Computed Tomography-guided Percutaneous Transpedicular Biopsy of the Thoracic Spine

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**Background:** Despite the recent, widespread use around the world of computed tomography (CT)-guided spinal biopsy for presurgical evaluation, its use has remained uncommon in Taiwan. Using 9 patients, we attempted to evaluate the safety of its use for the thoracic spine biopsy.

**Methods:** In the past 3 years (May 1996 to May 1999), 9 patients with known thoracic or multiple spinal lesions underwent CT-guided biopsy. The patients comprised 4 men and 5 women; with ages ranging between 28 and 85 years. For the transpedicular approach, patients were laid prone on the CT table. A trephine bone biopsy needle set was used after local anaesthesia. The specimens obtained had tissue pathology and/or bacterial/tuberculosis (TB) culture.

**Results:** Excellent results were achieved in 8 of the 9 patients, with no significant procedure-related complications. Among them, 2 were diagnosed as metastatic carcinomas; 3 as osteoporotic compression fractures; 2 were proved to be bacterial or tuberculosis spondylitis and the last one was a healing fracture.

**Conclusion:** CT-guided transpedicular trephine biopsy of the thoracic spine is a safe and effective method for preoperative evaluation of various thoracic spinal disorders. Based on the biopsy results, more effective treatment regimens were prescribed and, in turn, better outcomes were expected.

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**Key words:** computed tomography-guided biopsy, spine, trephine needle, transpedicular biopsy.

Computed tomography (CT)-guided percutaneous biopsy has been widely accepted as a cost-effective method for preoperative diagnosis of spine or skeletal lesions. When performing spinal biopsy, a posterolateral approach is often used. However, complex anatomy and the presence of vital organs in the region adjacent to the thoracic spine often preclude the standard posterolateral approach used for biopsy of the lumbar spine. In cases where the lesion is located in the pedicle or posterocentral vertebral body a transpedicular approach should be the preferred method. We successfully used this method in 9 patients with thoracic spine lesions and satisfactory results were obtained.
METHODS

During a 3-year period from May 1996 to May 1999, transpedicular biopsies of the thoracic spine under CT guidance were performed on 9 patients. The 9 patients consisted of 4 men and 5 women; ranging in ages from 28 to 85 years old. The biopsy sites included T3 (N=1), T5 (N=1), T6 (N=1), T7 (N=1), T8 (N=1), T9 (N=1), T11 (N=2), and T12 (N=1).

For the transpedicular approach, the patients were laid prone on the CT table (GE, HiSpeed Advantage® 1.X, Milwaukee, Wisconsin, USA) and the vertebrae undergoing biopsy were scanned. The entry site for biopsy was the intersection of the long axis of the pedicle with the skin surface. Standard pre-surgical skin preparation was performed and a sterile operative field was prepared, after which local anaesthetic was administered with a 4-cm long 22-Gauge needle, attached to a 10-cc syringe. A short 2-3 mm skin incision was made with a scalpel to facilitate further insertion of the guiding cannula. A guiding needle from a trephine bone biopsy needle set (Cook, Queensland, Australia) was inserted via the incision, targeting the cortex that intersected the line extrapolated from the pedicle's long axis. Repositioning of the guiding needle was sometimes necessary in order to obtain the correct alignment. Then, the guiding cannula was advanced over the guiding needle and manipulated towards the cortical surface. Upon successful positioning, the guiding needle could be withdrawn and a trephine biopsy performed through the guiding cannula. One ml of anaesthetic was administered through the cannula to anaesthetize the cortex before the trephine biopsy. The trephine biopsy was performed with the use of CT guidance to document the position of the needle within the lesion. Each procedure required approximately 30 to 40 min (35±5 min). Since immediate cytological evaluation by a cytopathologist was not possible in our hospital, two or three needle-passes were necessary so that an adequate specimen for pathological examination would be obtained. The specimens were placed in 37% formalin bottles and sent for histologic analysis. When infection was suspected, further bacterial or tuberculosis cultures were prepared from tissue aspirates obtained with a 22G fine Chiba aspiration needle (Cook Co., Bloomington, USA) passed through the guiding cannula.

RESULTS

We performed 9 biopsy procedures using a transpedicular approach to the thoracic spine. Definite diagnoses were made in 8 of the 9 patients, with one remaining inconclusive. The results led to changes in the treatment regimens in 4 patients (case 1, 3, 6, 9) and were crucial for the avoidance of an unnecessary operation and accompanied risks in one patient (case 9). Diagnoses were made based on the biopsy results and/or follow up examination. The clinical and imaging data were summarized in Table 1. The following are representative case reports.

