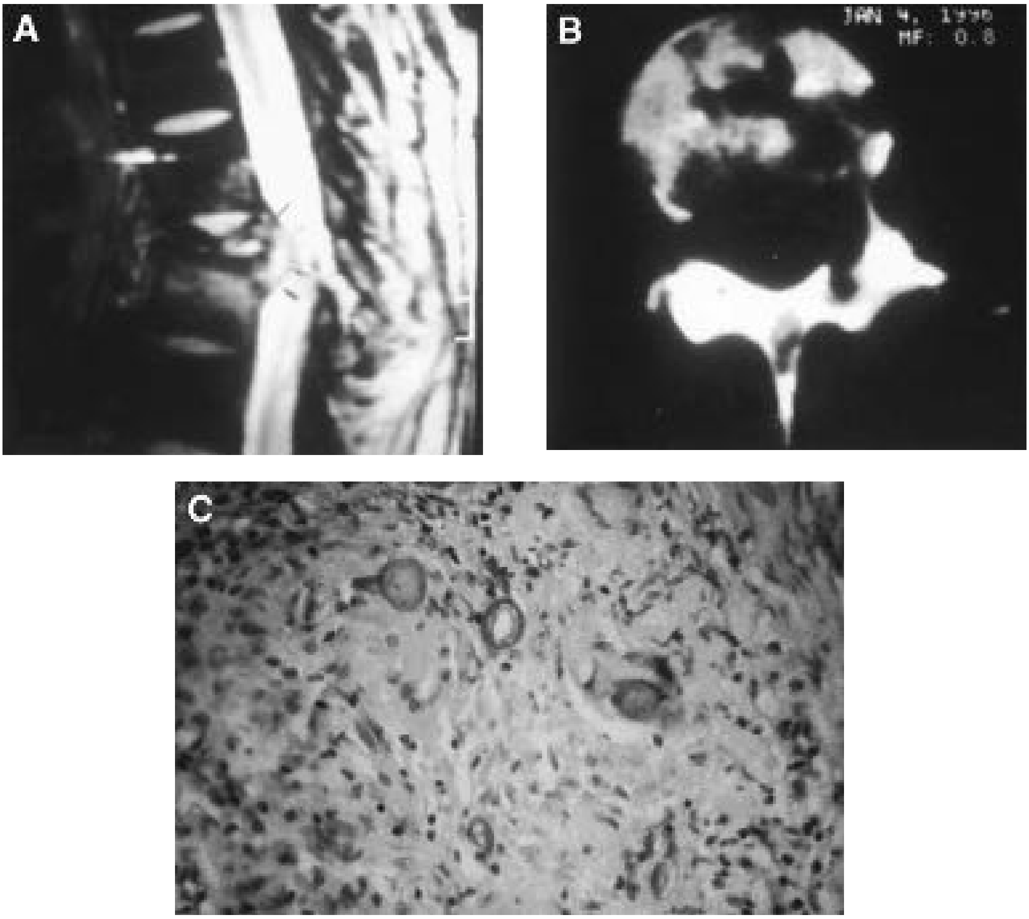


Fig. 13. **(A)** T2-weighted MRI image and **(B)** axial CT scan showing an osteolytic lesion of a thoracic vertebral body. **(C)** TPB revealed coccidiomycosis.

The objective of transpedicular discectomy is to accelerate the natural course of healing by evacuating the bulk of the offending infected disc and, conceivably, by opening channels through the subchondral bone to speed the process of disc invasion by the reparative granulation tissue. For these reasons, and because we had considerable experience in using the technique of the transpedicular route for vertebral biopsies, we decided to design a transpedicular approach for discectomy in pyogenic spondylodiscitis *(41–43,81)*.

The Percutaneous Transpedicular Discectomy Technique

Local or general anesthesia is suitable for percutaneous transpedicular discectomy, depending on the severity of pain. The patient is prone, either on a fluoroscopic table in the radiology suite or on an operating table in the surgical suite, as for a TPB procedure. The target for the pin is the pedicle that is caudal to the affected disc. The tip of the guide pin should be in the center of the pedicle bull's-eye on fluoroscopic view.

Using an image intensifier, the technician obtains a lateral view to determine cephalad angulation of the Steinmann pin in the sagittal plane; this approach is necessary for

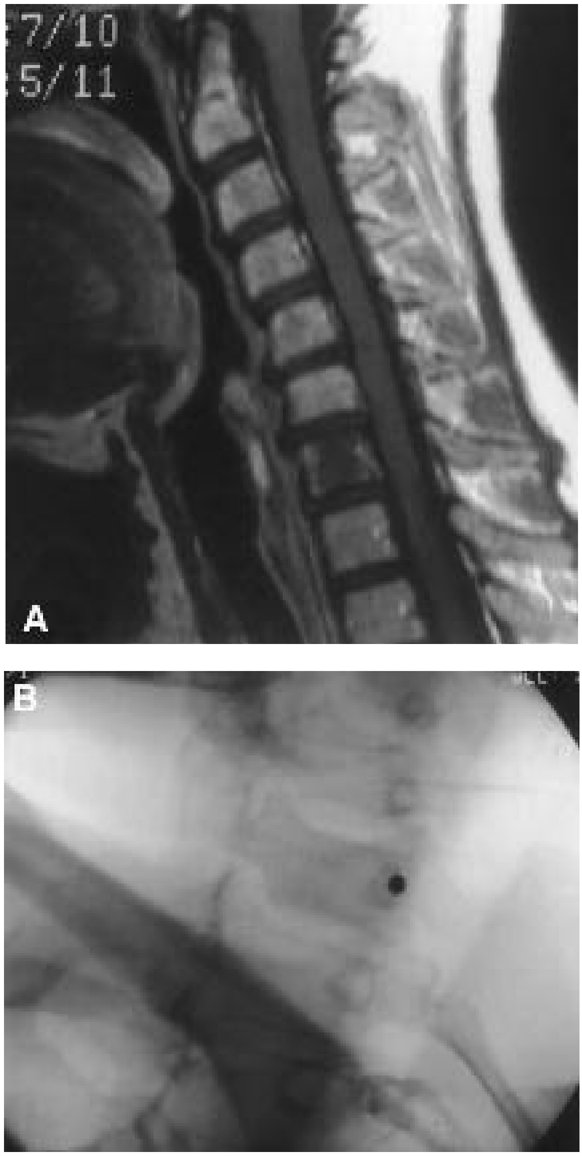


Fig. 14. (A) Sagittal T1-weighted MRI image showing a metastatic lesion. Needle biopsy failed. TPB bull's-eye **(B)** through the osteoblastic pedicle of the C7 vertebra **(C)** revealed an osteoblastic reactive bone with nidus of malignancy (a metastatic lesion from cancer of the breast [**D**]). **(E)** A CAT scan demonstrates the biopsy track. Usually needle biopsy fails in osteoblastic lesions. **(F)** An axial CT of a chondral lesion is shown. **(G)** TPB revealed chondrosarcoma.

