CLINICAL REPORT

Femoroplasty: A New Option for Femur Metastasis

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Abstract: Bone metastases are very frequent in patients with cancer and usually are located in the patient's long bones and spine. Various approaches to pain relief and stability to the affected bone have been used. The aim of the study is to report our experience with a new minimally invasive percutaneous technique in patients with bone metastases located in the head, neck, and proximal femur. The technique is performed under fluoroscopic guidance through the application of polymethylmethacrylate bone cement. Our descriptive, retrospective, longitudinal case series included 15 patients who underwent femoroplasty. All patients reported pain reduction and improved mobility, with no complications observed. The femoroplasty procedure caused pain relief by stabilizing the bone through the consolidation of the microfractures because of bone metastases. ■

Key Words: cancer pain, polymethylmethacrylate, polymethylmethacrylate cement, bone metastases, femur, femoroplasty

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INTRODUCTION

Bone metastasis is a frequent condition in patients with cancer. Its incidence depends on the primary tumor type. It develops in up to 50% of patients with cancer, most frequently breast, prostate, and lung cancers. Approximately 1.5 million new cancer cases are reported each year.[1] The most frequent symptom is pain, which is severe and as a result produces alterations in mobility. This has repercussions on the musculoskeletal system and therefore on quality of life.[2–4] The vast majority of cancer patients with bone metastases are in advanced stages of their disease. Some of these metastatic bone lesions involve long bones such as the femur, but there are few studies examining minimally invasive treatments for these areas. Therefore, our primary goal in this study was to examine whether such a therapy would improve quality of life and reduce pain in individuals with metastatic cancer to the femur.

Existing treatments for this kind of patient include surgery, radiation therapy, chemotherapy, hormonal therapy, and the use of bisphosphonates. Of these, radiation remains the treatment of choice. Commonly, pharmacological handling by itself does not control pain adequately in these patients[5]; for this reason, it is necessary to use a multimodal therapy that can offer a better option of integral palliation.

To provide pain relief and offer stability to the affected bone, physicians have been looking for new minimally invasive techniques to approach these bone metastases, such as vertebroplasty. Vertebroplasty consists of the application of bone cement to a compression fracture within the vertebral body, which produces substantial pain relief in 80–90% of the cases, with low morbidity. [6–11] Likewise, patients who were treated with the application of bone cement—under fluoroscopic or tomographic guidance—reported 90% of pain relief in different parts of the skeletal system such as tibia, pelvis, as well as several support points in the acetabulum, ilium, and sacrum. [12–19] At the femoral level, when the polymethylmethacrylate (PMMA) bone cement is used, it solidifies and permits stabilization of the bone structure and coxofemoral articulation. A lytic activity is originated as a consequence of the thermal action produced by the cement, reducing the metastatic activity, and it is suggested that this probably inhibits the regional nociceptors, thus alleviating pain, as in vertebroplasties.[20]

The objective of this study was to investigate a new, minimally invasive, fluoroscopically guided, percutaneous technique called "femoroplasty" in patients with metastatic disease in the head, neck, and proximal third of the femur.

ANATOMY

When performing femoroplasty, it is necessary to have good knowledge of the anatomical planes involved in the process. These planes are as described: In the first plane, the skin is innervated by the lateral femoral cutaneous nerve and vascularized by the superior gluteal artery. The superior gluteal artery is divided into 2 types, superior and deep. The obturator artery is divided into 2 types as well, the anterior and posterior. In the second plane, the muscles passing nearby are the tensor of fascia lata and the vastus lateralis.

In the third plane, we find the medial and lateral region of the greater trochanter of femur, between the meeting point of the gluteus medius and vastus medialis muscles.[21]

METHODS

The Ethics Committee of the Instituto Nacional de Cancerologia (IRB) approved this retrospective observational case series. Informed consent was obtained prior to intervention. Fifteen patients with metastatic disease of the femur were treated at the Instituto Nacional de Cancerologia, Mexico City, from November 2004 through December 2007. Inclusion criteria were as follows: (1) patients with primary malignancy of lung, breast, and prostate and metastatic lesions in the head, neck, and proximal one-third of the femur and (2) Karnofsky score >60%. Exclusion criteria were as follows: (1) impairment of coagulation and platelet dysfunction; (2) local infection at the proposed procedure site; and (3) cognitive dysfunction.

Outcome measures were visual analog scale (VAS) rating, use of opioid and nonopioid pain medication, and changes in function as measured by mobility. All patients were previously evaluated using the following studies: elevation of alkaline phosphatase, bone scanning, pelvis and affected hip X-ray, and pelvis MRI in some cases. Depending on the progression of their disease, some patients were receiving chemotherapy, radiotherapy, and both opioids and nonsteroidal anti-inflammatory drugs (NSAID) without satisfactory results.