Case 1
A 43-year-old female complained of mid back pain. No leg weakness was observed. The biochemistry profile was within normal limits. She had undergone surgery four years ago for breast carcinoma. MR imaging showed multiple spinal lesions suggestive of metastasis (Fig. 1A). CT-guided biopsy was performed for a tissue diagnosis (Fig. 1B). She was reluctant to undergo chemotherapy, or operation instead for supportive treatments.

Case 2
A 70-year-old female complained of lower back pain. No obvious lower extremity muscle power decrease or sphincter dysfunction was noticed upon routine physical examination. She had undergone surgery two years ago for right breast carcinoma. Her biochemistry profile was normal. MR imaging showed multiple spinal lesions suggestive of metastasis (Fig. 1A). CT-guided biopsy was performed for a tissue diagnosis (Fig. 1B). She was reluctant to undergo chemotherapy, or operation instead for supportive treatments.

Case 2
A 70-year-old female complained of lower back pain. No obvious lower extremity muscle power decrease or sphincter dysfunction was noticed upon routine physical examination. She had undergone surgery two years ago for right breast carcinoma. Her biochemistry profile was normal. MR imaging showed abnormal signal intensity and enhancement of the T11 and T12 vertebral bodies after Gd-DTPA administration (Fig. 2A). CT-guided biopsy was performed to rule out the possibility of metastasis (Fig. 2B). No malignant cells were found in the specimen. Minimal corpectomy of lower T12 and upper L1 vertebral bodies along with T11 to L2 transpedicular screw fixation was later performed because of persistent back pain and her inability to walk. The excised vertebral body specimen also showed no evidence of malignancy. The patient had an uneventful postoperative course.
Table 1. Clinical Features and Imaging Findings of the 9 Patients with Thoracic Spine Lesions that Underwent CT-guided Biopsy

<table>
<thead>
<tr>
<th>Patients</th>
<th>Age</th>
<th>Gender</th>
<th>Location of Lesions</th>
<th>Biopsy level</th>
<th>Clinical Presentation</th>
<th>Imaging</th>
<th>Enhancement in MRI</th>
<th>Paraspinal or Epidural soft tissue</th>
<th>Pathology</th>
<th>Management</th>
<th>Management plans changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28/M</td>
<td>T9</td>
<td>T9</td>
<td>Paraplegia</td>
<td>PE, CT, MRI</td>
<td>Body + pedicle</td>
<td>Yes</td>
<td>Pyogenic Spondylitis</td>
<td>Surgery</td>
<td>Yes</td>
<td>(anti-TB to antibiotics)</td>
</tr>
<tr>
<td>2</td>
<td>43/F</td>
<td>Multiple</td>
<td>T6</td>
<td>BP</td>
<td>PE, CT, MRI</td>
<td>Body + pedicle</td>
<td>No</td>
<td>Metastatic CA</td>
<td>Supportive</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>52/M</td>
<td>T10-12</td>
<td>T11</td>
<td>BP, RP, Weakness</td>
<td>PE, CT, MRI</td>
<td>Body</td>
<td>Yes</td>
<td>Healing Fracture</td>
<td>Surgery</td>
<td>Yes</td>
<td>(no anti-TB or antibiotics given)</td>
</tr>
<tr>
<td>4</td>
<td>69/F</td>
<td>T2-4</td>
<td>T3</td>
<td>Paraplegia</td>
<td>PE, CT, MRI</td>
<td>Body + pedicle</td>
<td>Yes</td>
<td>Inconclusive*</td>
<td>Supportive</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>76/F</td>
<td>T5-6</td>
<td>T5</td>
<td>BP referred to</td>
<td>PE, CT, MRI</td>
<td>Body</td>
<td>Yes</td>
<td>Osteoporotic Compression Fx</td>
<td>Supportive</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>70/F</td>
<td>T12-L1</td>
<td>T12</td>
<td>BP</td>
<td>PE, CT, MRI</td>
<td>Body + pedicle</td>
<td>No</td>
<td>Osteoporotic Compression Fx</td>
<td>Surgery</td>
<td>Yes</td>
<td>(supportive to OP)</td>
</tr>
<tr>
<td>7</td>
<td>72/F</td>
<td>T8-10</td>
<td>T8</td>
<td>Paraplegia, Numbness</td>
<td>CT, MRI</td>
<td>Body + Pedicle</td>
<td>No</td>
<td>Osteoporotic Compression Fx</td>
<td>Supportive</td>
<td>N6</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>83/F</td>
<td>T11-12</td>
<td>T11</td>
<td>Paraplegia, Urine retention</td>
<td>CT, MRI</td>
<td>Body + pedicle</td>
<td>No</td>
<td>Metastatic CA</td>
<td>Supportive</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>85/M</td>
<td>T5-8</td>
<td>T7</td>
<td>BP referred to costal region</td>
<td>PE, CT, MRI</td>
<td>Body + pedicle + disc</td>
<td>Yes</td>
<td>TB Spondylitis</td>
<td>Anti-TB Drug</td>
<td>Yes (OP to anti-TB)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BP: back pain; RP: radiculopathy; PF: plain film; CT: computed tomography; MRI: magnetic resonance imaging; Fx: fracture; OP: Operation; Tx: treatment