reaching the center of the affected disc without violating the confinements of the pedicle. The physician then holds the Steinmann pin firmly in this position and gently taps it with a mallet until its tip reaches the inner annulus along the posterior portion of the disc. Under no circumstances should the pin violate the inferior border of the pedicle, because the pin can damage the exiting nerve root. Avoiding an approach through the more cephalad pedicle prevents this danger. Image intensifier views in the oblique and

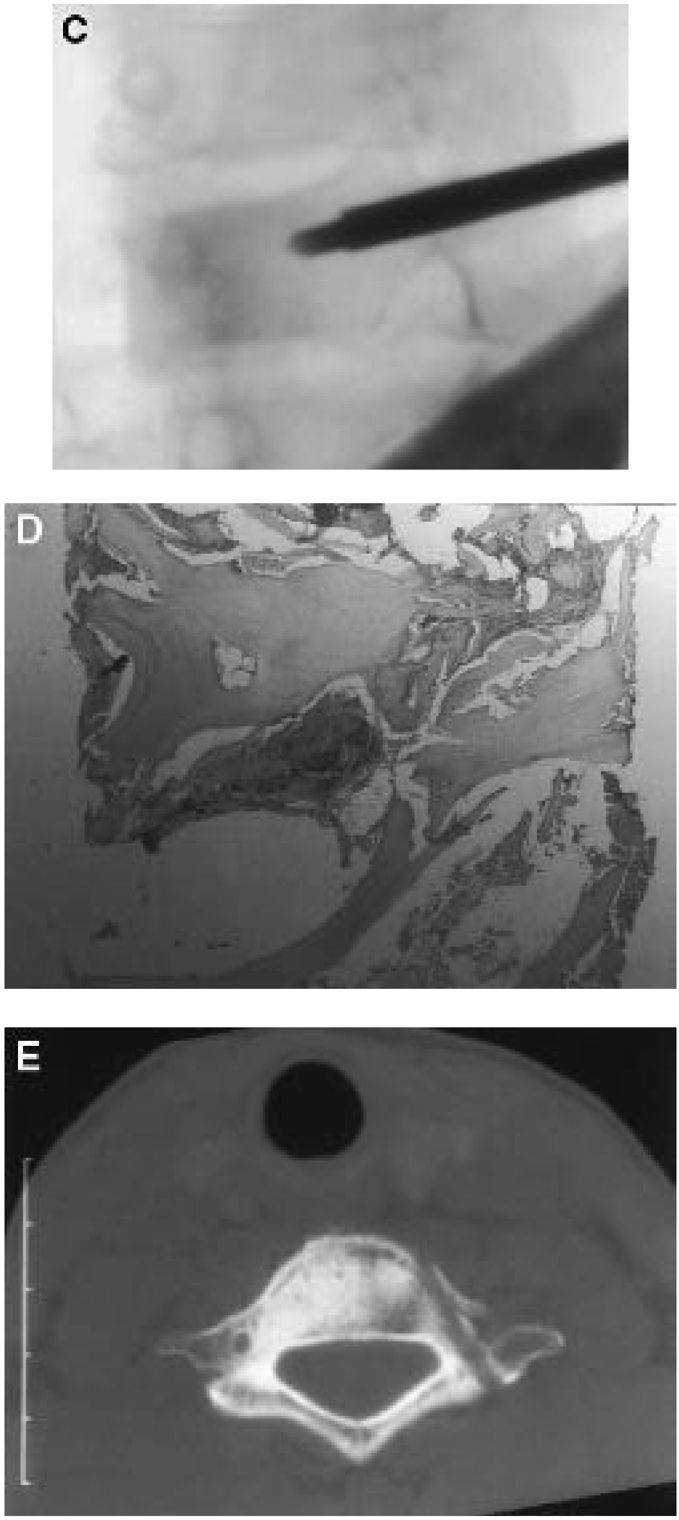


Fig. 14. *(Continued)*

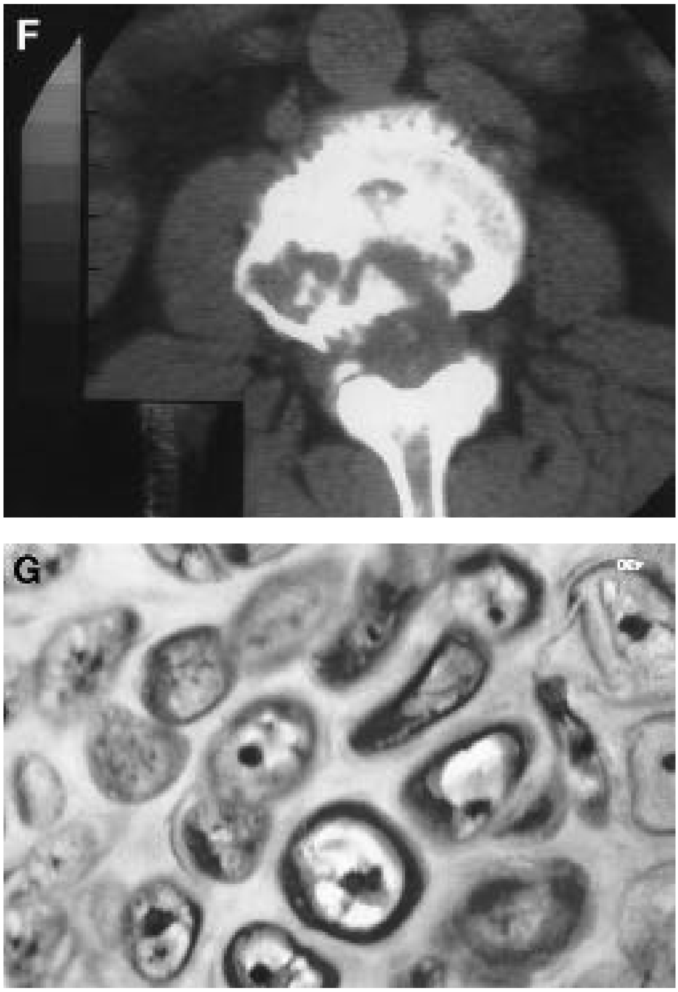


Fig. 14. *(Continued)*

lateral planes may be used to assess the progress of the pin and thus ensure the integrity of the pedicle and the track of the guide pin.

This procedure has three phases. The first phase is similar to the TBP approach. In the second phase, discectomy is performed by means of tissue forceps. A modified Kambin discectomy forceps (Smith & Nephew), which is inserted through the