20

Imaging of Multiple Myeloma

What is Multiple Myeloma?

Multiple Myeloma (MM) is a hematological disease that is formed by malignant plasma cells. Healthy plasma cells are mainly found in bone marrow and aid the body in fighting off infections by producing antibodies, also called immunoglobins. When the cancerous plasma cells begin to overproduce, they build up and take space in the bone marrow which leads to displacement of healthy blood cells, the production of nonfunctional immunoglobins, and abnormal proteins (see Figure 1). This overgrowth of cancerous cells commonly produces tumors called plasmacytomas in the bone, which is then considered MM.[1] Imaging is a critical element in the initial workup, staging, and treatment of MM, as it is utilized to determine the presence and extent of bone lesions in patients.

Role of Conventional X-Ray

The typical appearance of MM on conventional radiographs is described as multiple circular punched out osteolytic lesions scattered through the skeleton. These lesions are most commonly seen in the skull, pelvis, and long bones. With diagnosis, a complete skeletal survey is the initial recommended imaging study. This includes frontal images of the pelvis, humerus, and femur, along with frontal and lateral images of the skull, full spine, and chest. Although this is a cost effective and widely available option for detection of lytic lesions, the sensitivity of conventional x-ray is considerably lower than that of other imaging modalities and about 10-20% of lesions are not seen.[2]

Role of Computed Tomography

Computed Tomography (CT) is becoming a more widely used modality in imaging MM due to its increased sensitivity compared to x-ray, speed, comfort for the patient and its ability to reconstruct images into three dimensions.[2] Not only is CT great for detecting lesions that are located in areas of the body that are harder to visualize on x-ray such as the shoulders or ribs, the 3D reconstructions are helpful in treatment planning, with CT-guided biopsies, surgery, and radiation therapy planning (See Figure 2).[3]

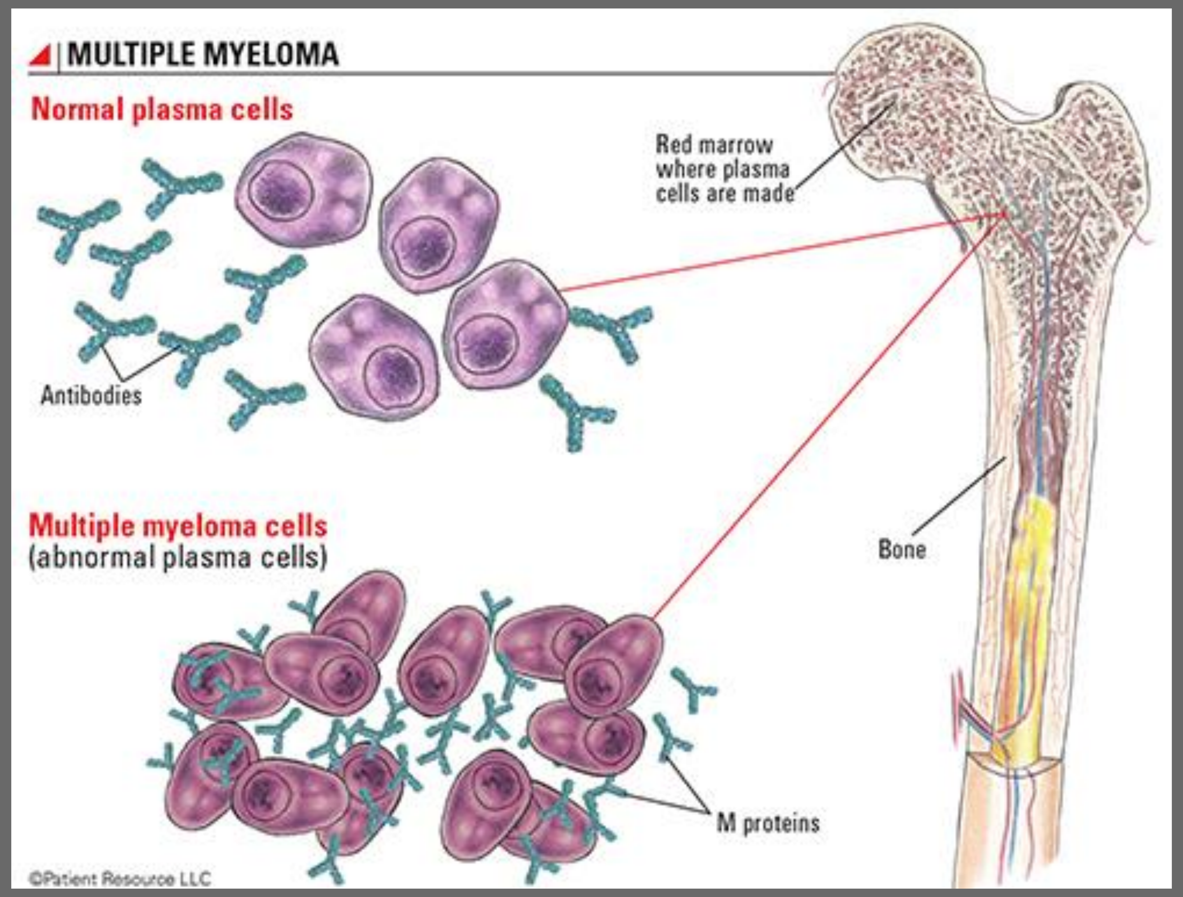

Figure 1. Origination of both normal and abnormal plasma cells, immunoglobins, and proteins.[4]

