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Compressive Osseointegration Into a Custom Acetabular Implant Masquerading as Tumor Recurrence: A Case Report

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Abstract

Background Compressive osseointegration is a durable method of achieving fixation in long-bone reconstruction, and radiographic findings are well described. The radiographic appearance of integration into the pelvis is poorly defined in the available literature.

Case Description We describe a 50-year-old man with a localized chondrosarcoma of the pelvis treated with wide resection and reconstruction using a custom acetabular device that used compressive osseointegration for fixation. A linear area of sclerosis was identified at the patient's 3-month followup surveillance film, which was concerning for tumor recurrence. We used PET-CT to document the absence of worrisome hypermetabolism and to support our suspicion that the abnormalities seen on a surveillance CT scan represented bony integration into the custom acetabular component rather than tumor recurrence.

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Literature Review The use of FDG-PET for staging and surveillance of chondrosarcoma is presently evolving. Several articles suggest it may be useful in differentiating low-grade chondrosarcoma from benign lesions.

Purposes and Clinical Relevance We found PET-CT useful to differentiate the midterm radiographic appearance of the remodeling produced by compressive implant osseointegration from local recurrence.

Introduction

Primary sarcomas of the pelvis represent unique diagnostic and therapeutic challenges [14, 19]. Complex pelvic anatomy makes resection difficult. In addition, the optimal mode of reconstruction has been debated in the orthopaedic oncology community [17]. Compressive osseointegration is a durable method of achieving fixation in long-bone reconstruction [2, 7, 12, 20], but no published reports are available regarding its use for acetabular reconstruction.

A defined clinical guideline for either method or frequency of surveillance imaging after resection of a localized sarcoma currently does not exist. Most orthopaedic oncologists suggest axial imaging at the primary tumor site (either CT scanning or MRI) along with a chest CT scan at defined intervals to determine the presence or absence of pulmonary metastasis. Positron emission tomography (PET), particularly with radiolabeled (18)F-2-deoxy-2-fluoro-d-glucose (FDG), has been described as a useful staging adjunct as a result of its ability to provide an in vivo metabolic tumor profile [9]. Its use for surveillance after tumor resection is less well described [4, 6, 9] but offers the potential to correlate potentially concerning radiographic findings with metabolic behavior. Standardized uptake values (SUVs) of less than 2.0 are generally

Fig. 1A–C (A) AP pelvis radiograph demonstrating a lesion in the anterior column and superior pubic ramus. (B) CT scan of the lesion in the anterior pelvis demonstrates bony expansion and cortical thinning consistent with a chondrosarcoma. (C) MRI of the lesion demonstrates increased T2 signal, associated soft tissue mass, and involvement of the hip.

suggestive of a benign etiology, whereas the range of SUVs greater than 2 is less specific. Fracture healing and bone remodeling are typically characterized by an SUV in the range of 0 to 2 [10, 16, 18].

We describe a patient with localized chondrosarcoma of the pelvis secondary to multiple enchondromatosis treated with a custom acetabular component that used compressive osseointegration. Followup CT scan showed findings consistent with recurrence so we used PET-CT to distinguish recurrence from remodeling from the implant.

Case Report

A 50-year-old man presented to our clinic with groin pain. Workup included a plain radiograph, CT scan, MRI, and PET scan (Fig. 1). The patient had an aggressive-appearing cartilaginous lesion within the anterior pelvis extending into the hip. He also had numerous benign-appearing cartilaginous lesions throughout the affected extremity. PET-CT revealed a maximum SUV of 6.4 within the pelvic lesion and maximum SUV ranging from 1.9 to 3.0 throughout the remainder of the extremity. The SUV is a useful measure for the evaluation of PET-CT images, which applies a metabolic profile to any given lesion. The value is a ratio of tissue reactivity concentration to injected dose divided by concentration of FDG. No distant lesions

Fig. 2 Custom acetabular component manufactured to accept a modular highly crosslinked polyethylene liner.

were identified. Biopsy of the mass revealed low-grade chondrosarcoma, and wide excision was recommended.

The patient underwent extraarticular resection of the mass, including the hip (Fig. 2). Surgical margins were negative for residual tumor. The acetabulum was reconstructed using a custom device that used compressive osseointegration for fixation (Compress; Biomet, Warsaw, IN, USA; this device is FDA-approved for use in the United States). In an effort to avoid the lesions more distal

in the extremity, a short cementless tapered stem was used for fixation on the femoral side. A bipolar femoral head (tripolar-type construct) was used in an effort to minimize postoperative dislocation risk.

The initial plan for surveillance postoperatively included quarterly CT scans of the chest and pelvis to assess for local recurrence or distant disease. After resection and reconstruction, the patient was kept nonweightbearing for 3 months to allow for the cementless acetabular component to achieve fixation. By 6 months postoperative, the patient achieved painless independent ambulation.