cannulated sleeve, allows extraction of additional tissue from the disc. These tissue samples are sent for pathohistological and bacteriological studies. Repositioning of the Steinmann pin through the pedicular tract allows direction of the biopsy instrument to a different part of the disc. By moving the biopsy forceps into these different positions, an adequate discectomy can take place in a piecemeal fashion (Fig. 19). The set is equipped with one straight and two different angled Kambin flexible discectomy forceps.

The third phase of the procedure involves suction aspiration through the use of a flexible automated nucleotome (Surgical Dynamics, Alameda, CA) (Fig. 20). The flexible automated nucleotome enters through the skin sleeve and the pedicular channel into

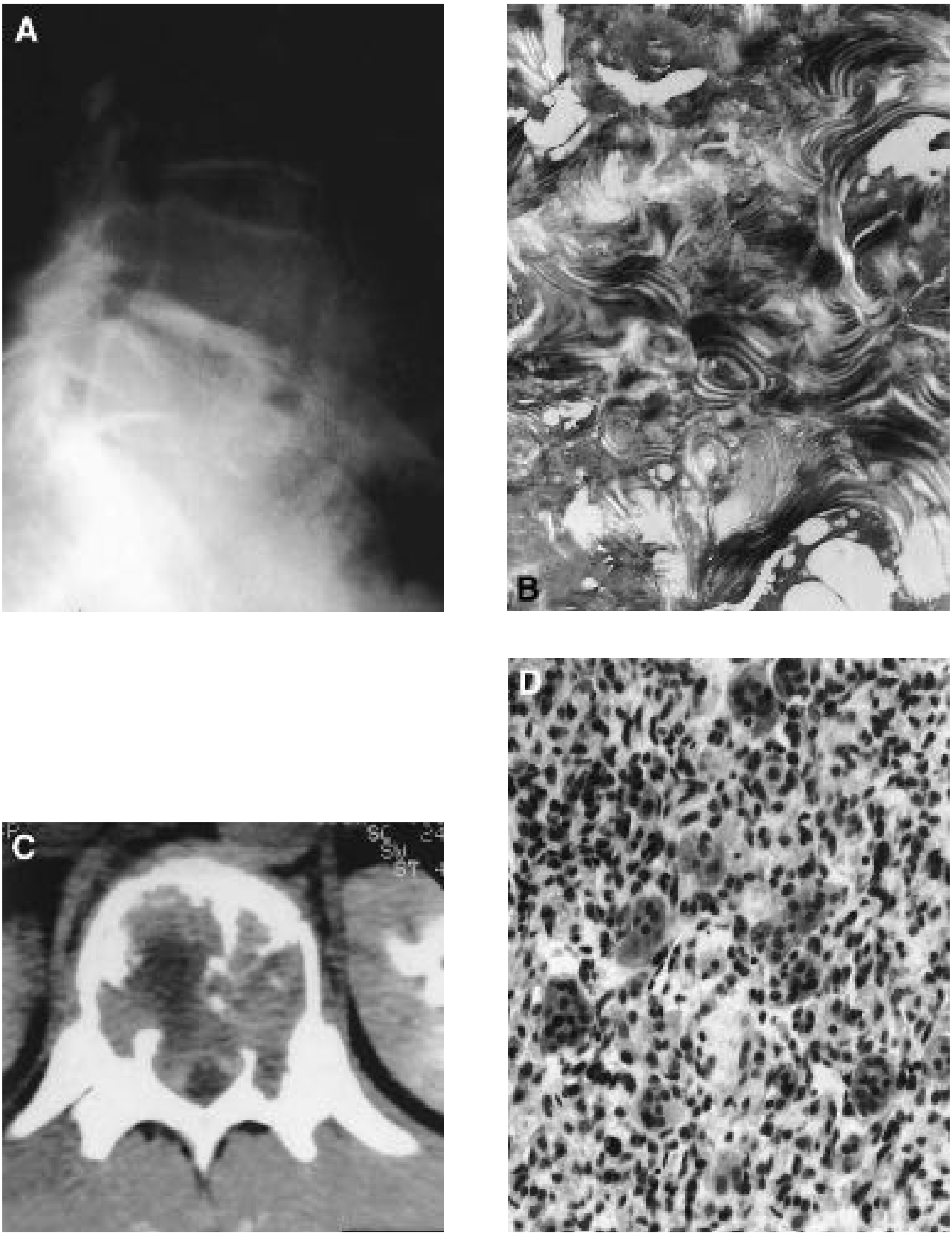


Fig. 15. **(A)** A lateral radiograph of an L5 vertebral lesion is shown. **(B)** TPB revealed Paget disease of bone. **(C)** An axial CT scan image of an osteolytic lesion is shown. **(D)** TPB revealed a giant cell tumor.

