CLINICAL STUDY

CT Fluoroscopy-guided Percutaneous Osteoplasty for the Treatment of Osteolytic Lung Cancer Bone Metastases to the Spine and Pelvis

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ABSTRACT

Purpose: To retrospectively assess the results of computed tomographic (CT) fluoroscopy-guided percutaneous osteoplasty (PO) of osteolytic lung cancer bone metastases, focusing on pain reduction, improved quality of life, and patient mobility.

Materials And Methods: Over a 43-month interval, 92 patients with lung cancer bone metastases underwent PO, including vertebroplasty and acetabuloplasty. A total of 261 lesions of the vertebral column and 22 lesions of the pelvis, ilium, and femur were treated with the use of CT fluoroscopic guidance. Clinical outcomes were assessed, including pain, quality of life, and mobility, 24 hours before, 24 hours after, and 1 and 3 months after osteoplasty.

Results: Pain reduction and improved quality of life and patient mobility were observed in most patients. Visual analog scale and Karnofsky Performance Scale scores changed significantly ($P < .05$), from 6.1 ± 1.4 and 69.3 ± 5.5 at 24 hours before osteoplasty, respectively, to 3.5 ± 1.2 and 75.2 ± 5.4 at 24 hours after the procedure, 3.3 ± 1.2 and 76.5 ± 5.8 at 1 month, and 2.9 ± 1.5 and 79.6 ± 5.8 at 3 months after PO. Mobility scale score, Frankel classification of spinal cord injury, and Harris hip score also changed significantly ($P < .05$) after osteoplasty. No major complications occurred.

Conclusions: PO was shown to be a highly effective and safe palliative therapy to reduce pain and improve quality of life and patient mobility, not only in vertebral metastases, but also in pelvic, iliac, and femoral metastases.

ABBREVIATIONS

KPS = Karnofsky Performance Scale, MPR = multiplanar reconstruction, PA = percutaneous acetabuloplasty, PMMA = polymethylmethacrylate, PO = percutaneous osteoplasty, PV = percutaneous vertebroplasty, VAS = visual analog scale

The incidence of bone metastases in advanced lung cancer is estimated to range from 30% to 40% (1,2). Lung cancer often metastasizes to the spine, pelvis, ilium, and upper part of the femur. The consequences of bone metastases are intense and drug-resistant pain (3). Patients may require walking aids or a wheelchair, and are often forced to take bed rest, with a considerable adverse effect on quality of life.

Noninvasive treatment options for the management of lung cancer bone metastasis include chemotherapy, targeted therapy, bisphosphonates, and radiation therapy. However, these therapeutic regimens are often not sufficient to restore the integrity of the bone and allow a return to early weight-bearing (4,5). Surgical options may be limited as a result of a high incidence of comorbidities (6,7). The consequences of insufficient surgical treatment options are physical deterioration and poor general quality of life.

Percutaneous vertebroplasty (PV) has been established as an effective treatment for metastatic disease of the spine (8–11). The use of percutaneous acetabuloplasty (PA) has been extended to osteolytic bone lesions in the pelvis, ilium, and femur, and has also been shown to be effective in the management of metastatic lesions around the acetabulum (12,13). The aim of this retrospective single-center study was to assess the clinical benefits of percutaneous osteoplasty (PO) with regard to pain reduction, improved quality of life, and patient mobility in patients with bone metastases from advanced lung cancer.

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MATERIALS AND METHODS

Patient Selection

This study was approved by the ethics committee of the Sixth People's Hospital, Shanghai Jiao Tong University. The principles of the Declaration of Helsinki were followed. The diagnosis of lung cancer had been made by using the standard clinical criteria.

The clinical indications for osteoplasty were regularly confirmed by an interdisciplinary team of medical oncologists, radiation oncologists, surgeons, and interventional radiologists before the intervention. Each patient underwent a physical examination by the referring clinician to identify the painful or fractured lesion(s). Informed consent by the patient or his/her legal guardian to undergo osteoplasty was obtained 24 hours before and immediately before the intervention, after an extensive explanation of the method and its potential complications and alternative treatments.