At the 9-month postoperative visit, the surveillance pelvic CT revealed an area of linear sclerosis worrisome for tumor recurrence (Fig. 3). A repeat PET-CT was obtained that revealed no evidence of hypermetabolism in this location and no changes in the appearance of the remainder of the lesions in the extremity (Fig. 4). We presumed the lesion represented osseointegration into the acetabular implant, and the decision was made to follow the lesion with serial PET-CT. At 12 months, the sclerosis became more abundant without evidence of hypermetabolic residual or recurrent malignancy.

Fig. 4 FDG-PET taken at 9 months postoperatively demonstrates no evidence of hypermetabolism in the area of sclerosis. Continued surveillance with FDG-PET at 2 years confirms the absence of hypermetabolism in this region supporting our suspicion that this lesion represented osseointegration rather than tumor recurrence.

Fig. 3A–C (A–C) Postoperative CT scans taken at 3 months (A), 9 months (B), and 2 years (C) postoperatively. At the 9-month surveillance scan, an area of linear sclerosis adjacent to the acetabular reconstruction was worrisome for tumor recurrence. At 2 years postoperative, this area remains largely unchanged with no evidence of cortical expansion, endosteal scalloping, or associated soft tissue mass.

Fig. 5A–B (A–B) Radiographs were taken 2 years after reconstruction.

The patient underwent an additional PET-CT, which remained negative for hypermetabolism. The patient is currently 2 years from surgery and remains independently ambulatory. Plain radiographs demonstrate no evidence of implant loosening or failure (Fig. 5).

Discussion

Obtaining adequate imaging for the purposes of identifying local recurrence after placement of an orthopaedic device is difficult. We used PET-CT to distinguish worrisome hypermetabolism from remodeling secondary to the implant and to support our suspicion that this lesion represented bony integration into the custom acetabular component. Definitive establishment of recurrence versus benign remodeling would entail tissue biopsy that has not yet been performed in this case. Because chondrosarcoma occasionally recurs after 5 years and rarely even after 10 years [21], this relatively short 2-year followup is certainly not definitive proof that this lesion is benign. The purpose of this case report is to bring to light a unique radiographic finding.

Endoprosthetic reconstruction is often precluded by severe pelvic bone loss after wide resection. Conventional acetabular implants that primarily rely on screw fixation and press-fit techniques will not typically achieve adequate initial stability to allow for reliable bone ingrowth. A device based on compressive osseointegration (Compress; Biomet) has been used in patients with severe long-bone defects with promising results [2, 7, 12, 20]. Initial concerns regarding the possibility of high contact stresses and pressure necrosis caused by compression of up to 800 pounds at the bone-implant interface over a very small surface area are reportedly unfounded by retrieval studies [3, 12]. Viable bone integration at the point of contact with the implant allows for direct transfer of stress, minimizing the possibility of stress-shielding seen with other cemented

and cementless designs. Despite the absence of literature to support its use for pelvic applications, we chose compressive osseointegration for fixation in this case as a result of the patient's young age and the high long-term failure rate associated with other cementless designs.

The diagnostic and therapeutic use of FDG-PET in evaluating bone and soft tissue sarcomas is currently evolving. Alternative modalities to diagnose recurrent tumor around an orthopaedic implant are available, including plain axial CT scanning and digital subtraction MRI [5, 11]. A literature search using the terms "PET" and "chondrosarcoma" returned 17 articles, of which only 12 pertain to sarcoma of the extremity. Makis and colleagues [13] described the case of a 42-year-old man with a history of Maffucci syndrome who developed rapid growth of a previously identified enchondroma. Similar to our patient, the biopsy-proven chondrosarcoma revealed a maximum SUV of 9.0 compared with other benign lesions measuring maximum SUV of 1.5. Purandare and colleagues [15] retrospectively reviewed the PET results of 12 patients with osteochondromas. Seven patients with biopsy-proven transformation to low-grade chondrosarcoma demonstrated moderate uptake with maximum SUV of 3.3 to 6.9, whereas one patient with dedifferentiated chondrosarcoma demonstrated relatively high metabolic activity with a maximum SUV of 11.4. Four patients with benign lesions had low uptake ranging from 0.8 to 1.3. In their review of 29 cartilaginous lesions, Feldman and colleagues [8] determined 18FDG-PET to be 90.9% sensitive and 100% specific in distinguishing benign from malignant lesions with a cutoff maximum SUV of 2.0. Finally, Akoi and colleagues [1] compared the PET findings of four enchondromas and one osteochondroma with six chondrosarcomas. The authors found a difference between benign (mean maximum SUV 0.96) and malignant (mean maximum SUV 2.23) cartilage lesions.

The biological process of osseointegration may be easily confused with tumor recurrence, particularly in the pelvis,

where plain radiographic evidence of osseointegration can be difficult to obtain. We describe the radiographic and clinical features that may help distinguish osseointegration into a custom acetabular component from local recurrence. Baseline preoperative 18FDG-PET was useful in this case to support the presumption of bony integration into the acetabular device rather than recurrence. Longer-term followup is required to confirm that this finding reflects benign bony remodeling.

