



Preoperative HIFU ablation combined with femoral bone marrow nailing for the treatment of pathological fracture of femur: a case report

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Introduction and importance: Bone is one of the common sites of metastasis in lung cancer. Pathological fractures of the femur significantly reduce patients' quality of life and increase the risk of death. However, there is still no consensus on the optimal treatment of pathological femoral fractures. The authors' report provides a treatment method for a patient with pathological fracture of lung cancer with preoperative HIFU lesion ablation followed by combined intramedullary nail fixation.

Case presentation: A 61-year-old Chinese woman was hospitalized with severe pain in her right thigh. X-ray and CT examination at admission considered pathological fracture of the right femur. MRI showed a comminuted fracture of the middle and lower part of the right femur, swelling of the surrounding soft tissue, and effusion. WBS showed an abnormal concentration of imaging agent at the right femoral fracture end and abnormal bone metabolism. After a lung biopsy, it was diagnosed as lung cancer with femoral metastasis and pathological fracture.

Clinical discussion: The patient underwent HIFU ablation before surgery to reduce the lesion, and a re-examination MRI showed that the signal at the lesion was significantly reduced, and the lesion volume was significantly reduced. The operation was performed by open reduction and intramedullary nail fixation, focal excision, and bone cement filling. After 6 months of follow-up, the patient's bone metastasis was not aggravated, and there was no loosening or fracture of the right femoral intramedullary nail.

Conclusion: This is a case of pathological fracture of the femur caused by bone metastases from pulmonary cancer. The patient used HIFU to reduce the lesion before the operation and combined it with intramedullary nail internal fixation to treat the pathological fracture. A satisfactory therapeutic effect was obtained. The authors believe that this is a safe and effective treatment. This case may be beneficial to the treatment of pathological fracture of bone metastasis of lung cancer.

Keywords: femoral, HIFU, pathological fracture

Background

Bone is one of the common metastatic sites of lung cancer^[1]. It has been reported that in the distribution of bone metastasis in lung cancer, femur metastasis is second only to the spine and pelvis^[2–4]. Pathological fracture of the femur significantly reduces the quality of life and increases the risk of death in patients with lung cancer^[5,6].

However, there is no consensus on how to achieve the best therapeutic benefits and outcomes for patients with femoral pathology^[7]. High-intensity focused ultrasound (HIFU) is an emerging non-invasive technique that can effectively reduce pain

and control local tumor size in patients with bone metastases^[8]. We proposed a treatment plan for preoperative HIFU ablation, reduction of lesions, and combination with femoral intramedullary nails for a patient with pathological femoral fracture of lung cancer.

Case presentation

A 61-year-old Chinese woman was hospitalized with severe pain in her right thigh. The patient had no clear history of trauma. She had diabetes for more than 7 years and was well-controlled on

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metformin and gliclazide. Computed tomography (CT) of the right femur at admission showed: Preoperative CT examination of the femur showed a fracture in the middle of the right femur with obvious local bone destruction (Fig. 1A). Preoperative X-ray of the right femur showed a fracture in the middle of the right femur, and the fracture separation and displacement were obvious (Fig. 2A, B). Before HIFU treatment, MRI showed a high T2 signal at the fracture site, and the surrounding soft tissue was swollen and wrapped with fluid, indicating a high possibility of pathological fracture (Fig. 3A, B, C). Whole-body bone scintigraphy (WBS) showed abnormal concentration of imaging agents at the fracture site, osteolytic bone destruction at the fracture site, and abnormal bone metabolism. Tumor bone metastasis with pathological fracture was considered (Fig. 4A). No abnormalities were found in blood routine, biochemistry, electrolytes, and inflammatory factors. On admission, chest CT examination was highly suspected of lung cancer, which was confirmed as lung adenocarcinoma after needle biopsy (Fig. 5A)

The main diagnoses were as follows: ①pathological fracture of the right middle femur, ②metastatic bone tumor of the right femur, ③adenocarcinoma of the right lung, ④type 2 diabetes. After obtaining the consent of the patient, radiofrequency ablation and tumor reduction were performed with HIFU before surgery.