*: expected as metastasis based on MR findings and clinical history, but biopsy showed no malignancy.

Fig. 1 A 43-year-old woman complained of mid back pain. (A) Midsagittal T1-weighted MR image without contrast enhancement showing multiple metastatic lesions of the thoracic spine and the collapsed body of the 6th vertebra with spinal cord compression (arrow). (B) CT scan showing transpedicular trephine needle biopsy of the vertebral body; note the guiding cannula (black arrow), the trephine needle (black arrowhead) and the osteolytic bony lesions over the 6th vertebral body, lamina and rib (white arrowheads).
Fig. 2 A 70-year-old woman complained of lower back pain. (A) Midsagittal T1-weighted MR image with Gd-DTPA enhancement showing abnormally enhanced T11 and T12 vertebral bodies (arrows), with mild T11 body collapse but no obvious cord compression. (B) CT scan shows transpedicular trephine needle biopsy of T11 right pedicle and body; note the guiding cannula (arrow) and the trephine needle (arrowhead). Coarse bony trabeculae of the vertebral body were noted but no obvious paraspinal or epidural soft tissue mass was noted.

DISCUSSION

CT-guided percutaneous biopsy of the spine has generally been accepted as a safe, accurate, and cost-effective method for preoperative evaluation of various spinal lesions. Only in rare circumstances is an open biopsy of the spine, a major surgical procedure, necessary. In an open biopsy, there is increased risk of postoperative morbidity which is exacerbated in elderly or high-risk patients.

The introduction of the CT scanner has greatly improved the sensitivity of the percutaneous procedure. For biopsy of the thoracic spine, a transpedicular approach can be used with safety; especially when the lesions are located in the pedicles or posterocentral portions of the vertebral body. In Renfrew's series, three cases of thoracic spine lesions were approached using a transpedicular approach with good results. Renfrew suggested this method as a possible substitute for the traditional posterolateral approach when the lesions were located in the pedicles or posterocentral portions of the vertebral bodies. Stringham et al reported 9 open and 9 closed CT-guided transpedicular biopsies in the thoracic and lumbar spine. Of the closed method, 6 cases were thoracic spine and 3 cases were lumbar spine. Adequate specimens were obtained in all cases and, consequently, he concluded that the pedicle could provide a safe conduit for biopsy along most of the spine. In our series, all procedures were carried out smoothly without significant complications. We achieved excellent results in all but one of the nine cases.

The fourth case in our series was a patient with acute paraplegia. Metastasis was suspected based on MR imaging findings (Fig. 3A). CT indicated appropriate positioning of the trephine needle and an adequate sample was obtained during biopsy, (Fig. 3B) but the biopsy proved to be inconclusive. Nevertheless, a poorly differentiated adenocarcinoma was demonstrated later in an endoscopic biopsy of the stomach. There are two possible explanations for the inconclusive result. It is possible that the distal lumen of our trephine needle had already been impacted with the hard and healthy bony tissue of the right transverse process of the third thoracic vertebra before the needle passed through the tumor. Consequently, the tumor tissue would have been dis-
Fig. 3 A 69-year-old female complained of upper back pain. (A) Midsagittal T1-weighted MR imaging with Gd-DTPA enhancement showing abnormal vertebral collapse, enhancement in the T2 to T4 vertebrae and enhanced epidural soft tissue (arrowheads). (B) CT scan showing the position of the trephine needle and the destructive bony lesion (arrowheads)

placed by the needle rather than collected. Another possibility is dislodgment of the tumor mass from the needle after successful sampling, due to its soft or necrotic texture. In several of the reported series, fine aspiration needles were also employed through the guiding cannula after the trephine needles had been withdrawn. Such a procedure might have been sensitive enough to make a conclusive diagnosis in this case. We had, in fact, used the combined method of fine aspiration needles and cutting needles in the lumbar spine. Based on our experience, combined use with the cutting needle should be routine, especially when a soft or necrotic tumor mass is expected from the CT or MR imaging done prior to biopsy. This is based on the reasoning that an adequate tissue sample can be obtained for more accurate pathological diagnosis and the use of a cutting needle does not significantly lengthen the procedure. The use of fine needle aspiration in combination with a cutting needle should be considered as a standard procedure when a cytopathologist is not available for an immediate review of the smear.

