Radiation-associated plasmacytoma following catheter ablation for atrial fibrillation

Justin Chow, MD,* Theresa Trotter, MD, MSc,† Peter Duggan, MD,*‡
Stephen B. Wilton, MD, MSc§

From the *Department of Medicine, University of Calgary, Calgary, Canada, †Department of Oncology, Division of Radiation Oncology, Tom Baker Cancer Centre, Calgary, Canada, ‡Department of Medicine, Division of Hematology, University of Calgary, Calgary, Canada, and §Department of Cardiac Sciences and Libin Cardiovascular Institute of Alberta, University of Calgary, Calgary, Canada.*

Introduction

Atrial fibrillation (AF) affects over 2 million people in the United States, and this number is expected to rise to over 5 million by the year 2050.[1] For those with symptomatic paroxysmal or persistent AF despite attempts at medical therapy, catheter ablation is a guideline-recommended treatment approach.[2] AF has become the most common indication for invasive electrophysiology testing and treatment, with procedure volumes in the United States more than tripling between 2000 and 2010.[3] Whereas acute and subacute complications of AF ablation are well documented,[3] less is known about later-onset adverse events. Of particular concern is the malignancy risk associated with medical radiation. Although advances in fluoroscopic equipment, catheterization laboratory procedures, and routine use of nonfluoroscopic mapping systems have decreased effective dose received by patients and operators during AF catheter ablation, stochastic events leading to malignancy remain a concern.

Case report

A 57-year-old man with history of paroxysmal AF and gastroesophageal reflux disease was referred for catheter ablation owing to frequent, symptomatic episodes of AF despite attempts at medical rate and rhythm control. He underwent radiofrequency (RF) pulmonary vein isolation using a wide antral encircling lesion approach,[4] guided by fluoroscopy and a nonfluoroscopic mapping system (NavX Velocity, St. Jude Medical Inc). Owing to recurrence of symptomatic, documented AF postablation, he underwent a total of 3 pulmonary vein isolation procedures over the course of 11 months. In total, he spent 65 minutes under direct fluoroscopy and received a dose area product of 204,800 mGy•cm^2 of cumulative radiation exposure, which converts to an approximate 43 mSV dose to the chest using the method of Le Heron.[5] Unfortunately, paroxysms of atrial fibrillation persisted despite these interventions.

Approximately 1.5 years after the patient's third RF ablation, he sustained a nontraumatic fracture of the posterior aspect of his right seventh rib. Imaging with a nuclear medicine bone scan and positron emission tomography / computed tomography (PET/CT) showed a lytic destructive bone lesion with associated soft tissue mass (Figure 1). This lesion measured 6.9 × 2.7 cm and was intensely hypermetabolic. CT-guided biopsy revealed a solitary bone plasmacytoma that expressed CD138 and exhibited kappa light chain restriction on pathology. At the time, serum protein electrophoresis revealed 3.9 g/L IgG kappa monoclonal protein. Magnetic resonance imaging of the spine and bone marrow biopsy were normal, and there were no other lesions seen on skeletal survey or whole-body PET/CT.

The patient's plasmacytoma was located directly in the field of the left anterior oblique fluoroscopic projection used throughout AF catheter ablation procedures (Figure 1). The entire lesion with a margin was treated to a dose of 50 Gy delivered in 25 fractions over 5 weeks, and posttreatment PET/CT showed both anatomic and functional resolution of the mass. However, 6 months after the patient completed radiotherapy, a surveillance PET/CT revealed several new osteolytic bone lesions. Furthermore, monoclonal IgG kappa had now risen to 15.0 g/L. A diagnosis of multiple myeloma was confirmed by bone marrow aspirate, and the patient is currently undergoing a course of chemotherapy to be followed by autologous stem cell transplantation. The patient has provided written consent for anonymous publication of his case record.

Discussion

We present the case of a patient who developed a solitary bone plasmacytoma within the field of exposure to fluoroscopic

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Address reprint requests and correspondence: Dr Stephen B. Wilton, Department of Cardiac Sciences and Libin Cardiovascular Institute of Alberta, University of Calgary, GE64 3280 Hospital Drive NW, Calgary, AB, T2N 4Z6, Canada. E-mail address: sbwilton@ucalgary.ca.

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KEY TEACHING POINTS

- We present the case of a 57-year-old man who developed a solitary bone plasmacytoma after 3 failed attempts at atrial fibrillation catheter ablation. The plasmacytoma was within the fluoroscopy field, suggesting that its development could have been influenced by medical radiation, though this has not been established.
- This is the first reported case of a solitary plasmacytoma arising after atrial fibrillation catheter ablation. Although there is a known, biologically plausible association between medical radiation and solid tumors, no such link has been established with plasma cell dyscrasias.
- Exposure to medical radiation from cardiovascular imaging and interventions is increasing. Though radiation-associated malignancy is uncommon, surveillance for such cases is warranted.

radiation for AF catheter ablation, and who later went on to develop multiple myeloma. To our knowledge, this is the first such reported case. Plasmacytomas are rare plasma cell tumors that can arise in both bone and soft tissues (extramedullary plasmacytoma).[6] Solitary bone plasmacytomas most commonly affect men in their 50s–60s and often present with a pathologic fracture.[6] Previous case series have shown that approximately 50%–60% of solitary bone plasmacytomas progress to overt multiple myeloma despite radiation treatment. The rate of progression to overt myeloma is far less—approximately 10%–15%—for extramedullary plasmacytomas.[7]