The HIFU treatment process is as follows: After the patient's general anesthesia took effect, the right lateral position was taken. Before the start of ablation, a slightly low echo shadow

HIGHLIGHTS

- There is no consensus on how to achieve the best therapeutic benefits and outcomes for patients with femoral pathology. High-intensity focused ultrasound (HIFU) is an emerging non-invasive technique that can effectively reduce pain and control local tumor size in patients with bone metastases. We proposed a treatment plan for preoperative HIFU ablation, reduction of lesions, and combination with femoral intramedullary nails for a patient with pathological femoral fracture of lung cancer.

was found on the outer side of the middle of the right thigh, with an unclear boundary, about $42 \times 48 \times 30 \text{ mm}^3$. The location of the lesion was determined by preoperative MRI and on-board ultrasound. The central layer of the lesion was selected and irradiated at a rhythm of 100W/1:3 until 5s. During the operation, the gray-scale changes of focal mass were observed, and the focal mass was full after treatment to 350s layer by layer.

After HIFU treatment, a re-examination MRI showed that the T2 signal at the right femur fracture was significantly reduced and the lesion area was reduced (Fig. 3D, E, F). After excluding contraindications, open reduction with intramedullary nail internal fixation, focal excision, and cement filling of the right femoral pathological fracture was performed under general anesthesia two days later. The brief procedure is as follows: After

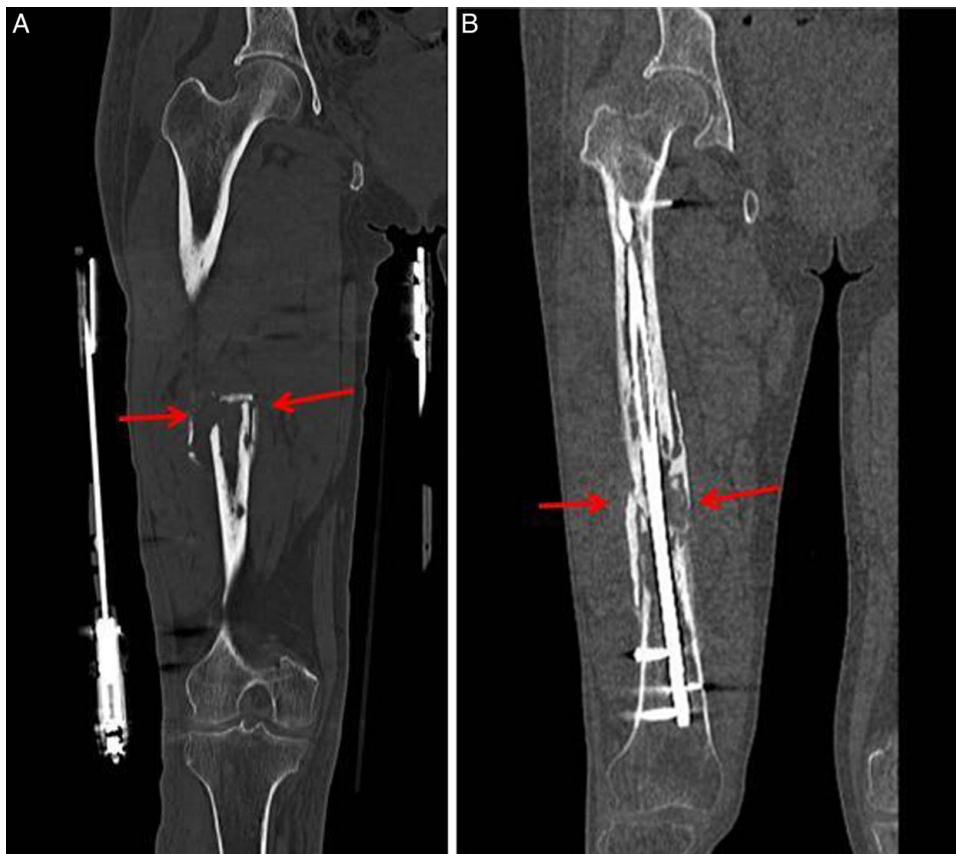


Figure 1. (A) is the preoperative computed tomography (CT) scan image, and (B) is the CT scan image at the 6th month after operation.

