

Microwave Ablation of Malignant Extremity Bone Tumors

Authors:

Qing-Yu fan, Yong Zhou, Minghua Zhang, Baoan Ma, Tongtao Yang, Hua Long,

Zhe Yu, Lianhe Zheng, Zhao Li

Level of Evidence: IV (Retrospective series).

Institute/address of Presenting Author:

Department of Orthopedic Surgery, Tangdu Hospital, Fourth Military Medical University, Xi'an, China, 710038

E-mail: bonetm@fmmu.edu.cn

Summary

Background: The current application of limb salvage process has some unsolved problems, such as prosthesis loosening, which severely limits the function of the preserved limbs. The patients must be prepared to face the prospect of needing a kind of revision surgery one or more in the future even amputation. Innovative approaches are needed to further improve functional outcome.

The upper temperature limit for plants and animals is less than 50 degrees C (120 degrees F). Between 60–100°C, there is near instantaneous induction of protein coagulation which leads to cell death. Hyperthermia could be adopted to treat bone tumors.

Questions/Purposes:

1. Is the oncological outcome after en bloc ablation by microwave induced hyperthermia comparable with that after traditional en bloc resection?
2. Is the functional result, especially the long-term result, after en bloc ablation better than that after traditional en bloc resection?
3. What is the fate of the dead bone?

Patients and Methods: Instead of en-bloc resection of tumor-bearing bone, it is dissected from the surrounding normal tissues, followed by devitalizing the bone segment and the extra-cortical bulk by microwave induced hyperthermia in situ through the antenna array which is properly distributed in the tumor bulk. During insertion of the antennas and the thermocouples, special attention will be paid to prevent accidentally spoil the surrounding tissues if blood and fluid would extrude out from the isolated bulk. After thermotherapy,, these soft died tissues were removed and/or curetted leaving behind the defective bone scaffold for reconstruction using any of the currently accepted methods. After re-strengthening the dead bone, its mechanical property becomes strong enough to support the weight bearing. In this way, the structures of the adjacent natural joints were salvaged well. From May 1999 to March 2012, 543 patients with malignant bone tumors of the extremities were treated by the novel method. The series includes 469 cases with high-grade malignant sarcoma (mainly osteosarcoma followed by MFH and Ewing's sarcoma), 54 cases with

low-grade malignancy (chondrosarcoma 38 cases, adamantinoblastoma 16 cases), and 21 cases with isolated metastatic lesion.

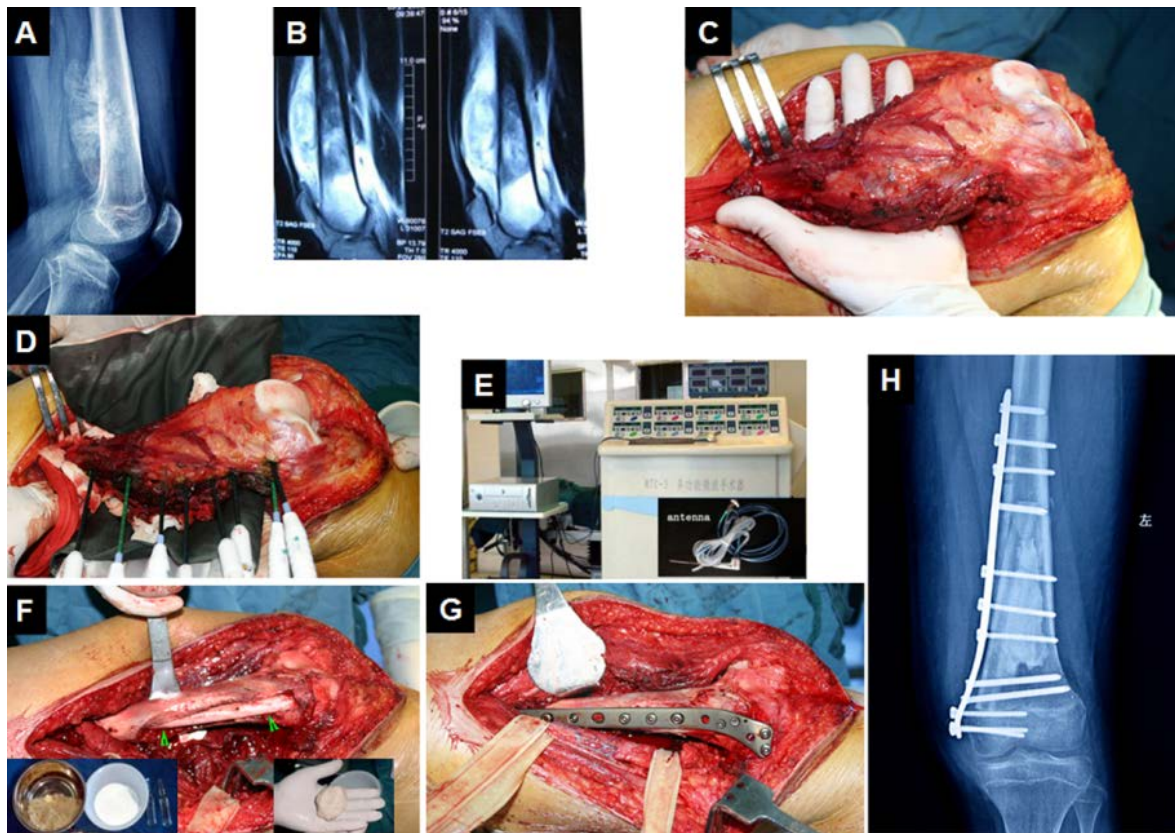


Fig1: Typical procedure for osteosarcoma at distal femur.