Figure 2. "Panel **a** shows a large lytic destructive lesion of the right acetabulum extending into the right iliac bone extraosseous extension. Panel **b** shows CT with volumetric rendering of the same lesion. Panel **c** shows SUV 41.1 over the right iliac lytic lesion."[3]

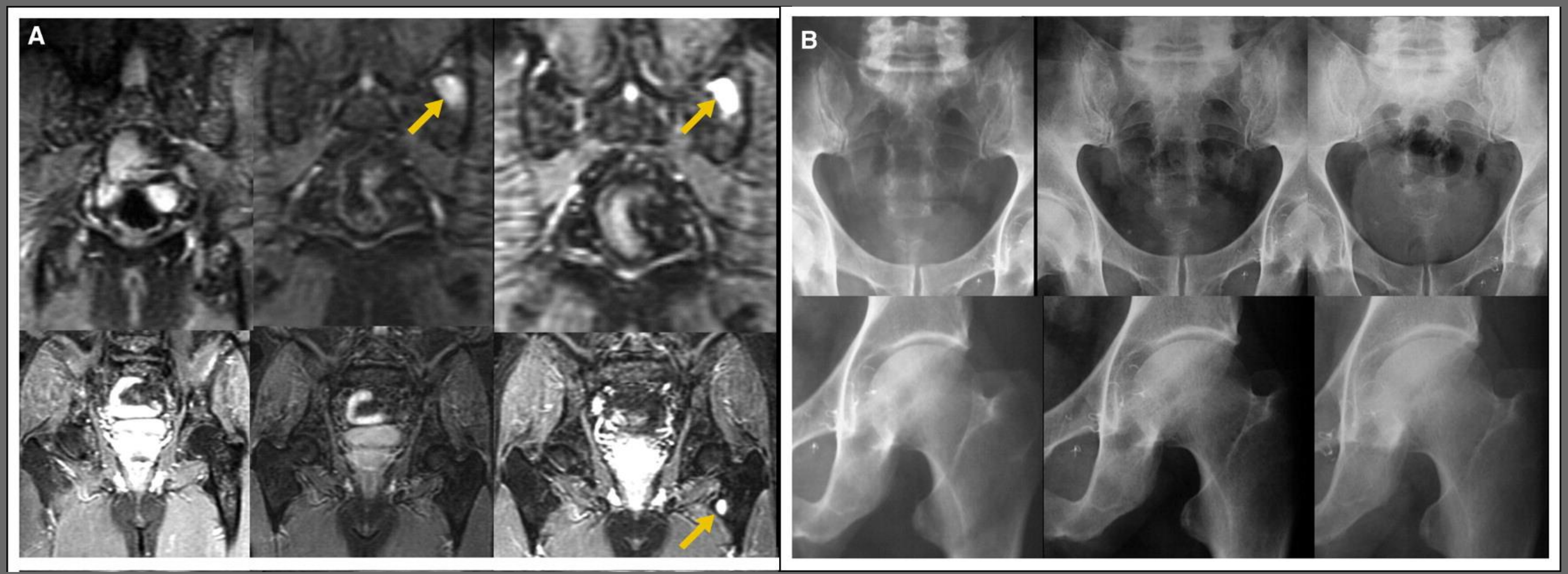

Figure 3. "Baseline short T1 inversion recovery magnetic resonance image (MRI) coronal views of pelvis show no focal lesions (FL). Over time, the patient develops a left sacral lesion and a lesion of the left lesser trochanter (A, arrows). X-rays of (B, top panel) the pelvis and (B, bottom panel) the proximal left femur at comparable time frames fail to demonstrate the FL seen on MRI."[5]

Role of MRI

Magnetic Resonance Imaging (MRI) has become one of the most important tools used in evaluating MM due to its high sensitivity and lack of radiation to the patient. MRI allows better visualization of the axial skeleton, bone marrow infiltration, neurological involvement and soft tissue involvement (See Figure 3).[2] On T1-weighted images myeloma bone lesions appear hypointense because of the low-fat content, and on T2-weighted, fat-suppressed images, the lesions appear hyperintense because of the high amount of water and cellularity. MRI is very useful in staging and determining prognosis. The pattern of bone marrow infiltration seen and the number of lesions present on MRI shows a relationship with overall survival. If more than one clear focal lesions is detected on MRI, the initiation of therapy is warranted. It was found that when more than seven focal lesions of 5 mm or more were present, the survival decreased significantly.[3]

Role of PET-CT

The full potential of using Positron Emission Tomography/Computed Tomography (PET-CT) with MM is still being researched. So far findings have shown great results. This modality is effective in sensing the active disease process by evaluating the metabolic activity of bone lesions, extraosseous manifestations, and marrow metabolic activity (see Figure 2). One study found that patients who were initially diagnosed with solitary plasmacytoma, in 40% of cases PET-CT detected new myeloma lesions, which led to upstaging and the start of treatment for some of those patients. PET-CT is also useful for detecting extramedullary tumors and predicting sites of impending pathological fractures due to the amount of radioactive isotope uptake, especially in conjunction with MRI. PET-CT has also been found to be the best at monitoring response to treatment.[3]

References

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