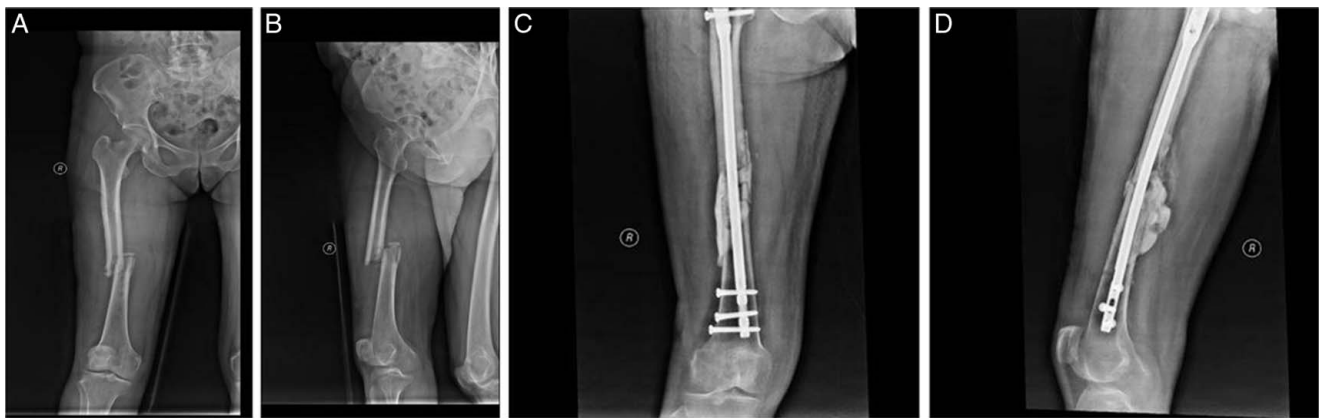


Figure 2. (A, B) Show preoperative X-ray examination. (C, D) are postoperative re-examination.

general anesthesia, the patient lay on the traction bed and disinfected the towel. A longitudinal incision of about 8cm was made on the anterolateral side of the right thigh. The incision was made layer by layer. The lateral femoral muscle and rectus femoris were separated in turn, and then the intermediate femoris muscle was dissected. The fracture end was fully exposed, and it was found that the bone of the fracture end was worm-eaten. The soft tissue and hematoma at the fracture end were removed, and the bone tissue of the lesion was completely destroyed and scraped. Then the fracture end samples were taken for examination (Fig. 5B). The fracture was reduced under direct vision, and the broken end

of the fracture was fixed with bone-holding forceps. Next, the femoral bone marrow internal nail was installed according to the technical requirements of internal fixation. Subsequently, the wound was thoroughly stanced and washed, and the bone defect was filled with bone cement. After the drainage tube was placed, the wound was sutured layer by layer and bandaged with pressure.

Postoperative antibiotic use for 24 h (cefazolin sodium 1g, q8h). On the second day after the operation, muscle training and knee joint activity training were carried out under the guidance of rehabilitation doctors. Postoperative DR showed that the right

