Surgical Oncology 24 (2015) 226–231

Contents lists available at ScienceDirect

Surgical Oncology

journal homepage: www.elsevier.com/locate/suronc

Review

Minimally invasive surgery for femoral neck fractures using bone cement infusible hollow-perforated screw in high-risk patients with advanced cancer

Patrick P. Lin [a], Hyun Guy Kang [b, *], Yong-il Kim [c], June Hyuk Kim [b], Han Soo Kim [d]

[a] Department of Orthopaedic Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA
[b] Orthopaedic Oncology Clinic, National Cancer Center, Gyeonggido, Republic of Korea
[c] Department of Nuclear Medicine, Seoul National University Hospital, Seoul, Republic of Korea
[d] Department of Orthopaedic Surgery, Seoul National University College of Medicine, Seoul, Republic of Korea

ARTICLE INFO

Article history:
Received 15 January 2015
Received in revised form
22 April 2015
Accepted 19 May 2015

Keywords:
Hollow-perforated screw
Percutaneous cementoplasty
Bone metastasis
Femur neck fracture

ABSTRACT

Objective: Pathologic or osteoporotic femoral neck fractures usually treated with joint replacement surgery rather than joint-preserving surgery because multiple screw fixation has a high risk for fixation failure and nonunion as well as the need for a postoperative protection period. However, joint-preserving surgery might be preferable in high-risk patients with short life expectancy due to advanced disease. Recently introduced hollow-perforated screws are devices for achieving percutaneous fixation by simultaneous injection to the weak bone area through its multiple side holes. We report our experience of surgical treatment of femoral neck fractures by controlled bone cement injection into the femoral head and neck through a modified hollow-perforated screw in patients with advanced cancer.

Methods: We modified the hollow perforated screw with variable placing of screw-side holes as fracture patterns. Polymethylmethacrylate (PMMA) bone cement was injected through the screw holes to control its injection into the selective areas of the femoral head and neck while avoiding the fracture sites. One or two of these were fixed percutaneously in 12 patients who have Garden stage I or II femoral neck fractures in the advanced state of advanced cancer. Seven patients had pathologic fracture by metastatic cancer, but 5 had osteoporotic fractures.

Results: Eleven patients died a mean of 4.1 months after surgery and 1 patient lived with ability to walk for 48 months. Sixteen modified hollow perforated-screws and 16 standard cannulated screws were used for fixation. The mean volume of cement injection was 13.8 ml. The complication developed in 4 patients: cement leakage to the hip joint in 2 patients, subtrochanteric fracture in 1 patient (5 months after surgery) and fixation failure in 1 patients (2 months after surgery). Nine patients could walk with or without a walking aid, and all others also could return to the prefracture-ambulation state with effective pain relief on the third postoperative day.

Conclusion: This current surgical method could be useful in patients with short life expectancy because of quick pain relief, early return to ambulation, simple operative procedures and short hospital stay. The modified hollow perforated screw which has a diversity of side hole locations for the regulation of bone cement injection into the planned area seems useful for selective femoral neck fractures.

Contents

* Corresponding author. Orthopaedic Oncology Clinic, National Cancer Center, 323, Ilsan-ro, Ilsandong-gu, Goyang-si, Gyeonggi-do 410-769, Republic of Korea.
E-mail address: ostumor@ncc.re.kr (H.G. Kang).

http://dx.doi.org/10.1016/j.suronc.2015.05.003
0960-7404/

1. Introduction

The femur neck is very vulnerable to fractures due to metastasis as well as osteoporosis in cancer patients [1–4]. When minimally displaced femoral neck fractures occur in subjects with normal bone density, joint-preserving surgery with multiple screws or pins has frequently been performed [5,6]. Meanwhile, in a low bone density condition which is frequently seen in advanced cancer, femoral neck fracture treatment with these screws or pins may result in fixation failure or nonunion that requires a postoperative protection period [7–12]. Therefore, pathologic or osteoporotic femoral neck fractures usually undergo joint replacement surgery with bipolar hip or proximal tumor prosthesis, regardless of fracture pattern [13–15]. Moreover, this major surgery also has been performed for relief of pain or bedside care rather than for restoration of patient's ability to walk. Joint conservative surgery might be preferable in some patients with a high-risk state of advanced disease because there is a lower operative morbidity and because early postoperative mobilization prolongs their short life expectancy.