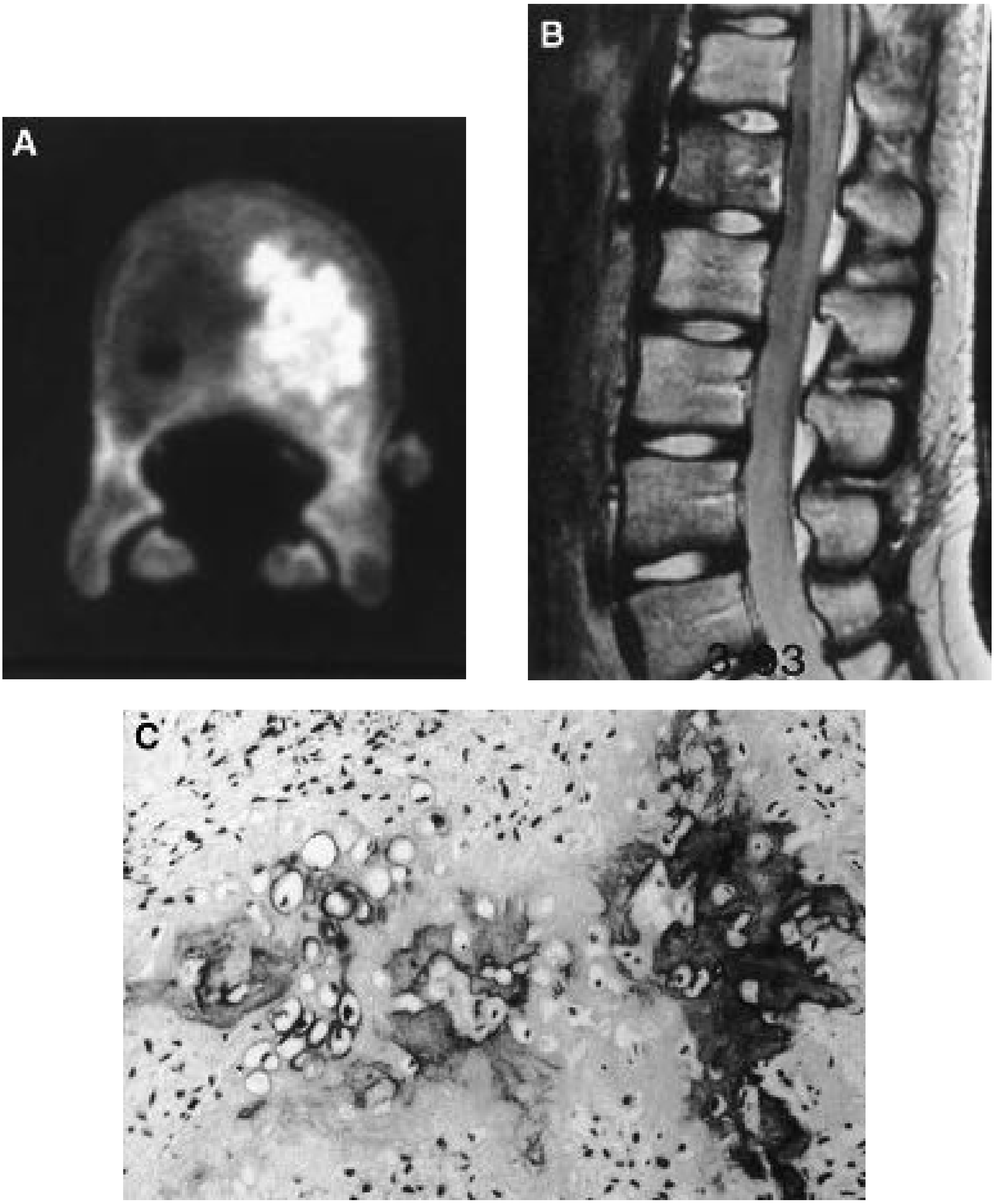


Fig. 16. (A) Axial CT scan image of osteoblastic lesion; **(B)** sagittal spin echo MRI. **(C)** TPB revealed osteosarcoma.

the vertebral body and disc space. The tip of the nucleotome is flexible to a maximum angulation of 90° in order to permit excision of different parts of the disc. The whole procedure is performed under fluoroscopic guidance. After completion of the discectomy, 10 French metal braided sheaths (Arrow International, Reading, PA) go through the pedicular channels into the discs for irrigation and drainage. These sheaths are attached to suction from a vacuum draining bag (Snyder Hemovac, Zimmer Patient