TECHNIQUE

The patients' blood pressure, pulse oximetry, and ECG were monitored continuously during the procedure; conscious sedation was achieved with fentanyl, propofol, and midazolam. One gram of IV cephalosporin was administered for prophylaxis prior to starting the procedure. Using fluoroscopy, the patients' pelvis and involved hip were imaged in the anteroposterior position. The patient was then placed in the lateral decubitus position with the affected side up and the hip slightly flexed. Using sterile technique, the area was then prepped, and the fluoroscopy machine was oriented so that the needle entry site could be lateral to the

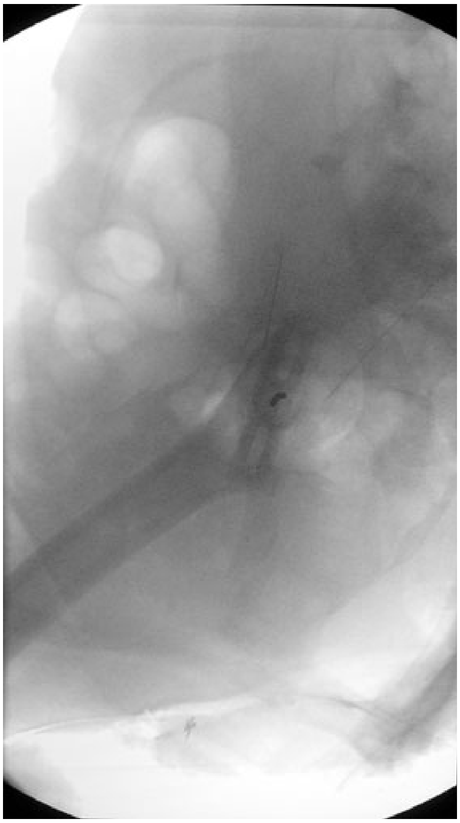

Figure 1. Lateral view of the femur with 22-gauge needles placed on both sides; bone biopsy needle located in the middle of the greater trochanter.

Figure 2. Correct position of the needle in AP view.

femur with a craniocaudal angle varying from 20 to 30 degrees. The C-arm was rotated until the femoral neck and head could be visualized and the greater trochanter appeared as an oval (tunnel view). The procedure site was infiltrated with 2% lidocaine, and two 22-gauge needles were placed for reference between the neck and head of the femur. An 11-gauge bone biopsy needle was then placed in the middle and upper area of the greater trochanter between the 2 spinal needles directed toward the femoral head and a third needle in the center. These needles are essential to locate the femur, depth, and trajectory of the biopsy needle (Figure 1). Once the biopsy needle touched bone, it was then advanced across the cortical region of the trochanter using both lateral and tunnel views for guidance (Figure 2).

A 22-gauge long spinal needle was passed through the biopsy needle as a guide before advancing the biopsy needle toward the femoral head; this reduced the possibility of needle deviation. The advancement of the spinal needle was sometimes complicated by bone hardening. In this circumstance, the biopsy needle was advanced through the greater trochanter until its tip reached the junction of the anterior and medial third of the femoral head. Once the biopsy needle was properly placed by this maneuver, the spinal needle was removed and the introduction of the biopsy needle continued (Figure 3).

Once the biopsy needle was placed adequately in the femoral head, its location was verified with 3 mL of nonionic contrast to evaluate the filling pattern and identify leaks into the articular space, veins, or muscle. If necessary, the needle was repositioned. Subsequently, we administrated the PMMA, using fluoroscopic guidance in the lateral view using real-time fluoroscopy (Figure 4).

Polymethylmethacrylate preparation: the PMMA was mixed to a semiliquid consistency and drawn up into 1-mL syringes. Administration of the PMMA was performed under fluoroscopic imaging in the AP and lateral view. To achieve satisfactory filling of the affected bone, the needle should be withdrawn while delivering the cement, directing the bevel of the needle toward the site that requires more filling (Figures 5A and 5B). The quantity of PMMA varies depending on

Figure 3. The biopsy needle advanced through the femoral head with the tip between the anterior and medial thirds.