The cumulative radiation exposure in patients with cardiovascular disease is increasing.[8] Based on initial evidence stemming from studies conducted in people exposed to whole-body radiation through nuclear accidents or by occupation, and now supported by long-term studies of those exposed to various imaging modalities, it is now accepted that medical radiation increases the risk of solid tumors such as lung, breast, or colorectal cancer in a linear fashion.[9,10] In addition to the baseline absolute lifetime risk of developing solid cancers in a normal population (45% in male and 37% in female subjects) gleaned from BEIR VII data,[10] the additional absolute lifetime risk of developing cancer with 60 minutes under fluoroscopy ranges from 0.03% to 0.21%,[11] with common "at-risk organs" comprising the lungs, stomach, bone marrow, and breast tissue.[11] In a sample size of 1 million people undergoing 60 minutes of fluoroscopy, this equates to another 300–2100 malignancies in addition to the approximately 400,000 that occur naturally. Pertaining to RF ablations in the electrophysiology laboratory, the lifetime risk of fatal malignancy associated with 60 minutes of fluoroscopic radiation exposure has been estimated to be approximately 500 per 1 million patients, although this estimate is highly equipment and operator dependent.[12]

Evidence linking medical radiation with hematologic malignancies such as solitary bone plasmacytoma or multiple myeloma, however, is far less robust. Hematopoietic malignancies as a group have been associated with CT and

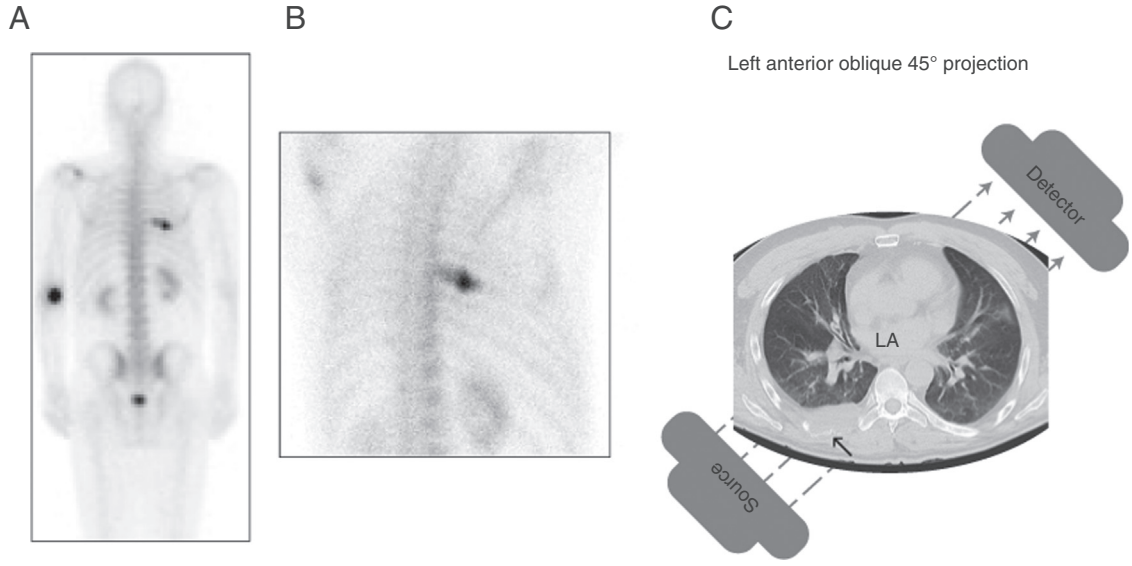

Figure 1 Imaging of solitary bone plasmacytoma at the time of initial diagnosis. Bone scan (**A:** posterior whole-body view; **B:** right posterior chest view) showing increased radiotracer uptake in posterior right seventh rib. **C:** Representative computed tomography image showing a destructive lesion (*arrow*) measuring 6.9 × 2.7 cm in this location, as well as the relative position of the left atrium (LA) and the fluoroscopic x-ray source and image intensifier (Detector) in the left anterior oblique 45° projection.

other forms of medical radiation, and in 1 case-control study of women receiving radiation treatment for cervical cancer, an increased risk of developing leukemia was seen with low doses of radiation up to 4.0 Gy.[13] Other than 2 small case-control studies that showed statistically negligible increases in the incidence of multiple myeloma/plasmacytoma after medical radiation,[14,15] there are no epidemiologic data available to associate medical radiation with the development of plasma cell dyscrasias, and certainly insufficient data to guide clinical decisions.

In this case, a solitary bone plasmacytoma developed directly within the field of repeated fluoroscopy, leading to suspicion that it may have been induced by radiation. However, we cannot exclude that the development and location of the plasmacytoma were coincidental, and the patient's relatively rapid progression to multiple myeloma suggests that this disease may have been present in a latent state even prior to AF catheter ablation. Whether medical radiation may accelerate local progression of subclinical plasma cell dyscrasias has not been studied.

Conclusion

To our knowledge, this is the first reported case of a plasmacytoma arising following cardiac catheter ablation. Though it is well established that medical radiation exposure increases the risk of developing malignancy, it remains unclear whether radiation was a factor in altering our patient's natural history of disease development and progression. Because exposure to medical radiation for cardiovascular diagnostics and interventions is likely to continue to increase for the foreseeable future, we require surveillance mechanisms to detect and evaluate the causality of uncommon, late adverse events, as seen in this case. This represents a significant challenge, as to do so feasibly and effectively will require linkage of cardiovascular and cancer registries with administrative data sources, and multicenter if not international cooperation. In the interim, this case underscores the importance of continued efforts to reduce exposure to medical radiation during catheter ablation procedures, and to consider including radiation-associated risks in informed consent discussions.

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