Journal of Radiology Nursing xxx (2018) 1–8

Contents lists available at ScienceDirect

Journal of Radiology Nursing

journal homepage: www.radiologynursing.org

Interventional Radiology Techniques for the Management of Painful Bone Metastases

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Keywords:
Bone metastases
Pain palliation
Ablation
Embolization
Cement augmentation
Fixation

A B S T R A C T

Metastatic cancer to the osseous structures can result in significant pain that can often be difficult to control with narcotic medication. Multiple interventional radiology treatments can be applied for palliative relief and improvement in patient quality of life. The most commonly used interventional radiology techniques include embolization, thermal ablation, vertebral augmentation, cementoplasty, and percutaneous internal fixation. These procedures are associated with unique considerations for the radiology nurse. We review the most common palliative techniques performed by the radiology team for patients with musculoskeletal metastases and focus on the salient nursing implications for preprocedural, intraprocedural, and postprocedural care.

Background

Bone metastases are common in patients with advanced cancer, and the treatment of bone metastases is a known clinical challenge. As advances in oncological treatments continue to extend overall survival in patients with cancer, the incidence of metastatic musculoskeletal disease and skeletal-related events will become more frequent (Li et al., 2012; Oster et al., 2013). Cancers that often metastasize to bone include breast and prostate, followed by lung, colon, stomach, bladder, thyroid, and kidney (Roodman, 2004). The presence of bone metastases can be associated with significant morbidity, including pain, pathological fracture, hypercalcemia, or neurological deficits. The etiology of bone pain may be explained through a combination of the tumor pressure on the periosteum and adjacent nerves, tumor-induced osteolysis resulting in microfractures or complete fracture, and the effects of tumor growth factors and cytokines (Mundy, 1997).

Interventional radiology options for the treatment of painful musculoskeletal metastases may vary based on treatment goals and location of disease but should always involve a multidisciplinary team approach that includes oncologists, radiation oncologists, and orthopedic surgeons. Nonradiological management options include surgical resection or amputation, local external beam radiotherapy, and bone-modifying agents (i.e., bisphosphonates). For patients, the goals of pain control and the maintenance of activities of daily living are paramount. For the clinical treatment team, meeting the patient's goals can translate to improvements in the patient's quality of life, decreased opioid dependence, decreased likelihood of immobility-associated morbidity, and lower overall health care costs (Lage, Barber, Harrison, & Jun, 2008; Oefelein et al., 2002; Saad et al., 2007; Sathiakumar et al., 2012; Weinfurt et al., 2002). The most common interventions performed by interventional radiologists for the palliation of metastatic bone tumors include embolization, thermal ablation, vertebral augmentation, cementoplasty, and percutaneous internal fixation. These minimally invasive treatments may be applied alone or in combination to achieve the desired palliative effect depending on treatment goals, tumor size and location, and surrounding anatomical structures.

Interventions

Embolization

Embolization describes the occlusion of the tumor arterial blood supply through the use of transcatheter endovascular techniques (Owen, 2010). This fluoroscopically guided technique works best for hypervascular bone tumors, of which the most common are renal and thyroid metastases. The goal of embolization is to devascularize and debulk the tumor, thereby providing pain relief by reduction of the compressive effects on the periosteum and adjacent nerves

Conflict of interest: None to report.

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https://doi.org/10.1016/j.jradnu.2017.12.006
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(Chuang et al., 1979; Koike et al., 2011). Typically, a 5-Fr catheter is introduced into the arterial system through a common femoral or radial artery access. Angiography is used to define the vascular distribution of the tumor and determine the branches to be targeted for embolization (Figure 1A and B). A microcatheter may be inserted coaxially to allow subselective catheterization of individual tumor-feeding vessels. Embolization from a subselective location allows for maximal delivery of the embolic agent to the tumor while minimizing the risk for nontarget embolization (Figure 1C). Embolization should be carried out until stasis of the vessel has been achieved (Figure 1D). The injected embolic material can vary from noncalibrated microparticles, calibrated microspheres, gelatin sponge, coils, or liquid agents such as glue or Onyx™ (ev3, Irvine, CA). The ultimate choice of embolic agent depends on operator experience, tumor vascularity, vessel accessibility, and collateralization with surrounding healthy tissue. For pain palliation purposes, microsphere or microparticulate embolization is typically performed; however, chemoembolization has been described for the treatment of sarcoma (Chu et al., 2017; Jiang et al., 2016).