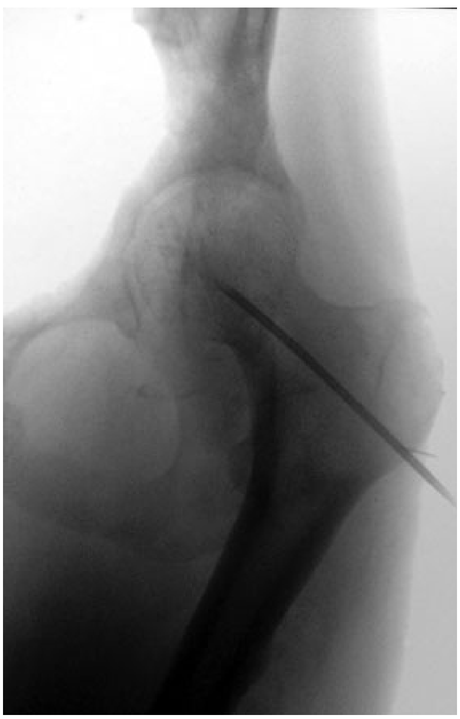

Figure 4. Lateral view to verify PMMA distribution.

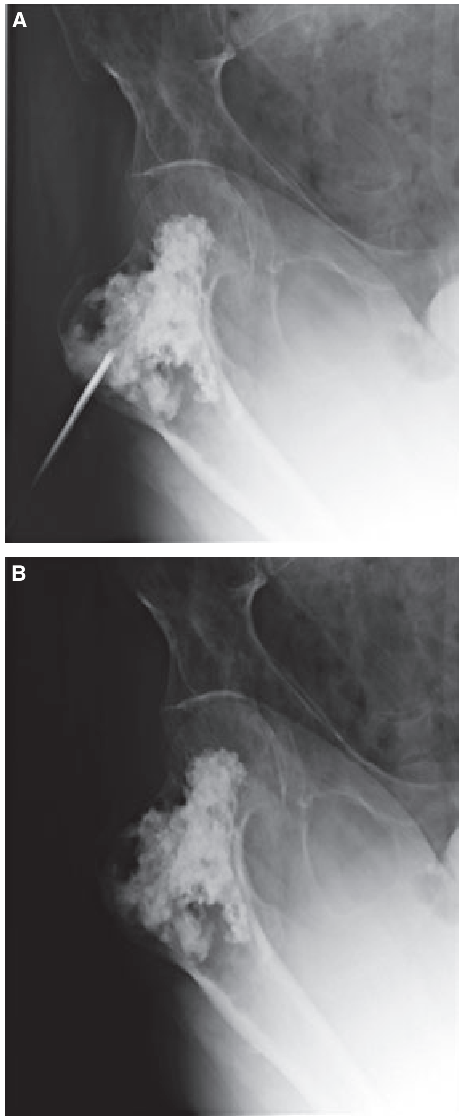

Figure 5. (A) AP VIEW: PMMA application; (B) view of the procedure's final step.

Table 1. Baseline characteristics

Characteristics	Men (*n* = 7)	Women (*n* = 8)	*P* value
Age	62.8 ± 13.8	42.6 ± 12.6	0.01
Mets source			
Breast	NA	6	NA
Prostate	6	NA	NA
Lung	1	2	NA
Previous radiotherapy	7	8	0.9
PMMA mL	7.1 ± 2.3	4.8 ± 2.4	0.08
VAS basal	6.3 ± 0.9	5.3 ± 0.7	0.03

PMMA, polymethylmethacrylate; VAS, visual analog scale; Mets source, origin of the metastasis.

the extent of the metastatic lesion and patient size. Filling should be stopped once the distribution of cement in the metastatic area has been achieved.

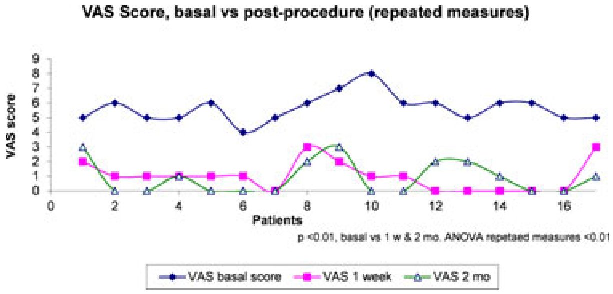

Figure 6. VAS score for pain.

RESULTS

We performed 17 femoroplasties in 15 patients (2 bilateral): 8 women (mean age 42.6 ± 12.6), 2 with lung cancer and 6 with breast cancer, and 7 men (mean age 62.8 ± 13.8), 6 with prostate cancer and 1 with lung cancer (Table 1). The distribution of affected sides was as follows: 10 right sides and 7 left sides of affected femur in 15 patients. The mean volume of PMMA used was 6.3 ± 2.6 mL.

Analgesic drug consumption decreased in all patients more than 50% compared with baseline levels and was maintained throughout follow-up (ANOVA repeated measures $P < 0.01$). Moreover, 15 sides saw improvement according to Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, while only 2 reached slight improvement and one was unchanged.