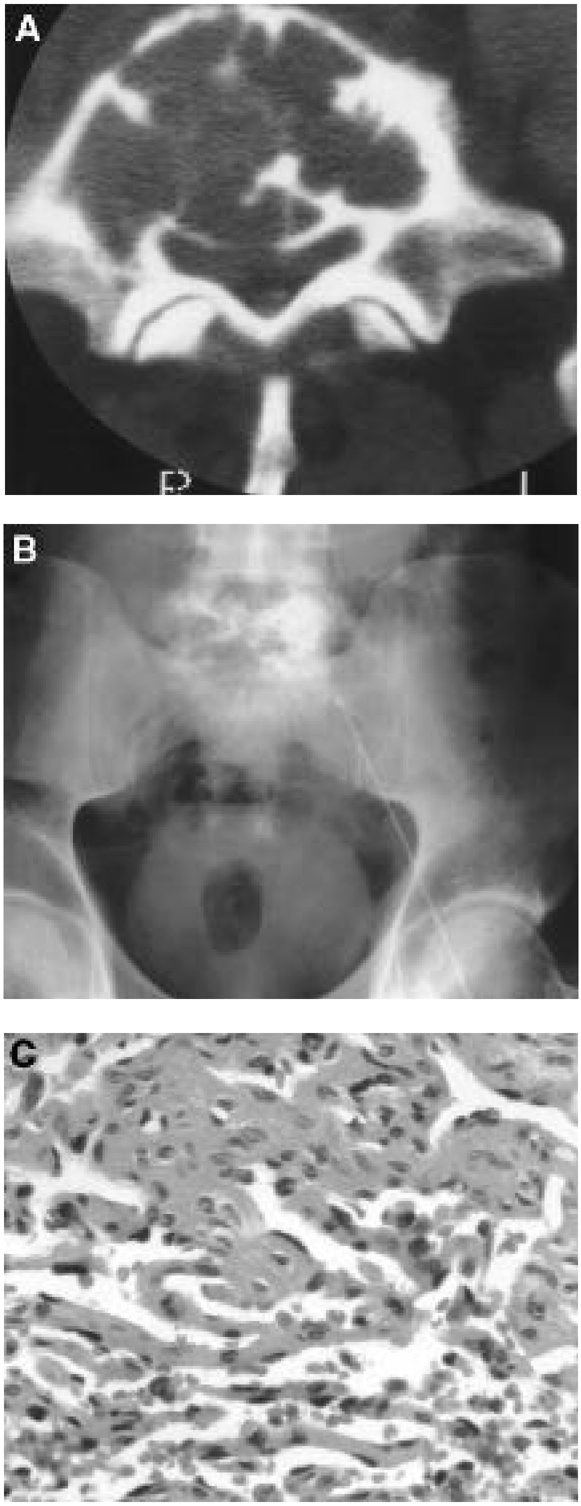


Fig. 17. Axial CT scan of **(A)** an osteolytic vascular lesion as seen on **(B)** arteriogram. **(C)** TPB revealed hemangioendotheliosarcoma.

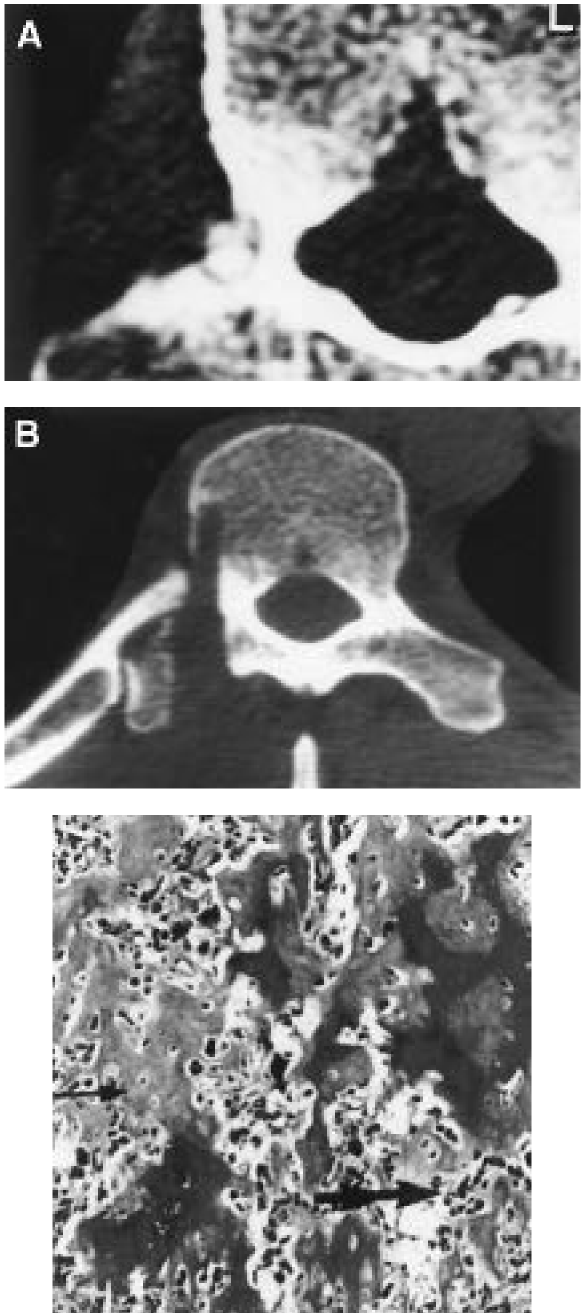


Fig. 18. (A) Axial CT scan demonstrating a painful osteoid osteoma of pedicle. TPB cored out the whole osteoid osteoma **(B)** as seen in **(C)**. This biopsy was diagnostic and therapeutic. Three years postoperatively the patient was free of pain.

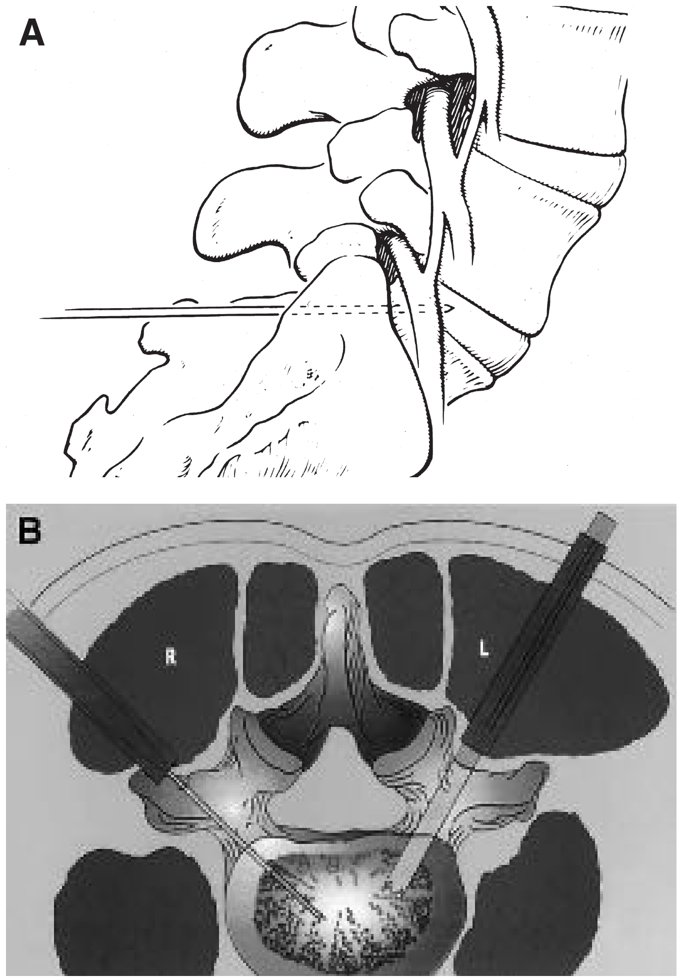


Fig. 19. **(A, B** [right]**)** Diagrammatic demonstration of a guide pin into intervertebral disc (A, lateral lumbosacral view). A 2-mm Steinmann pin is introduced percutaneously rostrally angled through the pedicle, which is caudal to the affected disc, and advanced to the disc (right side). **(B,** left**)** Axial view of diagrammatic demonstration of pin into disc, with dilator and external sleeve abutting against pedicle. The toothed biopsy cutting tool removes a core of bone from the pedicle and vertebral body to allow easy passage of the dissection forceps **(C)**. The external sleeve allows easy percutaneous passage of the discectomy instrumentation **(D)**. (Modified with permission from ref. *41*.)