A, B: Image data shows an osteosarcoma of distal femur

C: Dissect the tumor-bearing bone from surrounding normal tissues with safe margin.

D: Put a heat-isolation pad between the tumor bone and surrounding normal tissues and began to deliver electromagnetic energy into tumor bone

E: The microwave generator and antenna

F: Remove or curettage the dead soften tumor mass and give fibular bone autograft. The mixture materials of bone chips and bone cement was used filling the cavity.

G: Restore the normal shape of the femur and give a prophylactic fixation

H: X-ray film after surgery. The devitalized bone allows effective re-attachment of muscles and tendons, and produces a lasting biological reconstruction eliminating the problems of prostheticwear. The natural knee joint was retained perfectly. Function is still perfect after surgery 11 years.

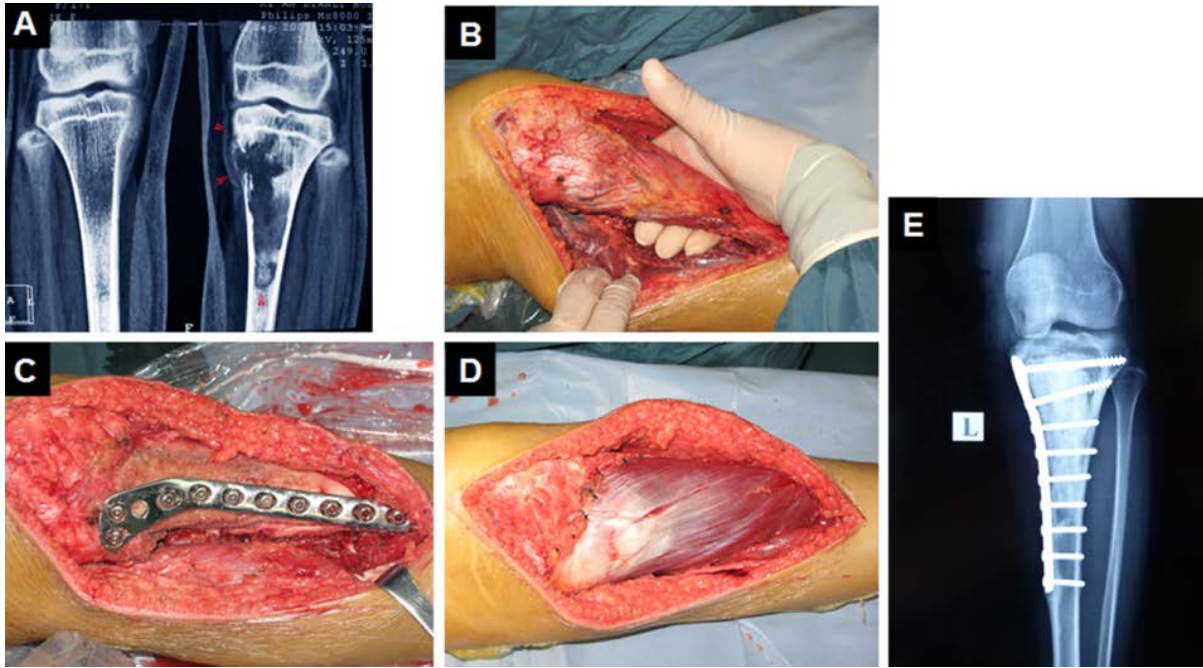


Fig 2: Typical procedure for osteosarcoma at proximal tibia:

- A: x-ray film before surgery
- B: isolation of tumor bone
- C: give a prophylactic fixation after MWA
- D: transfer the medial head of gastrocnemius muscle
- E: x-ray film after surgery

Results: The over 3-year survival rate was 59.1% for high-grade malignancy, 88.7% for low-grade malignancy. In the majority of the patients, cosmetic and useful limbs were preserved.

Local recurrence rate was 9.8% for the high grade malignancy (mainly occurred at the early stage of the research).The overall fracture rate was 2.6%. Deep infection rate was 1.8%. The complication rate is lower than the literature reports.

Conclusions: The functional outcome is expected to be superior after MW ablation, since no joint replacement—neither prosthetic nor allograft—could function better than an intact native joint. After heat necrosis, the dead bone maintains both the osteoconduction and osteoinduction properties. The oncological and functional results are encouraging. The application of microwave induced hyperthermia for treatment of malignant bone tumors is an effective, simple, and inexpensive method without compromising survival or local recurrence. Furthermore, the devitalized bone frame is biologically autogeneous so that once the healing does occur, it is durable and does not have the potential for loosening inherent in a metal prosthesis. Hyperthermia should deserve more attention than it has received until now.