Musculoskeletal Imaging Findings of Hematologic Malignancies

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Jeffrey Klein, MD • Hi. I’m Jeff Klein, editor of RadioGraphics and today I’m pleased to have with us Dr. Aaron Schein of the Keck School of Medicine at the University of Southern California, and Dr. Shannon Navarro also of the University of Southern California Los Angeles County, who are the authors of one of our featured papers in the current May 2017 issue of RadioGraphics. Their paper is entitled “Musculoskeletal Manifestations of Hematologic Malignancies.” Dr. Schein and Navarro welcome to our RadioGraphics podcast.

Aaron J. Schein, MD • Thank you.

Shannon M. Navarro, MD, MPH • Thank you.

J.K. Shannon we’ll start with you. Your paper reviews the spectrum of hematologic malignancies including leukemia, lymphoma and multiple myeloma as depicted on cross-sectional imaging and obviously nuclear medicine. Table 1 in the paper provides a real nice review of these entities and the patient characteristics, risk factors, and treatment options that place into perspective the conditions that you review in detail in your paper. Can you review this table with us?

S.M.N. Yes. So hematologic malignancies are highly diverse entities and having some clinical contacts can help the radiologist. To start off with multiple myeloma, it’s a rare entity in young patients, but it’s the third most common hematologic malignancy. Risk factors include the male sex, increasing age, African-American ethnicity, radiation exposure and monoclonal gammopathy of undetermined significance. Treatment options for multiple myeloma include chemotherapy, stem cell treatment, radiation, steroids, and biologic treatments. Lymphoma can be separated into Hodgkin type and non-Hodgkin lymphoma of which the latter is much more common. In adults there is an approximate four to five percent incidence rate of non-Hodgkin lymphoma. Risk factors for lymphoma include increased age, immunosuppressive medication, certain onco-viruses, family history, obesity, and infections such as H. pylori or HIV. Treatment options include chemotherapy, targeted biologic therapy, stem cell transplant, and radiation therapy. Leukemia represents 30% of all childhood cancers. There’s a three to four percent incidence rate of leukemia in adult patients. Risk factors for leukemia include Down syndrome, exposure to radiation, obesity, family history, cigarette smoking, chemical exposure, and exposure to onco-viruses such as human T cell leukemia virus type 1. Treatment options for leukemia are chemotherapy and targeted biological therapies.

J.K. Terrific. Thanks so much. Aaron let’s move to you. In your paper after reviewing the normal bone marrow appearance, you show a case that illustrates the increased sensitivity of MR as compared to conventional radiography in assessing marrow changes. Can we look at Figure 2 and review the findings that are illustrated in this case?

A.J.S. Sure. So just to kind of lay the background, the normal pattern of bone marrow maturation is that in a neonate almost all of the bone marrow in the body is red marrow. And then over the course of time the red marrow starts to convert to fatty marrow, first in the epiphyses of the long bones, then in the diaphysis of the long bone and finally within the metaphysis. So typically you’ll have a little bit of residual red marrow in the proximal metaphysis of the long bones, for example the humeri and the femurs. So in Figure 2 we have a radiograph that is essentially normal. You can see the primary trabeculation pattern including the compressive and tensile trabeculae of the femoral neck, the cortex appear to preserve without endosteal scalloping. There’s no periosteal reaction although in the joints you wouldn’t expect to have periosteal reaction because there’s no periosteum. The MRI in Part B is a proton density fat saturated image that shows some subtle increased signal both within the epiphysis and the metaphysis of the proximal left femur and within the left acetabulum and supra-acetabular iliac bone. It wouldn’t fit into the normal pattern of red marrow reconversion, but it is a subtle finding and it would be expected to cause some sort of confusion at the time of initial interpretation. Subsequently this patient went on to have a PET CT which showed FDG lividity in those locations which would be more concerning.

J.K. Great. Thank so much for that. Shannon let’s go back to you. You begin the review of malignancies by providing a table which is Figure 5 in your paper of the World Health Organization classification of lymphoma and then you delve into the bony involvement in these various conditions. You mentioned that the bone involvement is more often seen in non-Hodgkin lymphoma than in Hodgkin lymphoma; and you review in detail the use of FDG PET in the assessment of marrow involvement. Your paper shows a series of cases with marrow and soft tissue involvement in Hodgkin and B and T cell non-Hodgkin lymphoma. Let’s look at fairly dramatic example which is Figure 12 in the paper which is a case of a young patient with non-Hodgkin lymphoma as demonstrated on CT, MR and PET imaging.
S.M.N. So in this example of a young male with T cell non-Hodgkin’s lymphoma we have a T1 oblique coronal MR image of the sacral iliac bones and the lower lumbar vertebrae which show replacement of the normal T1 hyperintense fat signal with abnormal hypointense signal. The abnormal signal with corresponding hyperintense signal on corresponding STIR images reflects bone marrow infiltration. The maximum intensity projection images from the FDG PET show multi-focal increased uptake of tracer in the osseous structures. So this case is a demonstration of how much more sensitive PET and MRI are in evaluating bone marrow infiltration. On the contrary, the CT findings are much more subtle with patchy areas of sclerosis in the sacrum and iliac bones, but it’s much more obvious on the MRI and the PET.

J.K. Sure, terrific, thank you so much. Aaron in the next section of your paper you review the leukemic involvement of marrow and the emerging use of MR including diffusion weighted imaging and also FDG PET. Can we review Figure 14 which is a case of ALL in a pediatric patient?

A.J.S. Sure. So overall leukemia accounts for approximately 30% of all childhood malignancies with ALL accounting for approximately 25% overall, and leukemia can have various appearances at imaging. For example you may have periosteal reaction, you may have focal lucent lesions, and you may have a sclerotic appearance. It’s also not unusual to have soft tissue components. So in Figure 14 we have a coronal post-contrast T1-weighted fat saturated image of the essentially the knees and proximal tibias showing a pattern of abnormal enhancement within the proximal right tibial metaphysis and diaphysis and epiphysis with a small amount of periosteal enhancement and soft tissue components extending anteriorly. Contralaterally you can also see a focus of abnormal enhancement within the left tibial diaphysis. The CT image demonstrates patchy sclerosis within the proximal right tibia and also shows that anterior soft tissue component. The image from the PET scan shows increased tracer activity within the pre-tibial soft tissue mass.

J.K. Great, thank you so much. Shannon let’s go back to you. Your paper concludes with a section on multiple myeloma which is a subject that we’ve highlighted in the journal in several recent papers actually. Let’s look at Figure 17 if we may which shows a typical case of both cranial and axial skeletal involvement by multiple myeloma.

S.M.N. So Figure 17 shows some of the classic imaging findings of multiple myeloma. So on the lateral skeletal skull radiograph there are multiple punched out lesions in the calvaria which is characteristic for plain radiograph depiction of multiple myeloma. The corresponding T1 weighted MRI shows bone marrow replacement of the lower lumbar vertebrae with bone marrow signal that is hypointense as compared to the intravertebral disks.

J.K. Great. Thank you so much. So I think that concludes our podcast. I’d like to thank Dr. Aaron Schein and Shannon Navarro from the University of Southern California and thank them for taking the time today to discuss their paper on the Musculoskeletal Manifestations of Hematologic Malignancies which again appears in the current May 2017 issue of *RadioGraphics*. Doctors thank you so much.

A.J.S. It’s been a pleasure.

S.M.N. Thank you for having us.

J.K. Great.