Care Division, Dover, OH). Irrigation takes place by instilling a solution of 2 g of cefazolin (Ancef; Smith-Kline Beecham, Philadelphia, PA) and 10 mL of saline. Eventually, culture results will dictate the choice of antibiotics.

Discussion

Percutaneous transpedicular discectomy for spondylodiscitis is a technically safe surgical procedure and is feasible in the thoracic as well as the lumbar spine. The

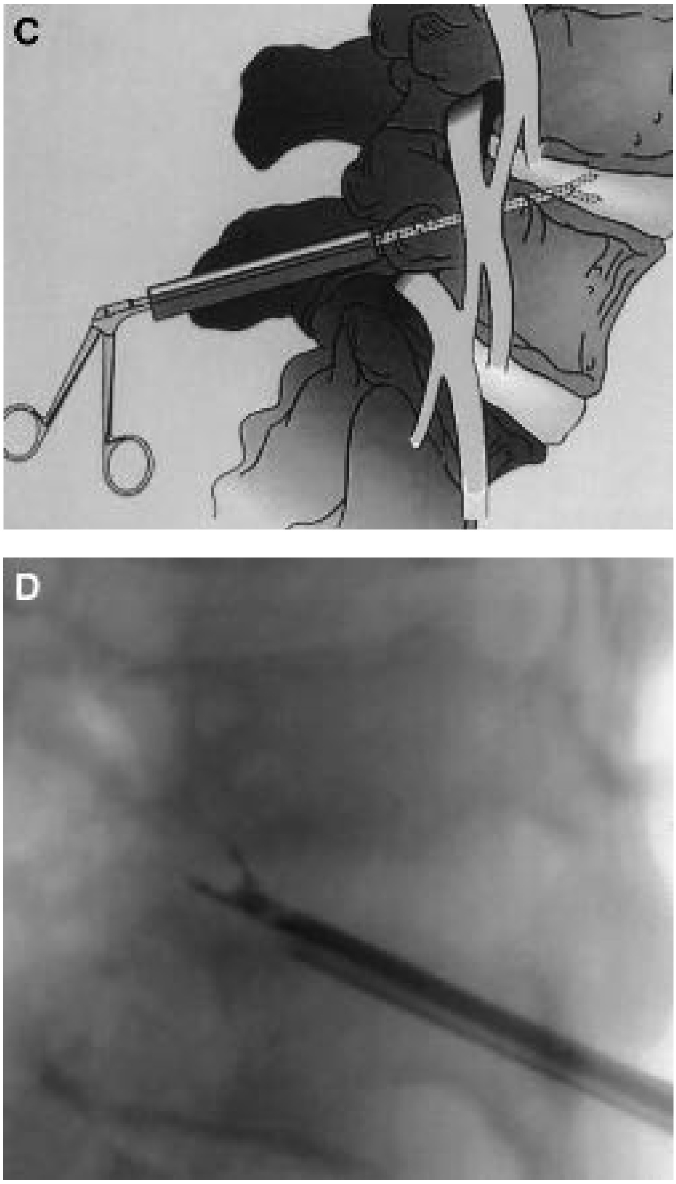


Fig. 19. *(Continued)*

transpedicular tract allows the use of relatively large instruments for aggressive decompression without concern about possible spinal cord, nerve root, or vascular injuries. Our technique advocates bilateral access with channels measuring 5.15 mm, which allow the passage of relatively large discectomy forceps and an automated nucleotome. We strongly urge that access of the intended discectomy level be from the more caudally placed adjacent pedicle. Access through a more cephalad pedicle has the potential of penetrating the inferior borders of the pedicle and damaging the exiting nerve root.

