Case report

High protracted $^{99m}$Tc-HDP uptake in synthetic bone implants — A potentially misleading incidental finding on bone scintigraphy

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A B S T R A C T

We report the case of a 56-year-old male with bilateral total knee prostheses suffering from bilateral knee pain mainly on the right side and referred for bone scintigraphy. The medical history of the patient revealed an opening wedge high tibial osteotomy performed nine years earlier, with insertion of two blocks of ceramic made of hydroxyapatite and tricalcium phosphate in a wedge configuration as synthetic bone substitutes. The porous structure of these implants is analogous to the architecture of cancellous bone and permits fibrovascular and bone ingrowth, promoting the healing process. Planar scintigraphy and SPECT/CT showed an intense uptake within those implants in the early phase as well as in the late phase of the bone scan. It also showed bilateral patellofemoral arthritis. A $^{99m}$Tc-labeled antigranulocyte antibody scintigraphy was negative for infection or inflammation. Bilateral patellar resurfacing led to complete symptom regression, confirming that this scintigraphic pattern with such a high tracer uptake reflects bone substitute osteointegration has not yet been published. This should be considered in patients with such bone replacement materials that are increasingly used, in order to avoid false diagnosis of inflammation or infection.

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1. Introduction

Synthetic bone substitutes are used in orthopedic procedures as osteoconductive matrix promoting the healing process [1]. Bone scintigraphy is a sensitive method for the assessment of bone remodeling, consequence of mechanical, inflammatory or infectious disorders of the bone. We present a case with intense $^{99m}$Tc-hydroxyethylene diphosphonate ($^{99m}$Tc-HDP) uptake in a synthetic hydroxyapatite and tricalcium phosphate bone graft, subsequently studied by antigranulocyte antibody scintigraphy.

2. Case report

A 56-year-old male with bilateral total knee prostheses, experiencing bilateral knee pain prevailing on the right side, was referred for bone scintigraphy.

In the patient’s history, multiple surgical procedures involving the right knee were reported. Nine years before, he was treated for medial compartment arthritis of the right knee secondary to genu varum. An opening wedge high tibial osteotomy was performed with the insertion of two blocks of bone void fillers (HATriC™, Arthrex, Floridá) into the osseus defect, corresponding to ceramic calcium phosphate in a wedge configuration with a porous multi-directional structure analogous to that of cancellous bone, allowing fibrovascular and bone ingrowth. As it is not intended to be a load-bearing device, a rigid fixation technique with metal plate and screws is also necessary (Fig. 1A).

Two years after surgery, the patient was diagnosed with an osteomyelitis of the right tibia, around the screws. He underwent ablation of this material, bone curettage and concomitant antibiotic treatment for six months. At that time, the radiographs also showed a good incorporation of the synthetic bone substitutes into the bone (Fig. 1B and 1C).

Four years later the patient developed bilateral gonarthrosis which led to bilateral total knee replacement without patellar resurfacing. Chronic bilateral knee pain developed progressively, mainly on the right side, without swelling or redness of the soft tissues.

A three-phase bone scan was performed followed by a SPECT/CT of both knees after intravenous injection of 24 mCi (887 MBq) of $^{99m}$Tc-HDP on a dual-head gamma camera (Symbia T16, Siemens Healthcare, Germany), using a low-energy high-resolution parallel-hole collimator. Focal hypervascularization on the early phase images as well as intense linear horizontal uptake on the delayed images were observed below the right tibial plateau (Fig. 2A and 2B). A moderately increased uptake
in both patellofemoral joints was observed, without any significant periprosthetic uptake, excluding any prosthesis loosening.

SPECT/CT revealed an intense and well-delineated uptake of $^{99m}$Tc-HDP perfectly matching the two dense synthetic implants in the bone identified on CT images, under the right tibial plateau, anteriorly and posteriorly to the tibial prosthetic stem (Fig. 2C). These well delimited focal uptakes were seen on images corrected for the attenuation as well as on those without correction. The aspect of the implants on CT-scan was unchanged compared to a previous one acquired six years earlier, with no evidence of bony lytic lesion, periosteal reaction or bone infiltration which could suggest an infection. The SPECT/CT also showed an uptake to patellofemoral arthritis of both knees.

