67Ga Scintigraphy in the Evaluation of Postsurgical Low Back Pain

Prashant Jolepalem1, Raymond Yeow2, and Paresh Mahajan1

1Department of Diagnostic Radiology and Molecular Imaging, Oakland University William Beaumont School of Medicine and William Beaumont Health System, Royal Oak, Michigan; and 2Oakland University William Beaumont School of Medicine, Rochester, Michigan

A 62-y-old man presented with chronic, diffuse lower back pain 8 mo after undergoing extensive lumbar spine surgery for osteomyelitis that included an L4 and L5 diskectomy with partial corpectomy, followed by anterior spinal fusion of L4 and L5 with a fibular allograft, and L3 to S1 posterior fusion via spinal instrumentation. Since the surgery, he had multiple

![FIGURE 1. Plain film (A) and axial CT scan of L3 (B) showing inferior endplate erosion and evidence of periostitis (arrows).](image1)

![FIGURE 2. 99mTc-MDP bone scan (A) in anterior and posterior projections showing mild activity at L3. More intense uptake is incidentally seen at compression deformity surrounding T11. 67Ga-citrate scan (B) at 24 and 48 h in posterior projection shows progressively increasing uptake in mid lumbar spine.](image2)

![FIGURE 3. (A) SPECT/CT of 99mTc-MDP bone scan showing that activity is localized to fixation screws and does not involve disk space or bone fragments. (B) SPECT/CT of 67Ga scan showing that spatially discordant uptake involves disk space and inferior endplate of L3 and extends anteriorly to allograft.](image3)
admissions due to intractable lower back pain and sepsis. However, multiple bacterial cultures of biopsy samples from the operative site never demonstrated any growth. On the current admission, radiographs (Fig. 1A) and a CT scan of the lumbar spine (Fig. 1B) demonstrated erosion of the inferior endplate of L3 and a potential bone fragment anteriorly—findings highly suggestive of osteomyelitis. Bacterial blood cultures were negative. The patient underwent 67Ga scintigraphy, which was compared with a 99mTc-methylene diphosphate (MDP) bone scan performed 2 d prior to the scintigraphy. The patient was injected with 188.7 MBq (5.1 mCi) of 67Ga-citrate intravenously. A large-field-of-view multipeak camera with a medium-energy parallel-hole collimator was used to obtain scintigrams at 24 and 48 h. Static images of the neck and chest, abdomen and pelvis, and lower extremities were obtained in both the anterior and the posterior projections. SPECT/CT was performed at 48 h for anatomic localization of the abnormal radiotracer uptake and was compared with the previously performed 99mTc-MDP bone scan.

The bone scan demonstrated an area of increased uptake in the body of L3 (Fig. 2A), which was localized to the distal ends of the fixation screws by SPECT/CT (Fig. 3A). Although the location of the activity was suggestive of loosening, the patient had undergone surgery only 8 mo previously; therefore, postsurgical reactive changes could not be excluded. Osteomyelitis involving the hardware remained a possibility, although this location did not correspond to the suggestive findings on correlative imaging. The 67Ga scan was expected to help delineate this differential.

On the 67Ga planar images (Fig. 2B), there was progressively increasing uptake in the mid lumbar spine. On SPECT/CT performed 48 h after radiotracer administration (Fig. 3B), there was spatial discordance of the uptake near L3 when compared with the 99mTc-MDP bone scan. The uptake was clearly localized to the inferior endplate of L3 and involved the disk space, allograft site, and anterior bone fragment. These findings were compatible with osteomyelitis or diskitis in this location. The fixation hardware was not involved in the infectious process. Another biopsy sample was taken, guided by the site of activity from the 67Ga scan, and the sample grew Candida.

**QUESTION 1**

What property of 67Ga makes it a valuable agent in imaging inflammatory processes?

A. Localizes to white blood cells in bone marrow.
B. Binds to transferrin.
C. Localizes to infection sites by binding to leukotaxis.
D. Binds to interleukin-8.

**QUESTION 2**

What is the target organ with 67Ga administration?

A. Large bowel.
B. Small bowel.
C. Liver.
D. Salivary glands.

**QUESTION 3**

Which one of the following is not a common cause of false-negative 67Ga findings?

A. Recent gadolinium administration.
B. Blood transfusions.
C. Inadequate bowel preparation.
D. Antibiotic use.

**QUESTION 4**

In which of the following conditions would 67Ga scintigraphy not be useful?