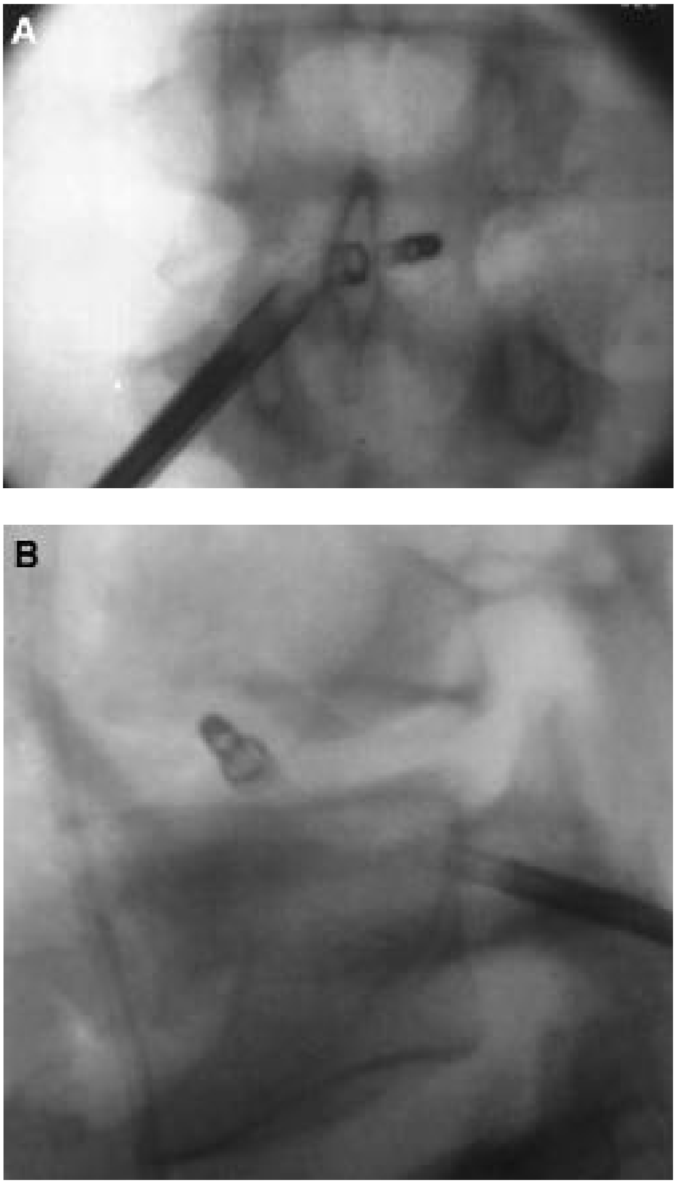


Fig. 20. **(A)** AP and **(B)** lateral radiograph demonstrating flexible nucleotome within disc space during the procedure, debulking infected disc and evacuating pus and necrotic material. **(C)** Appearance of nucleotome in action on one side and discectomy by means of Kambin discectomy forceps on right side. **(D)** Axial CT scan of vertebral body demonstrating drain tube transversing pedicle. (Partially reproduced with permission from ref. *38*.)

We also strongly recommend that the procedure take place under fluoroscopic guidance, aiming the guide pin a bull's-eye into the pedicular center or just superior to the pedicular equator. The procedure also allows the installation of Hemovac tubes (Zimmer Health Care Division, Dover, OH) for drainage and antibiotic irrigation. Although the procedure can be done safely and effectively under local anesthesia, we advocate

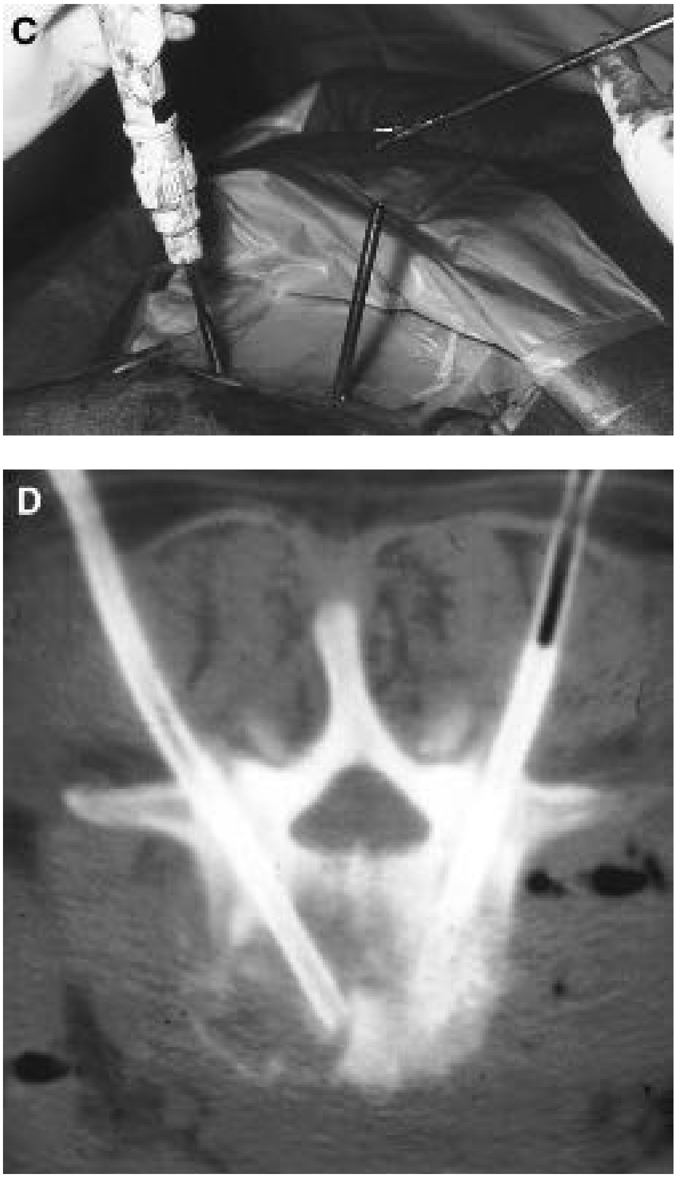


Fig. 20. *(Continued)*

general anesthesia because of severe pain in most patients with spondylodiscitis. Local anesthesia is useful in high-risk septic patients or those with other serious medical conditions. Immediate response after transpedicular discectomy is usually observed in 75% of unselected patients *(41,43,81)*. With proper indications, as we have practiced ever since the publication of the original article, we have achieved almost a 95% success rate (Figs. 21 and 22).

Percutaneous transpedicular discectomy is ineffective for the treatment of spondylodiscitis with severe neurological deficit caused by large epidural inflammatory tissue