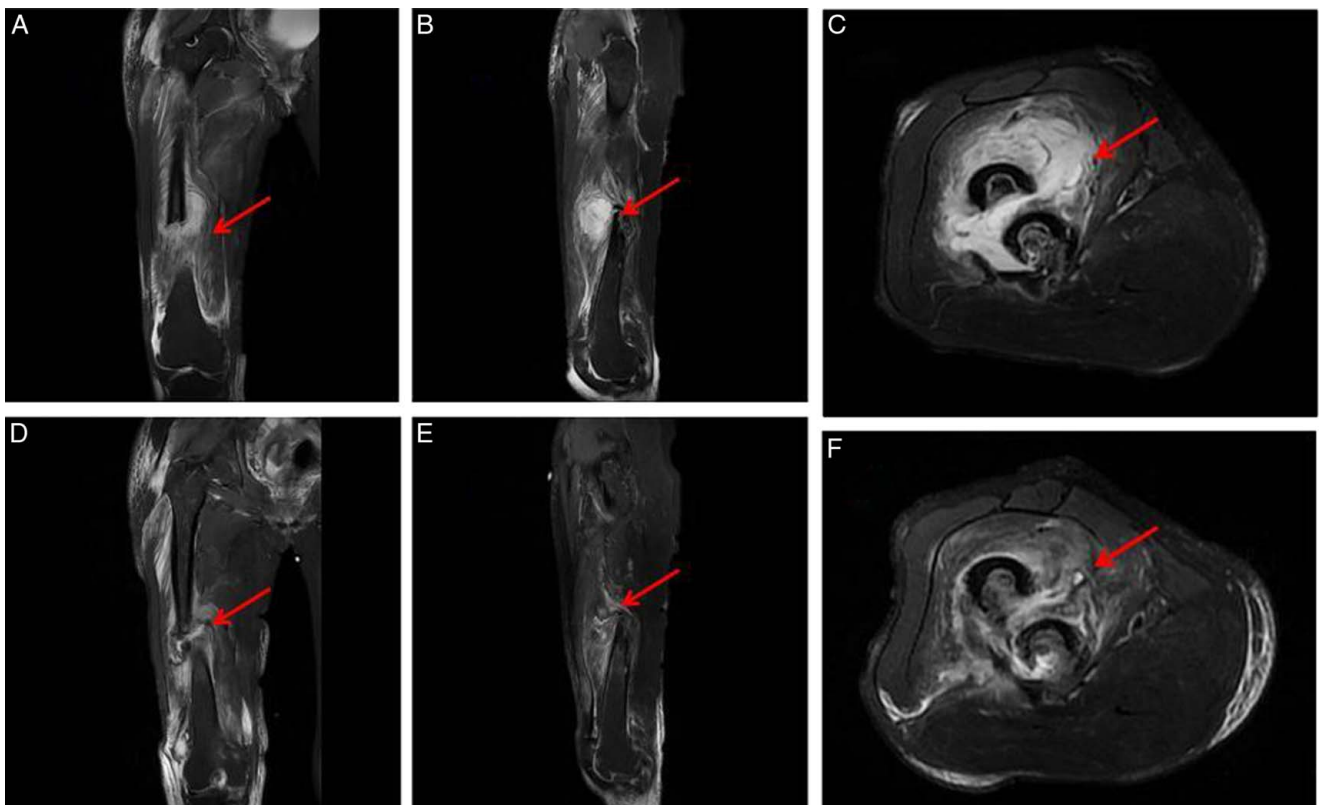


Figure 3. (A–C) are MRI examinations before high-intensity focused ultrasound (HIFU) treatment. (D–F) are the images of MRI re-examination after HIFU treatment.

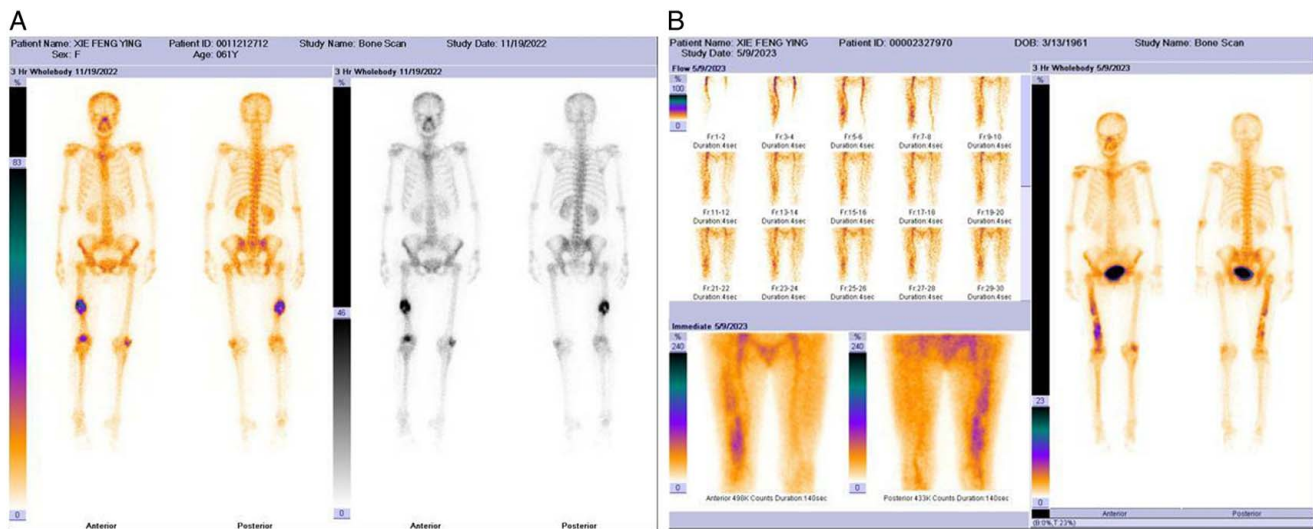


Figure 4. (A, B) are the images of whole-body bone scintigraphy before and after high-intensity focused ultrasound treatment, respectively.

femoral intramedullary nail was fixed in position, and the fracture end was in good alignment (Fig. 2C, D). After A-level wound healing, the patient was discharged from the hospital. The patients were followed up at 1, 2, 3, 6, 9, and 12 months after the operation and then every 6 months to evaluate the fracture healing and recurrence of tumor bone metastasis. At the 6th month after the operation, the CT scan of the right femur showed that the intramedullary nail was well fixed and the local cortical bone was thinned (Fig. 1B). WBS re-examination showed bone destruction in the middle and lower segments of the right femur, and the imaging agent in the center of the lesion was sparser than before (Fig. 4B).