Baseline mean VAS score for pain was 5.6 ± 1.1. Pain was localized in the affected pelvic member. Post-procedure VAS was 1.2 ± 2.3, remaining at the same level throughout the follow-up of 2 months (*t*-test [basal vs. following measures] and ANOVA repeated measures <0.001) (Figure 6). All patients reported pain reduction on the treated pelvic member and improved mobility; however, analgesic intake was not modified because of patients' pathology. There were no complications observed, but 3 patients presented with transient pain that improved 10 days after the procedure.

DISCUSSION

Polymethylmethacrylate use at sites of bone metastases resulted in improved function, pain relief, and health-related quality of life. The use of PMMA at sites other than the vertebrae is a novel, interventional approach that may be used to potentially reduce pain and improve patient function. The mechanisms of bone cement–induced analgesia and functional improvement are likely to be multifactorial. The injection of bone cement may aid in the stabilization of microfractures, reduce thermal damage, and reduce cytotoxicity in bones. Furthermore, the antineoplastic effect of bone cement may play a significant role in treating osteolysis.[22,23] The present study demonstrated a sustained effect on pain relief (decreased VAS score) at femoral level across PMMA use, with improvement in function and pain (WOMAC score.)

Our study did not find any serious complications, perhaps because of the femoral characteristics (long bone, size, easy approach) in our study population. The literature mentions potential complications in femoroplasty, including infection (osteomyelitis), cement leakage, nerve and vascular injury, persistent pain, incident fracture after cementoplasty, rejection to PMMA, and avascular necrosis of femoral head by cement leakage to the circumflex artery. Three previous case series had been reported without detailed description of the technique.

One previous series reported 11 patients who presented with osteolytic lesions and severe pain (none of whom were treated with previous radiotherapy), and 5 patients presented with fracture at the femoral neck or trochanter. The author used a greater volume of injection than our study of PMMA (up to 30 mL) and found a clinical improvement in pain relief without any information regarding statistical significance.[24] In our study, every patient was treated with radiotherapy (standard medical therapy for bone metastases) and pharmacologic treatment. They presented with significant pain and functional impairment. The technique presented in our study seems easier than Kang's technique, in spite of the fact that we used only one bone biopsy needle and we did not use special tools, for example, hollow perforated screws.

The other 2 case series reported one and 2 cases, respectively. The case report used cementoplasty at the femoral head with optimal pain relief. The author used a double approach (neck and acetabulum) with the patient in prone position.[25] We consider prone position a more difficult position than lateral decubitus. The lateral decubitus position allowed us to visualize the AP and lateral views of femur in a better way. It also allowed us to modify the angle to obtain a coaxial or tunnel vision view. The lateral decubitus approach resides in the middle of greater trochanter, consequently allowing us to use only one needle to reach the femoral head.

The last report took into account 2 cases of femur cementoplasty. In both patients, the author found improvement in pain relief; however, one had a pathologic fracture in the treated area, and in the other, the patient did not improve in functionality.[26] In contrast, we did not have pathologic fracture postprocedures. We observed improved WOMAC scores in every patient.

Adequate pre-, intra-, and postprocedure evaluations of the patient are necessary. The venography procedure is an important tool that allows us to adequately fill the lesion and detect potential leakage into the vasculature. PMMA bone cement should be confined to the area of bone defect. Because of the high temperature reached during the hardening process, the cement can cause thermal necrosis and produce a dysfunction in nociceptors. It can also achieve analgesia and stabilize the bone through the consolidation of the microfractures in the affected lower limbs.

Drawbacks to this study include a retrospective and nonuniform case series format, which is inherently flawed and subject to reporting bias. Future study will clarify the exact indications and outcomes of this technique. In spite of these problems, we suggest this procedure may be best for those patients presenting with Karnofsky performance scores over 60%, with pain on the affected pelvic extremity, and whose physical activities present risk of fractures of the femoral bone, a situation that rapidly deteriorates their quality of life.

