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Review

Palliative percutaneous stabilization of lower extremity for bone metastasis using flexible nails and bone cement

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ABSTRACT

Objective: Percutaneous stabilization (PS; percutaneous flexible nailing and intramedullary bone cement injection) was performed at lower extremity long bones in patients with multiple bone metastases with short life expectancy to get mechanical stability and local tumor control. We evaluated the usefulness of PS by clinical status, F-18-FDG PET-CT and bone scintigraphy (BS).

Methods: Patients comprised 15 patients (total 20 sites) who had undergone PS for the metastatic bone tumors of lower extremity long bones (femur and tibia). After percutaneous flexible nailing, bone cement was injected (mean amount = 15.5 ± 6.4 ml). Patients' clinical status was evaluated by visual analog scale (VAS). Qualitative assessment of PET-CT and BS was categorized by improved, stable and aggravated states of PS lesion. Quantitative assessment of PET-CT was performed by maximum and mean standardized uptake value (SUVmax and SUVmean).

Results: PS was performed in all of the patients without complication, and showed significant pain improvement of VAS (7.2 ± 0.2 vs. 2.8 ± 0.3, $P < 0.001$). PS lesion showed improved state in 65% (13/20) and stable state in 35% (7/20). However, naive bony metastatic lesion showed mostly aggravated state in 90% (19/20) in the same patients, which was significantly different compared with PS lesion ($P < 0.001$). In PS lesion, SUVmax (10.1 ± 6.9 vs. 7.1 ± 5.2, $P = 0.008$) and SUVmean (6.2 ± 4.8 vs. 4.6 ± 3.7, $P = 0.008$) showed significantly decreased uptake after PS.

Conclusion: By PS in lower extremity long bones, patients can reduce regional pain, and has the possibility of local tumor control. PS can be performed for lower extremity bone metastasis in poor general condition to perform conventional intramedullary nailing.

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Introduction

Bone metastasis is the most common malignancy among skeletal malignancy. Approximately 80% of patients with advanced cancer exhibit radiological evidence of skeletal metastasis [1,2]. Femur is the most common metastatic site in the extremity long bones, with an incidence of 30–50%, and patients need structural stability especially on weight bearing bone metastasis like pelvic bone, femur, and tibia [3]. Surgical techniques for bone metastasis include curettage and internal fixation, open or close interlocking intramedullary nailing and prosthesis or allograft reconstruction. Up to now, intramedullary nailing is the most accepted fixation method in the femoral and tibial bone metastasis, because of its ease of insertion and load-sharing properties [4]. However, fixation of bone metastasis remains controversial especially in patients with multiple organic failure, short life expectancy due to advanced cancer.

Recently, minimally invasive surgery with small incisional scar, minimal blood loss and short operative time has become available for high risk patients. Other palliative surgical techniques without tissue dissection include cementoplasty, ethanol injection, cryoablation and radiofrequency ablation, etc [5]. Percutaneous cementoplasty is known for favorable outcomes in spinal tumors and in flat bone locations such as pelvis, scapula and sternum [6,7]. However, the risk of pathologic fracture is still high when percutaneous cementoplasty is solely performed in a long bone without metal fixation.

Percutaneous flexible nail (Ender nail) insertion technique has been used for structural stability with minimal operative complication [8]. Palliative surgical method for humeral metastasis with flexible nail insertion and bone cement injection into the space of medullary canal was recently introduced [9]. Small diameter of intramedullary flexible nail fixation provides the space for percutaneous bone cement injection. As the lower extremity bones need more structural stability for ambulation, sole technique of intramedullary flexible nail fixation of lower extremity was insufficient for ambulation in patients with poor configuration [8]. We think that the combinational percutaneous surgery (flexible nail insertion and bone cement injection) can be useful in long bone metastasis patients who cannot perform conventional intramedullary nailing due to poor life expectancy. The breakage of flexible nail is fatigue fracture by repetitive mechanical stress. Patients with multiple bone metastasis usually have lower body mass index (BMI) and ambulation is not frequent due to other organ metastasis. Furthermore, as co-injection of bone cement is expected to reinforce the flexible nail, the strength would be stronger than sole flexible nail.

The purpose of the study is to evaluate the effect of percutaneous flexible nail insertion and cement injection in long bone metastasis by evaluating pain status, ambulation status and image analysis.

Materials and methods

Patients selection

Between March 2008 and December 2011, we enrolled 26 patients who underwent percutaneous flexible nail fixation and intramedullary bone cement injection (percutaneous stabilization, PS) for lower extremity bone metastasis. These patients had short life expectancy with advanced metastatic lesions including unresectable primary cancer and multiple organ impairment. All of the patients were unable to ambulate prior to the procedure. We only included patients with severe bone pain and imminent due to intramedullary endosteal scalloping caused by diaphyseal lesions in whom cortical stability was preserved. The patients were unable to undergo conventional intramedullary nailing due to their short life expectancy by multiple metastases. Patients with subtrochnateric lesion, pathologic fractures or joint destructive lesions were excluded. Preoperative decisions were made by the multidisciplinary team which included hemato-oncologists, radiologists, anesthesiologists, radiation therapists and orthopedic surgeons. A total of 15 patients (M:F = 7:8, mean age = 60.5 ± 14.9 yrs) who had undergone F-18-FDG Positron Emission Tomogrphy (PET) - Computed Tomography (CT) and/or bone scintigrapy (BS) before and after PS were included. The primary cancers were lung (6 patients), breast (2 patients), prostate (2 patients), osteosarcoma (1 patient), cholangiocarcinoma (1 patient), pulmonary angiosarcoma (1 patient), hepatocellular carcinoma (1 patient) and renal cell carcinoma (1 patient). The 20 sites of PS were femur (16 sites) and tibia (4 sites) (Table 1).

Percutaneous stabilization (PS) procedure

After spinal anesthesia, patients were placed in the supine position so that fluoroscopy could be operated without disturbance. Flexible nails (4.5 mm in diameters; Smith & Nephew plc, London, UK) long enough to pass the intramedullary metastatic lesion were inserted. When the flexible nail is completely seated, its tip of entry point was be buried beneath the cortex to prevent soft tissue irritation. After fluoroscopic confirmation of the flexible nail fixation, bone cement is injected. A percutaneous vertebroplasty (PV) needle (10 gauge, 11 cm; poverty needle, Kyungwon Medical, Seoul, Korea) is directly inserted into the osteolytic lesion by hammering. Once PV location is identified on fluoroscopy, high viscosity bone cement (polymethyl metacrylate; Depuy International Ltd, Blackpool, UK) was injected. Mean amount of cement injection in each site was 15.5 ± 6.4 ml (range = 3–31 ml) (Table 1). All of the PS treatments were done by the same orthopaedic physicians at our institution.

Radiation therapy

Radiation therapy was performed before (1 site) or after (14 sites) PS as decided by the radiation oncology and orthopedic surgeons. Radiation therapy was not performed in the remaining 5 sites (Table 1).

Clinical status assessment

Patients' pain status was evaluated by the visual analog scale (VAS) with range from 0 (no pain) to 10 (worst pain imaginable). VAS was assessed a day before PS (pre-PS VAS), and after PS (post-PS VAS; first 6 week visit post PS). In addition, patients' ambulation