References

1. Aoki J, Watanabe H, Shinozaki T, Tokunaga M, Inoue T, Endo K. FDG-PET in differential diagnosis and grading of chondrosarcomas. *J Comput Assist Tomogr.* 1999;23:603–608.
2. Bhangu AA, Kramer MJ, Grimer RJ, O'Donnell RJ. Early distal femoral endoprosthesis survival: cemented stems versus the Compress® implant. *Int Orthop.* 2006;30:465–472.
3. Bini SA, Johnston JO, Martin DL. Compliant prestress fixation in tumor prostheses: interface retrieval data. *Orthopedics.* 2000;23:707–711; discussion 711–712.
4. Bredella MA, Caputo GR, Steinbach LS. Value of FDG positron emission tomography in conjunction with MR imaging for evaluating therapy response in patients with musculoskeletal sarcomas. *AJR Am J Roentgenol.* 2002;179:1145–1150.
5. Carl M, Kock K, Du J. MR imaging near metal with undersampled 3D radial UTE-MAVRIC sequences. *Magn Reson Med.* 2012 Feb 28 [Epub ahead of print].
6. De Wit M, Raabe A, Seegers B, Buchert R, Beck-Bornholdt HP, Alberti W, Hossfeld DK. Time benefit in the assessment of recurrences following fractionated radiotherapy in an experimental tumour system using positron-emission tomography with 18F-fluorodeoxyglucose. *Int J Radiat Biol.* 2004;80:529–539.
7. Farfalli GL, Boland PJ, Morris CD, Athanasian EA, Healey JH. Early equivalence of uncemented press-fit and Compress femoral fixation. *Clin Orthop Relat Res.* 2009;467:2792–2799.
8. Feldman F, Van Heertum R, Saxena C, Parisien M. 18FDG-PET applications for cartilage neoplasms. *Skeletal Radiol.* 2005;34:367–374.
9. Franzius C, Daldrup-Link HE, Sciuk J, Rummeny EJ, Bielack S, Jürgens H, Schober O. FDG-PET for detection of pulmonary metastases from malignant primary bone tumors: comparison with spiral CT. *Ann Oncol.* 2001;12:479–486.
10. Halaç M, Mut SS, Sönmezoglu K, Yılmaz MH, Ozer H, Uslu I. Avoidance of misinterpretation of an FDG positive sacral insufficiency fracture using PET/CT scans in a patient with endometrial cancer: a case report. *Clin Nucl Med.* 2007;32:779–781.
11. Hayter CL, Koff MF, Shah P, Koch KM, Miller TT, Potter HG. MRI after arthroplasty: comparison of MAVRIC and conventional fast spin-echo techniques. *AJR Am J Roentgenol.* 2011;197:W405–411.
12. Kramer MJ, Tanner BJ, Horvai AE, O'Donnell RJ. Compressive osseointegration promotes viable bone at the endoprosthesis interface: retrieval study of Compress implants. *Int Orthop.* 2008;32:567–571.
13. Makis W, Hickeys M, Lisbona R. Interesting image. Maffucci syndrome with extraosseous chondrosarcoma imaged with F-18 FDG PET-CT. *Clin Nucl Med.* 2010;35:29–31.
14. Morris CD. Pelvic bone sarcomas: controversies and treatment options. *J Natl Compr Canc Netw.* 2010;8:731–737.
15. Purandare NC, Rangarajan V, Agarwal M, Sharma AR, Shah S, Arora A, Parasar DS. Integrated PET/CT in evaluating sarcomatous transformation in osteochondromas. *Clin Nucl Med.* 2009;34:350–354.
16. Salavati A, Shah V, Wang ZJ, Yeh BM, Costouros NG, Coakley FV. F-18 FDG PET/CT findings in postradiation pelvic insufficiency fracture. *Clin Imaging.* 2011;35:139–142.
17. Schwartz AJ, Kiatisevi P, Eilber FC, Eilber FR, Eckardt JJ. The Friedman-Eilber resection arthroplasty of the pelvis. *Clin Orthop Relat Res.* 2009;467:2825–2830.
18. Shin D, Shon O, Byun S, Choi JH, Chun KA, Cho IH. Differentiation between malignant and benign pathologic fractures with F-18-fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography. *Skeletal Radiol.* 2008;37:415–421.
19. Shin KH, Rougraff BT, Simon MA. Oncologic outcomes of primary bone sarcomas of the pelvis. *Clin Orthop Relat Res.* 1994;304:207–217.
20. Tyler WK, Healey JH, Morris CD, Boland PJ, O'Donnell RJ. Compress periprosthetic fractures: interface stability and ease of revision. *Clin Orthop Relat Res.* 2009;467:2800–2806.
21. Unni KK, Inwards CY. *Dahlin's Bone Tumors: General Aspects and Data on 10,165 Cases.* 6th ed. Baltimore, MD, USA: Lippincott Williams & Wilkins; 2009:89.