Embolization procedures are typically performed under monitored moderate sedation using a combination of fentanyl and midazolam. Adequate hydration is recommended before angiography as the use of significant amounts of contrast media may be required. The placement of a urinary catheter is often very helpful for monitoring urine output during and after the procedure. For pelvic embolization procedures, a urinary catheter can also improve target visualization by voiding the bladder of radiopaque urine. Prophylactic antibiotics to cover skin flora may be administered, although there is no consensus in the literature on requirement for antibiotic prophylaxis (Abdelsalam, Kobayashi, Avritscher, Gupta, & Tam, 2014; Sutcliffe et al., 2015; Venkatesan et al., 2010). In addition to peripheral pulse and access site assessments, sensory-motor neurological examinations are critical. Specific questions related to symptoms of numbness or weakness may help with the early detection of procedural complications.

Patients are expected to have postprocedure pain, which is typically greatest in the first few hours after injection of embolic material. Nontarget embolization, defined as reflux or undesired collateral administration of embolic material into nontumoral arteries, may result in pain, transient or permanent paresthesias, loss of sensation, or muscle and skin necrosis. Initial management includes conservative measures, such as warm compresses, oral anticoagulation medications, and physical therapy. If nontarget embolization results in vascular compromise of a distal extremity, a surgical consultation is warranted. Postembolization syndrome is an expected occurrence after tumor embolization irrespective of tumor location (Barton et al., 1996; Keller, Rosch, & Bird, 1983). Signs and symptoms include local pain at the tumor site, low-grade

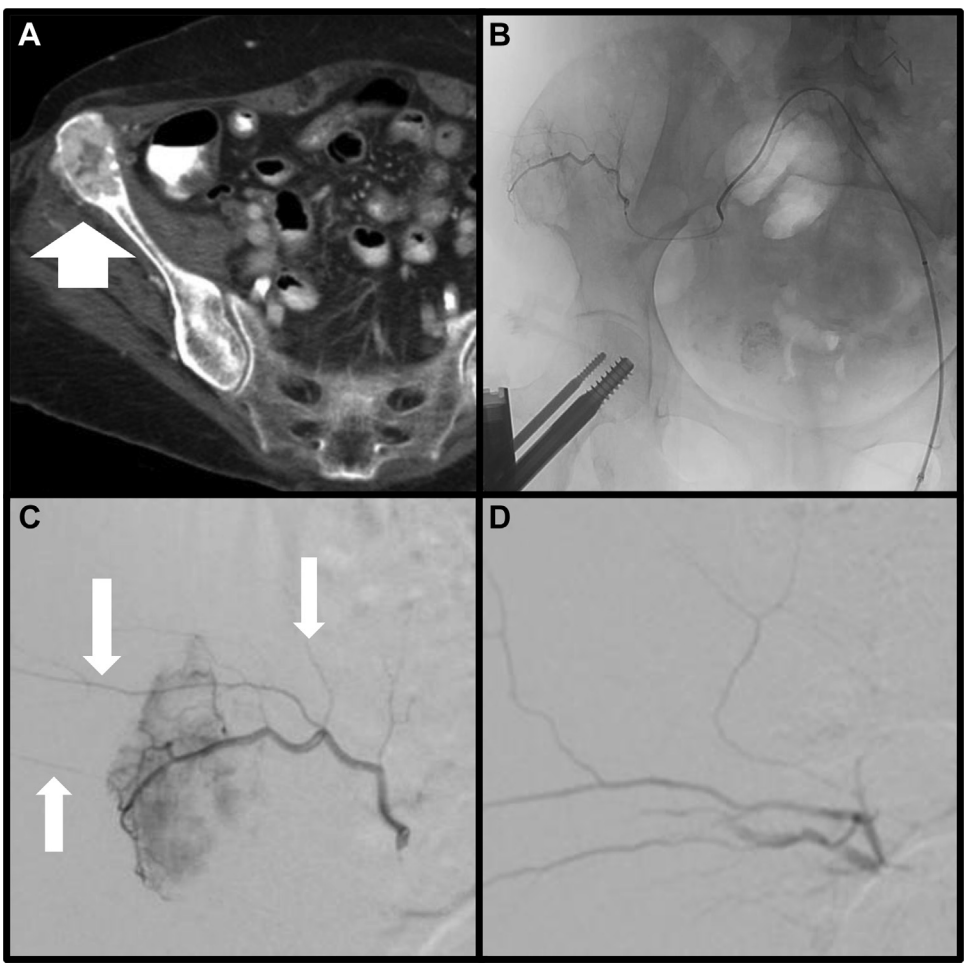

Figure 1. (A) Embolization for a 64-year-old woman with hypervascular metastatic renal cell carcinoma to the right iliac anterior spine (*large arrow*). (B and C) Selective microcatheter angiography delineates vascular supply before selective embolization using 500 nm particles. (C) Note muscular branches (*small white arrows*), which if embolized by nontarget particles, could result in procedure-related musculoskeletal pain. (D) Final angiogram image demonstrates complete tumor embolization with preservation of muscular branches.