Considering the positive early-phase bone scintigraphy, inflammation could not be totally excluded and a $^{99m}$Tc-labeled murine IgG antigranulocyte antibody scintigraphy was performed (Scintimun®, $^{99m}$Tc-besilesomab, IBA/CIS bio international, France). Planar images followed by a SPECT/CT were performed 4 h and 24 h after the injection of 20 mCi (747 MBq) of Scintimun®. Those images did not reveal any pathological uptake at the sites of increased activity observed on the bone scan, but only a thin curvilinear uptake, postero-medially to the tibial prosthetic stem, due to post-operative medullar regeneration (Fig. 3). We concluded that our patient’s symptomatology was not linked to the right tibial implants, but was related to advanced bilateral patellofemoral osteoarthritis prevailing on the right side. Bilateral

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**Fig. 1.** Post-surgical radiograph of high tibial opening wedge osteotomy of the right knee showing the two-phase ceramic calcium phosphate insert in a wedge configuration used as a synthetic bone substitute and fixed with stainless steel plate and screws (A). The control radiography of the right knee after ablation of osteosynthesis material, bone curettage and antibiotherapy, showed a persistent hyperdensity of both synthetic bone substitutes, which are well incorporated in the bone (B and C).

**Fig. 2.** Bone scintigraphy (blood pool (A) and bone phase (B) planar images in anterior and posterior views, and SPECT/CT images (C)) showing intense early and delayed uptake of the two dense structures under the right tibial plateau. It also revealed moderate uptakes on both patellas, prevailing on the right side, corresponding to arthritis.
patella resurfacing led to a complete symptom regression, confirmed at 10 months follow-up.

3. Discussion

Proximal tibial osteotomy has become the standard treatment for young and active patients enduring medial compartment arthritis of the knee, by either closing lateral or opening medial wedge osteotomy. In the case of opening medial wedge osteotomy, synthetic void-filling materials can be used as an alternative to bone autologous or allogenic bone grafts [2].

Among synthetic bone substitutes, ceramics of various compositions are commonly used, providing an osteoconductive lattice that will permit osteogenesis. However, contrary to demineralized bone matrix, ceramics have no osteoinductive properties [3]. In our patient, two HATriC™ ceramic bone fillers were used, composed of 60% of hydroxyapatite and 40% of β-tricalcium phosphate, adopting a porous structure analogous to that of cancellous bone, permitting fibrovascular ingrowth and used as a matrix for bone formation. Osseous ingrowth begins soon after surgery, with progressive loss of the radiolucent area around the implant on radiographs. After some months, the implant is supposed to be embedded in the bone, with disappearance of the denser aspect of the implant compared to the adjacent bone: the design of the ceramics allows osteointegration, which means resorption of the ceramics and its replacement by bone during the healing process [3].

99mTc-HDP is a bone-seeking radiotracer corresponding to a diphosphonate agent 99mTc-labeled. The intensity of its uptake in a tissue is dependent on local blood flow, tissue composition and osteoblastic activity [4–6].

In the similar case of ocular hydroxyapatite implants, the increased uptake of bone seeking radiolabeled tracers has been well documented on late images. It has even been used for the assessment of adequate fibrovascular ingrowth using planar and SPECT imaging [6–8]. For porous bone synthetic ceramic implants, the vascular ingrowth within the implant allows sufficient tracer delivery to the implanted region, and the bone ingrowth as well as a higher concentration of hydroxyapatite and calcium into the implant offer more surfaces for 99mTc-HDP uptake compared to the surrounding bone tissue. This could explain a markedly increased tracer uptake on bone scan. In our case, unlike what was reported in ocular implants [9], the early phase also revealed a significant uptake of radiotracers within the bone substitutes, raising the question of a local inflammatory or infectious process. In order to evaluate the etiology of this finding, a Scintimun® was performed, proven to be accurate and efficacious for the diagnosis of peripheral bone infections, with an even higher sensitivity than 99mTc-HMPAO-labeled white blood cells [9]. On the basis of CT morphological criteria, of negative Scintimun®, and of a disappearance of the symptoms after patella resurfacing, at 10 months follow-up, an infection could be excluded. Finally, the case presented here demonstrates that some synthetic bone substitutes, such as the HATriC™ implants, can be associated with an increased 99mTc-HDP uptake, even on the early phase of bone scan. Such a bone scintigraphy pattern must not lead to a false positive diagnosis of inflammation or infection. This pitfall should be considered in patients with such bone replacement materials that are increasingly used.

References