In the period between June 2007 and December 2010, 92 patients with lung cancer with bone metastases underwent osteoplasty. The mean age of the patients was 57 y ± 9, with a range of 33–79 y. All patients referred for PO had severe pain refractory to conservative analgesic therapy and a life expectancy of greater than 3 months. These patients underwent four cycles of first-line chemotherapy or targeted therapy. If the lung cancer was considered to be effectively controlled during the course of the systemic therapy, the patients received PO after agreement by all the members of the group. Radiation therapy was administered to patients reporting persistent pain 3 months after the procedure.

Inclusion and Exclusion Criteria

The indication for PV was in accordance with the Society of Interventional Radiology quality improvement guidelines (14,15). Painful vertebrae with extensive osteolysis or invasion secondary to benign or malignant tumors were indications for PV. Radiculopathy in excess of vertebral pain (caused by a compressive syndrome unrelated to vertebral collapse), asymptomatic retropulsion of a fracture fragment causing significant spinal canal compromise, and asymptomatic tumor extension into the epidural space were regarded as relative contraindications to vertebroplasty. The absolute contraindications were improvement with analgesic therapy, myelopathy in patients with spinal canal compromise as a result of retropulsion of bone fragments or a tumor, active local or systemic infections, uncorrectable coagulopathy, and an allergy to bone cement or opacification agents.

There are no widely accepted guidelines for prescribing PA. The main indications for acetabuloplasty included pain, impending fracture, and perceived need for bone reinforcement (12,13). Injection of polymethylmethacrylate (PMMA) usually is indicated in acetabular osteolyses involving the weight-bearing part of the acetabulum, that is, the acetabulum roof and femur. Contraindications for PA include articular cortical destruction of the acetabular roof more than 5 mm in diameter and soft tissue involvement more than three times the area of bone destruction (13). Although leakage of PMMA in the hip joint is a potential complication, periacetabular fractures or extensive nonarticular cortical destruction are not considered contraindications for the procedure (12,13). Active local or systemic infections, uncorrectable coagulopathy, and an allergy to bone cement or opacification agents were absolute exclusion criteria for PA.

Imaging Workup and Guidance

Before osteoplasty, the previous cross-sectional images obtained for all patients within 2 weeks, such as those computed tomography (CT), magnetic resonance imaging, or positron emission tomography/CT, were evaluated by a team of interventional radiologists.

Each patient underwent a preintervention and postintervention CT scan (Sensation 4 or 16; Siemens, Forchheim, Germany) of the involved bone with coronal and sagittal multiplanar reconstructions (MPRs). The CT scan involved 3-mm slices and coronal and sagittal MPRs to visualize the extent of the bone destruction, detect the possible involvement of the posterior wall of the vertebral body and the integrity of the acetabular lesion, and plan the needle trajectory for osteoplasty. Based on postinterventional CT scan, the distribution of PMMA in the bone body and PMMA leaks were analyzed.

The entire osteoplasty procedure, including the needle placement and PMMA injection, was performed under CT fluoroscopic guidance (CARE Vision CT; Siemens) only. The needle was inserted under intermittent single-shot CT fluoroscopic acquisitions. Continuous CT fluoroscopy was used only during the PMMA injection. The needle tip and adjacent cement distribution within the bone were monitored in real time on a ceiling-mounted in-room monitor (256 × 256 imaging matrix interpolated to 1,024 × 1,024 for display) by moving the table along the *z*-axis in incremental steps of 1.0 mm, using a control panel attached to the CT table. Precautions with respect to radiation protection of the operator during CT fluoroscopy included aprons, thyroid shields, and eyeglasses of 0.5-mm lead equivalent.

Procedure

For the cervical spine, an anterolateral approach (patient in supine position) was generally used, whereas an intercostovertebral approach (patient in prone position) was used for the thoracic and lumbar spine. A lateral approach (patient in supine or lateral position) was generally used for the pelvis, ilium, and femur. By using fluoroscopic guidance, the practitioner infiltrated the skin and subcutaneous tissues overlying the pedicle of the target bone with 1% lidocaine (Xudong Haipu, Shanghai, China). The vertebroplasty needles (Murphy M2; Cook, Bloomington, Indiana) used were 15-, 13-, or 10-gauge and 10 or 15 cm in length, whereas the acetabuloplasty needles used were 13- or 10-gauge and 10 or 15 cm in length.