A new novel surgical technique for the treatment of femoral neck metastasis using hollow perforated screws and bone cement was introduced [1]. The hollow-perforated screw is a new device for achieving greater fixation and for injecting material into the weak bone area simultaneously through its multiple side holes. It showed effective pain relief and reliable stability through a simple surgical method [1,16]. However, unregulated cement injection through the multiple side holes of the screw might be unfeasible for femoral neck fractures due to high risk of cement leakage through the fracture site. Therefore, we modified the screw by placing side holes according to fracture patterns for injection of cement into the planned areas of the femoral head and neck. We report our experience of surgical treatment of femoral neck fractures with percutaneous fixation of modified hollow-perforated screws and controlled bone cement injection in high-risk patients with advanced cancer.

2. Materials and methods

2.1. Patients

This study was approved by the Institutional Review Board (IRB) of our hospital, and informed consent was obtained from both patients and their families. The procedure and its possible complications were fully explained before the operation, and we obtained permission to use our specially designed hollow-perforated screw. We retrospectively reviewed 12 advanced cancer patients with femoral neck fractures who were treated with modified hollow-perforated screws and simultaneous bone cement injection through their adjusted side holes in between April 2008 and February 2010. These consecutive patients had suffered from unresectable primary cancer and 2 more major metastatic lesions associated with an estimated short life expectancy. We included only patients with undisplaced or minimally displaced femoral neck fractures with relatively well preserved femoral head contours. Patients who had ipsilateral osteolytic lesions in the proximal femur, such as the subtrochanter or lesser trochanter, on preoperative radiographs were excluded. There were 3 men and 9 women with a mean age of 68.2 years (range 45–83 years), and their mean body mass index (BMI; weight (kg)/(height (m))^2) was 21.3 (range 15.8–26.2). The primary tumors were lung cancer in 6 patients, breast cancer in 2 patients, hepatocellular carcinoma in 1 patient, cervical cancer in 1 patient, B-cell lymphoma in 1 patient and myelocytic leukemia in 1 patient. The location of the femoral neck fracture was subcapital in 6 patients, transcervical in 2 patients and basicervical in 4 patients. The displacement of the femoral neck was rated using the Garden System [17], and showed stage I in 7 patients and stage II in 5 patients. Six patients had pathologic fractures due to metastatic cancer, but other 6 patients had fractures due to osteoporosis by preoperative radiographic evaluation. We obtained 4 postoperative pathologic results: metastases in 2 and no tumor in 2 (Table 1). Spinal anesthesia was usually performed, but 2 patients underwent local anesthesia due to lower lumbar metastases as well as high risk for pulmonary complications due to general anesthesia. Each patient's walking ability was reviewed at the time of prefracture, on the third postoperative day and at the last follow-up month. The numeric rating scale (NRS) scores for pain were measured on the third postoperative day [18].

2.2. Modification of hollow-perforated screw

A hollow-perforated screw was devised by modifying a 6.5-mm cannulated screw (Multihole Injection Screw; SOLCO, Seoul, Korea). The medical engineering department of our institution added multiple side holes measuring 2 mm in diameter (Fig. 1). In this study, each screw had different placement of side holes, depending on the fracture pattern on preoperative radiographs.

2.3. Operative procedure

The procedure was performed in the lateral decubitus position. After sterilization and draping the affected leg, imaginary lines were drawn on the skin to indicate the femoral shaft and neck under fluoroscopic guidance. First, two or three 2.2-mm guide wires were placed in the femoral neck percutaneously under image intensification. A small skin incision was made at the site of the correctly located guide wire, and the bone was drilled using a cannulated drill bur. We collected bone fragments attached to the cannulated drill bur for a pathologic examination. One or 2 modified hollow-perforated screws were introduced along the guide wires, and 1 or 2 standard 6.5-mm cannulated screws were also introduced for supplementation. After checking for the opening direction of the side hole and location of the placed screw fluoroscopically, a biopsy needle (10 gauge, 11 cm) was moved along the guide wire into the modified hollow-perforated screw. The guide wire was removed and a low-viscosity PMMA bone cement