A. Fever of unknown origin.
B. Inflammatory bowel disease.
C. Sarcoidosis.
D. Lymphoma.

**CASE DISCUSSION**

67Ga is not an ideal imaging agent because of multiple high-energy photopeaks (93, 185, 288, and 394 keV), low abundance, and a high scatter fraction. However, the physiologic properties of 67Ga still make it an extremely useful agent in appropriate clinical scenarios. It can often uncover an underlying cause of fever or infection that clinicians had not previously considered. It is considered superior to radiolabeled leukocytes in cases of pulmonary inflammatory diseases, drug-induced inflammation, leukopenia, diskitis, vertebral osteomyelitis, and chronic-phase infections. 67Ga may also be
the better choice in fever of unknown origin depending on the patient history and suspected sources. Additionally, SPECT/CT can help to mitigate some of the shortfalls of its imaging characteristics.

In our case, the patient had signs, symptoms, and imaging findings suggestive of osteomyelitis in his lumbar spine for several months. However, there was no pathologic evidence, and many courses of antibiotics did not relieve his symptoms. After $^{67}$Ga localized an infectious process in the inferior endplate of L3 involving the allograft site, a more targeted biopsy was performed with a subsequent fungal culture, which demonstrated growth of *Candida*. This was an unexpected finding and an extremely rare case of fungal diskitis in an immunocompetent patient. The patient was started on appropriate long-term antifungal therapy, and his symptoms eventually resolved.

**BIBLIOGRAPHY**


*For the answers, see page □□□.*
Answers to the Questions on Pages 1 and 2

Question 1
Answer: B

$^{67}$Ga is a ferric ion analog that binds to transferrin, which is an acute-phase reactant—a protein whose plasma concentrations increase in response to inflammation. The cells at the site of inflammation will locally express different interleukins and tumor necrosis factor-$\alpha$, which causes these serum proteins to accumulate. As a result, $^{67}$Ga bound to transferrin will flow to the site of inflammation. Since it has a stronger affinity for lactoferrin, it will bind to the lactoferrin being released by neutrophils at the site of inflammation. Additionally, $^{67}$Ga will bind to bacterial siderophores and neutrophil cell membranes (whether living or dead), making it a sensitive agent for chronic infections.

Question 2
Answer: A

Although the liver will appear to have the most uptake on the images, the large bowel will actually receive the highest dose of radioactivity because it is the principal method of excretion and has a slow transit time. The dose to the liver is 0.023 Gy (2.3 rad)/185 MBq (5 mCi). The salivary glands will have normal physiologic uptake initially, which washes out over the next 48 h. The small bowel typically does not accumulate $^{67}$Ga.

Question 3
Answer: D

Recent gadolinium administration has been observed to cause decreased $^{67}$Ga-citrate localization because it increases the level of serum ferric ions, which will saturate the receptor sites. Similarly, recent blood transfusions will cause an increased serum iron level that results in competitive inhibition of the transferrin binding sites. Poor bowel preparation or constipation will cause physiologic radiotracer accumulation, which can obscure pathologic findings. Some have advocated for laxative use before imaging with $^{67}$Ga; however, one risks causing inflammation that would bring about aberrant uptake. Antibiotics have not been known to cause decreased $^{67}$Ga uptake, likely because they do not share any similar pharmacokinetics. In fact, one of the indications for gallium scintigraphy is to monitor antibiotic effectiveness in combating chronic infections.

Question 4
Answer: B

$^{67}$Ga is not as useful for inflammatory bowel disease or for abdominal or pelvic infections because abnormal accumulation is nearly impossible to distinguish from physiologic excretion. $^{99m}$Tc- or $^{111}$In-labeled white blood cells would be the more appropriate choice in inflammatory bowel disease. $^{67}$Ga is excellent in fever of unknown origin because the long half-life allows for a greater imaging duration. It also has the advantage over $^{111}$In of localizing to sources of chronic infections or tumors, which are often incidentally discovered as the cause for fever of unknown origin. $^{67}$Ga has the characteristic $\lambda$-panda sign (configuration of uptake in mediastinum and salivary glands, respectively) that is sensitive and specific for sarcoidosis. $^{67}$Ga was initially used as an imaging agent for active lymphoma before largely being replaced by $^{18}$F-FDG PET.