REFERENCES

1. Jemal A, Siegel R, Ward E, et al. Cancer statistics, 2007. *Cancer CA Cancer J Clin* 2007;57:43–66.
2. Schaefer O, Lohrmann C, Herling M, Uhrmeister P, Langer M. Combined radiofrequency thermal ablation and percutaneous cementoplasty treatment of a pathologic fracture. *J Vasc Interv Radiol* 2002;13:1047–1050.
3. Perrin RG, Laxton AW. Metastatic spine disease: epidemiology, pathophysiology, and evaluation of patients. *Neurosurg Clin N Am* 2004;15:365–373.
4. Coleman RE. Clinical features of metastatic bone disease and risk of skeletal morbidity. *Clin Cancer Res* 2006;12:6243s–6249s.
5. Fallon M, McConnell S. The principles of cancer pain management. *Clin Med* 2006;6:136–139.
6. Tschishart C, Finkelstein J, Whyne C. Optimization of tumor volume reduction and cement augmentation in percutaneous vertebroplasty for prophylactic treatment of spinal metastases. *J Spinal Disord Tech* 2006;19:584–590.
7. Fourney DR, Schomer DF, Nader R, et al. Percutaneous vertebroplasty and kyphoplasty for painful vertebral body fractures in cancer patients. *J Neurosurg* 2003;98:21–30.
8. Galibert P, Deramond H, Rosat P, Le Gars D. Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty. *Neurochirurgie* 1987;33:166–168.
9. O'Brien J, Sims J, Evans A. Vertebroplasty in patients with severe vertebral compression fractures: a technical report. *AJNR Am J Neuroradiol* 2000;21:1555–1558.
10. Amar A, Larsen D, Esnaashari N, Albuquerque FC, Lavine SD, Teitelbaum GP. Percutaneous transpedicular PMMA vertebroplasty for the treatment of spinal compression fractures. *Neurosurgery* 2001;49:1105–1115.
11. Weill A, Chiras J, Simon JM, Rose M, Sola-Martinez T, Enkaoua E. Spinal metastases: indications for and results of percutaneous injection of acrylic surgical cement. *Radiology* 1996;199:241–247.
12. Kelekis A, Lovblad K, Mehdizade A, et al. Pelvic osteoplasty in osteolytic metastases: technical approach under fluoroscopic. Guidance and early clinical results. *J Vasc Interv Radiol* 2005;16:81–88.
13. Marcy PY, Palussière J, Descamps B, et al. Percutaneous cementoplasty for pelvic bone metastasis. *Support Care Cancer* 2000;8:500–503.
14. Hokotate H, Baba Y, Churei H, Nakajo M, Ohkubo K, Hamada K. Pain palliation by percutaneous acetabular osteoplasty for metastatic hepatocellular carcinoma. *Cardiovasc Intervent Radiol* 2001;24:343–346.
15. Cotten A, Deprez X, Migaud H, Chabanne B, Duquesnoy B, Chastanet P. Malignant acetabular osteolyses: percutaneous injection of acrylic bone cement. *Radiology* 1995;197:307–310.
16. Kelly C, Wilkins R, Eckardt J, Ward W. Treatment of metastatic disease of the Tibia. *Clin Orthop Relat Res* 2003;415 Suppl:S219–S229.
17. Harris K, Pugash R, David E, et al. Percutaneous cementoplasty of lytic metastasis in left acetabulum. *Curr Oncol* 2007;14:4–8.
18. Mercy P, Palussiere J, Descamps B, et al. Percutaneous cementoplasty for pelvis bone metastasis. *Support Care Cancer* 2000;8:500–503.
19. Swanson KC, Pritchard DJ, Sim FH. Surgical treatment of metastatic disease of the femur. *J Am Acad Orthop Surg* 2000;8:56–65.
20. Deramond H, Wright NT, Belkoff SM. Temperature elevation caused by bone cement polymerization during vertebroplasty. *Bone* 1999;25:S17–S21.
21. Netter FH. *Lower Limb. En: Atlas of Human Anatomy*, 4th ed. Philadelphia: Saunders, Elsevier Inc; 2006.
22. Baroud G, Samara M, Steffen T. Influence of mixing method on the cement temperature-mixing time history and doughing time of three acrylic cements for vertebroplasty. *J Biomed Mater Res B Appl Biomater* 2004;68:112–116.
23. Belkoff SM, Molloy S. Temperature measurement during polymerization of polymethylmethacrylate cement used for vertebroplasty. *Spine (Phila Pa 1976)* 2003;28:1555–1559.
24. Kang HG, Roh YW, Kim HS. The treatment of metastasis to the femoral neck using percutaneous hollow

perforated screws with cement augmentation. *J Bone Joint Surb (Br)* 2009;91:1078–1082.

25. Wang WG, Wu CG, Gu YF, Li MH. Percutaneous osteoplasty for the management of a femoral head metastasis: a case report. *Korean J Radiol* 2009;10:641–644.

26. Yamada K, Matsumoto Y, Kita M, et al. Clinical outcome of percutaneous osteoplasty for pain caused by metastatic bone tumors in the pelvis and femur. *J Anesth* 2007;21:277–281.