Discussion

In this case, the HIFU technique was used to ablate bone metastases and reduce lesions before the operation. Subsequently, bone metastases were surgically removed, intramedullary nails were used to treat fractures, and bone cement was used to fill bone defects. This treatment effectively controlled the progression of bone metastases, reduced the pathological fracture in the middle of the femur, and solved the bone defect of the femur.

Many malignant tumors, especially the primary tumors of breast, prostate, lung, and other organs, are easy to metastasize to bone, causing pain in patients and even pathological fractures^[9,10]. It has been reported that in the course of lung cancer patients, about 40% of patients will experience bone metastasis^[11]. Preventing or delaying disease progression and relieving symptoms is the purpose of bone metastasis treatment. For patients with bone metastasis, chemotherapy, radiotherapy, biologically targeted therapy, immunotherapy, endocrine therapy, local ablation, and other treatment methods can be used. For patients with potential fractures or pathological fractures, surgical treatment can be used^[3,12].

In 2007 and 2012, HIFU technology was approved by CONFORMITE EUROPEENNE (CE) and US Food and Drug Administration (FDA) for the treatment of bone metastases from malignant tumors, respectively^[8,13,14]. As a non-invasive, non-ionizing radiation thermal ablation technology, HIFU plays a role mainly through instantaneous thermal ablation effect and mechanical effect mechanism^[14,15]. Compared with conventional radiotherapy, HIFU does not need to bear the risks associated with ionizing radiation during radiotherapy and is not limited by the dose. HIFU treatment can be repeated as many times as needed according to the patient’s condition, and compared with other ablation methods, HIFU technology is less invasive and safer^[16].

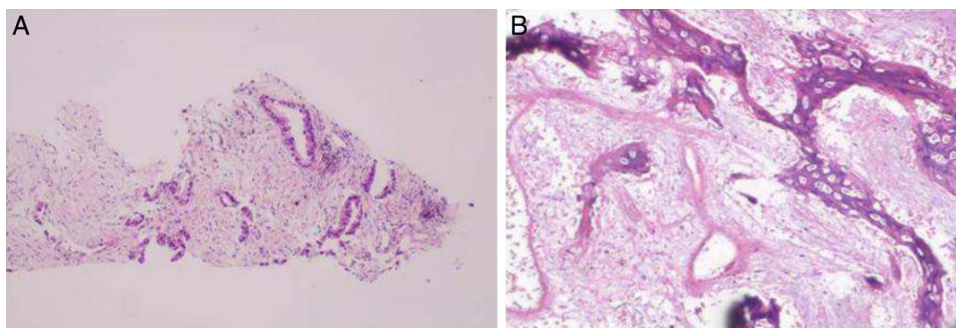


Figure 5. (A) is a lung biopsy image, (B) is an intraoperative biopsy image.

At present, there are few studies on HIFU technology to control disease and reduce bone metastases, and only a few clinical trials have been mentioned. Alessandro Napoli^[17] used HIFU to treat pain with bone metastases and studied its local tumor control effect. After 1–3 months of follow-up after treatment, it was concluded that HIFU could effectively relieve pain caused by bone metastases and confirmed the potential value of HIFU for local control of bone metastases. The patient we reported used HIFU for ablation before surgery. By comparing MRI before and after treatment, it was found that the bone metastasis lesions at the fracture end were significantly reduced after HIFU treatment, which confirmed the reduction effect of HIFU on bone metastasis lesions.

Conclusion

This patient with a pathological fracture of the femur caused by bone metastasis of lung cancer achieved a good outcome by using HIFU to reduce the lesion before the operation and then combined with intramedullary nail internal fixation. We believe that this is a safe and effective treatment. The treatment of this patient may be beneficial to the treatment of pathological fracture of bone metastasis of lung cancer.

Ethical approval

This study was approved by the Medical Research Ethics Committee of Suining Central Hospital (Ethics Code KYLLMC20230018). This research was conducted in full compliance with the codes of ethical conduct from the Declaration of Helsinki. Written informed consent was obtained from the patient before she was enrolled in the study.

Consent

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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Author contribution

Z.Q.W. finished the whole treatment; Z.Y.W., A.C.W., and X.H. collected the data; L.Y. and B.W. wrote the manuscript; All authors reviewed the final manuscript. All authors agreed to be accountable for all aspects of the work.

Conflicts of interest disclosure

All the authors have no conflict of interest related to the manuscript.

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Data availability statement

The authors declare that all data supporting the findings of this study are available within the article.

Provenance and peer review

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