From our limited number of cases, we found pedicle involvement to be an unreliable indicator for establishing or ruling out the possibility of metastasis, which contradicts the results reported by Rupp in 1995. However, the existence of epidural or paraspinal soft tissue seems to be a more reliable finding for diagnosing a spinal tumor mass or tuberculosis. Tuberculosis should be particularly considered when the intervertebral disc is involved.

MR imaging is far more sensitive in detecting spinal lesions than plain radiographic imaging or computed tomography. However, it also places the burden of a more complicated differential diagnosis upon the radiologist in the daily interpretation of MR films. When imaging ambiguity makes metastasis part of the list of differential diagnoses, there may be a compulsion to perform additional unnecessary examinations such as biopsy (open or closed). In our limited experience, plain radiographs or computed tomography still play an important role in the differential diagnosis of spinal disorders. MR images are sensitive but can be ambiguous when it comes to evaluating and differentiating the various spinal lesions; MR imaging findings can be misleading and over-diagnosis can easily occur depending on circumstances.

Transpedicular approach can be safely applied to either thoracic or lumbar spine biopsy using either CT or fluoroscopic guidance. However, when a lesion was located in lateral lumbar vertebral body, a posterolateral or a lateral approach should be used instead, But, if a similar lesion occurs in thoracic
spine, a fine-needle transthoracic aspiration biopsy or a surgical open biopsy would be the preferred methods.\(^{15,20}\) It's quite unreasonable to use a thick trephine or core biopsy needles to do a transthoracic spine biopsy either via a posterolateral or a lateral route. It depends on the locations and the types of the lesions (osteoblastic or lytic) then a correct biopsy needle and approaching pathway could be determined.

Significant complications may combine with either CT-guided biopsy or surgical approach in spinal intervention.\(^{6,11-25}\) Of a review series of 94 cases, 6 complications were noted, including 1 aortic puncture, 2 psosas muscles punctures, 1 biopsy at an incorrect level and 2 aborted procedures secondary to patient discomfort.\(^{6}\)

In the limited cases reported by Kuttapuram and Pierot et al, no complications were encountered.\(^{11,17}\)

In the reported series by Metzger with 7 patients and 9 procedures, only a small pneumothorax was complicated with the transthoracic spinal biopsy procedure.\(^{20}\) In two large series reported, the complication rates associated with CT-guided spinal or musculoskeletal biopsies were ranging from less than 1% to 6.4% which were accompanied by a high diagnostic accuracy.\(^{6,10}\) The reported accuracy rates of CT-guided spinal biopsy were ranging from 71% to 96.8%.\(^{15,19,21}\) It mainly depends on the nature of the lesions undergoing biopsy. The diagnostic accuracy in tumoral lesions may be up to 100%, while in case of suspected infectious lesions it could fall to 57%.\(^{15,22}\)

In Faciszenski's retrospective based review, a 11.5% complication rate was directly attributed to the 1223 anterior thoracic or lumbar spinal fusions.\(^{25}\)

In McDonnell's series with 447 patients, whom received anterior spinal procedure, complications occurred in 140 (31%) patients.\(^{26}\) Two of them died from pulmonary complications. In a review report for metastatic spinal tumor surgery, based on 80 patients, the author reported thirty-five complications in 20 patients (25%).\(^{23}\)

The complications depend upon the patient's conditions, locations of the lesions, the surgical procedures and the needles used in the CT-guided biopsy. However, based upon the above reports, a closed CT-guided biopsy procedure does possess a potential of low complication rate when compared with that of a major spinal surgery.

We concluded that CT-guided percutaneous transpedicular biopsy is a safe and effective method for preoperative diagnosis of lesions of the thoracic spine. The procedure can obviate the need for major surgery in many instances and can facilitate appropriate surgical planning in others. Many of the potential complications of more invasive investigative procedures can also be avoided with the transpedicular approach.

REFERENCES

15. Fazzi UG, Wadell G. Semi-open needle biopsy of the