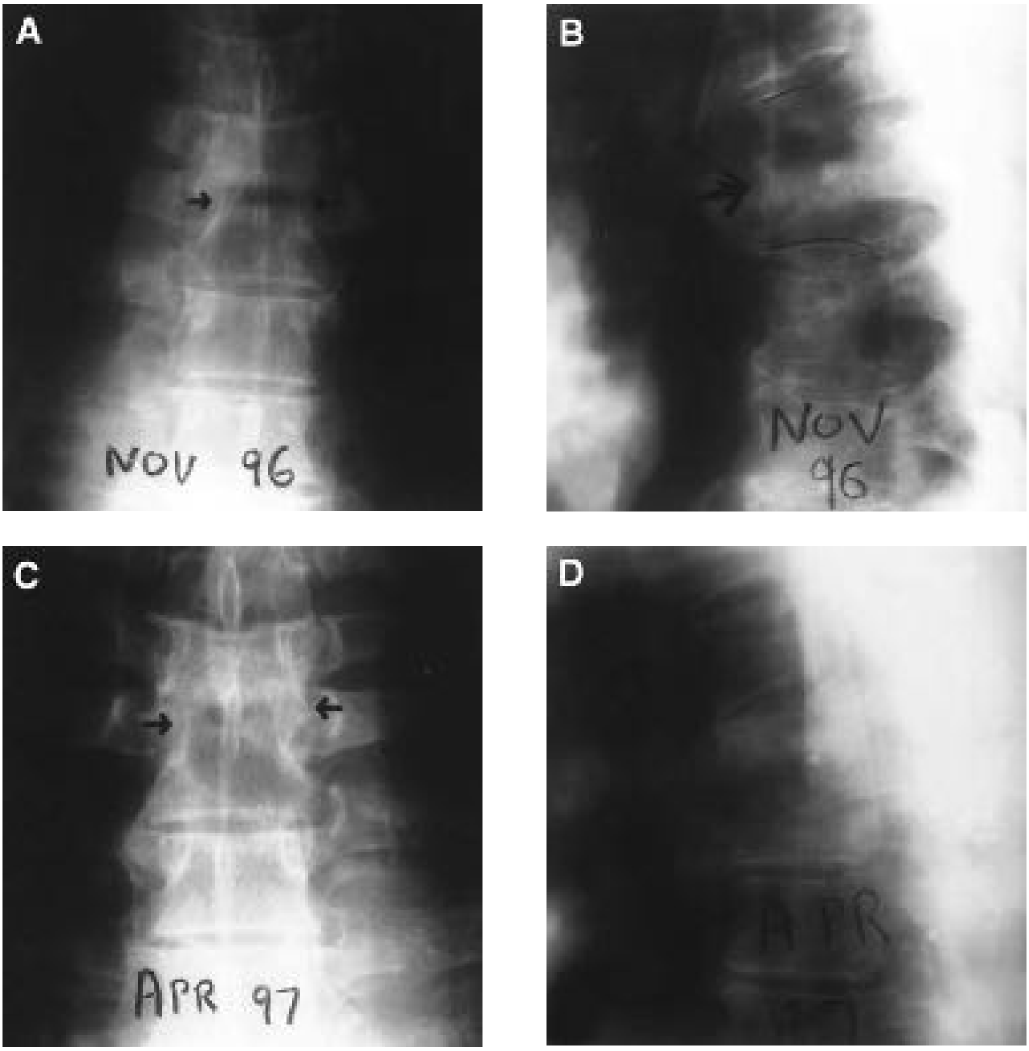


Fig. 21. **(A)** AP and **(B)** lateral view of spondylodiscitis of T4–T5 region treated by percutaneous transpedicular discectomy. **(C,D)** Five months later there was a complete bony ankylosis. (Reproduced with permission from ref. *41*.)

compressing the neural elements. Therefore, percutaneous transpedicular discectomy is contraindicated for the treatment of any spinal epidural abscess, or when there is neurocompression of the cord or the conus medullaris in the thoracic or thoracolumbar spine by inflammatory granulation tissue.

In conclusion, percutaneous transpedicular discectomy is safe and highly effective during the early stages of spondylodiscitis, when bone destruction is not extensive. It is ineffective in the presence of infected disc herniation, foraminal stenosis, and excessive bone destruction with spinal deformity. This procedure is contraindicated when there is spinal epidural abscess and neurocompression by deformity, inflammatory tissue, or a combination thereof.

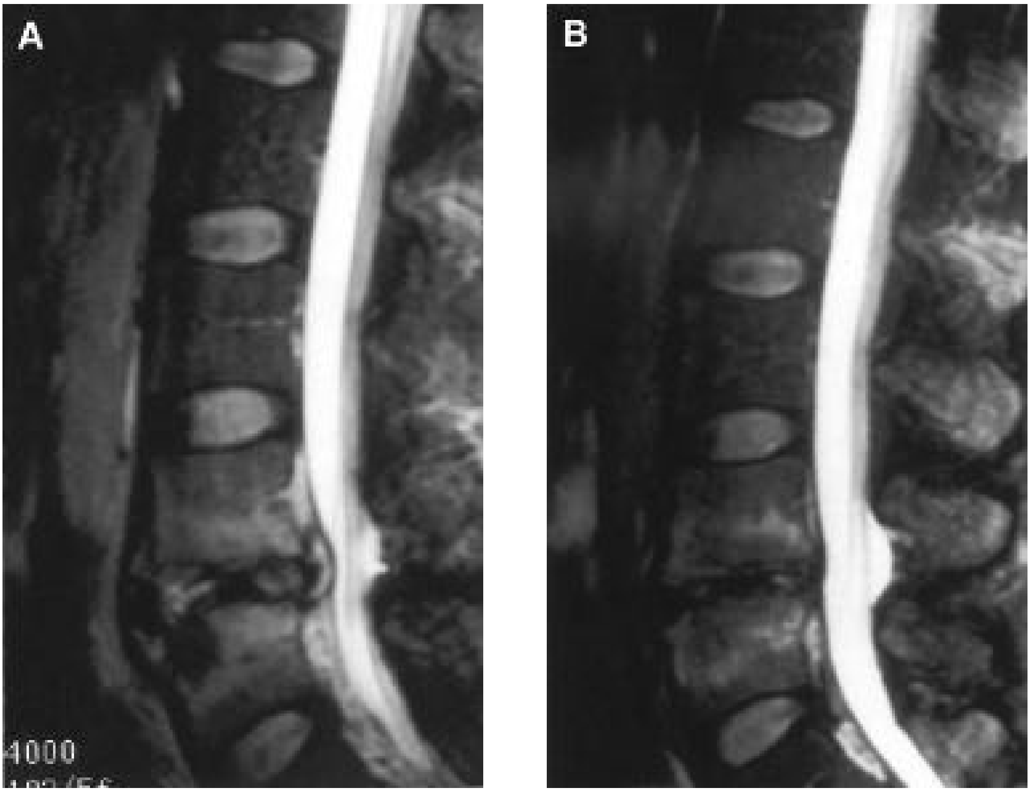


Fig. 22. **(A)** A sagittal T2-weighted MRI image of the lumbar spine in a 38-yr-old woman demonstrates changes typical of spondylodiscitis with a small epidural component. **(B)** A sagittal T2-weighted MRI image 2 mo postoperatively, showing resolution of the infection without kyphosis. The discectomy accelerated the natural process of healing and prevented kyphotic deformity. (Reproduced with permission from ref. *38*.)

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