Use of yttrium-90 hydroxyapatite radiosynovectomy as a primary modality of treatment in diffuse pigmented villonodular synovitis of the knee joint: A first case report

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ABSTRACT

Pigmented villonodular synovitis (PVNS) is a rare, relatively benign, intra-articular lesion characterized by a slowly progressive proliferation of synovial tissue. Knee is the most frequently involved joint. Localized and diffuse forms of synovial involvement were reported. In extensive diffuse cases, total synovectomy is needed, almost impossible to achieve. Hence, other treatment modalities such as intra-articular injection of yttrium-90 have been tried and shown to be effective in reducing the rate of local recurrence with "acceptable" joint damage. Radiosynovectomy is based on the irradiation of the joint synovium by the intra-articular administration of various β-emitting radiopharmaceuticals. We describe the first case report of use of yttrium-90 hydroxyapatite particulates in a 33-year-old male who presented with diffuse PVNS of knee joint as a primary modality of treatment.

Keywords: Knee joint, pigmented villonodular synovitis, radiosynovectomy, yttrium-90 hydroxyapatite

INTRODUCTION

Pigmented villonodular synovitis (PVNS) is a benign proliferative histiocytic disorder of the synovium. In 1941, Jaffe *et al.* described it as a group of synovial, tenosynovial, and bursal lesions.[1] Localized and diffuse forms of synovial involvement were reported. In most cases, the disease is monoarticular and involves mainly the knee joint; the hip and ankle joints follow in frequency.[2] The mainstay of treatment has been surgical or arthroscopic synovectomy. Arthroscopic synovectomy has reduced morbidity and is well-tolerated by patients. The relapse rates of surgery are reported to be relatively high, ranging between 8% and 46%, respectively.[3] Radiation synovectomy (RS), involving a radiopharmaceutical injection into the joint. Yttrium-90 (Y-90) is considered to be a promising radionuclide for use in RS of joints owing to its favorable decay characteristics.[4] Hydroxyapatite (HA) particles are regarded as one of the most suitable carriers for applications in RS.[5] We describe the first case of application of Y-90 HA in the treatment of Knee joint PVNS.

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CASE REPORT

A 33-year-old male patient presented with left knee joint swelling of 3 months duration. Swelling was involving mainly the suprapatellar fossa with mild pain present [Figure 1]. X-ray of knee was done, which showed soft tissue swelling with no bone involvement. Magnetic resonance imaging (MRI) of knee joint [Figure 2] was done, which showed innumerable finger like projections appearing hypointense in all pulse sequence is seen diffusely along the synovial membrane of left knee joint, more in suprapatellar synovial recess with tense joint

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effusion, suggesting PVNS. He was referred for RS due to high rate recurrence with surgery. Three phase bone scintigraphy showed perfusion phase [Figure 3] demonstrating increased perfusion in the left knee joint and blood pool images shows increased blood pooling consistent with synovitis. Whole body images [Figure 4] showed increased uptake in left knee joint. Before joint puncture, local anesthesia was administered with 2% lidocaine-hydrochloride. Knee joint aspiration just before the Y-90 HA administration revealed brownish discoloration of the fluid due to the breakdown of blood products (hemosiderin) within the joint [Figure 5]. Preparation of Y-90 HA: Cold kits of HA particles (1–10 μ size range) were prepared by freeze drying 5 mg of HA particles dispersed in a suitable buffer solution of pH ~ 8.5. For radiolabeling with Y-90, 1 mL of sterile, apyrogenic normal saline was added to the kit vials followed by addition of Y-90 activity. Reaction mixtures were incubated at room temperature for 30 min (pH ~ 8) after thorough mixing. Subsequently, the supernatant was separated from the precipitated Y-90-labeled HA carefully. The radiolabelled HA particles obtained as precipitate were subjected to a further washing using 1 mL of sterile, apyrogenic normal saline to ensure the removal of free Y-90 activity in case of possible leaching from the labeled particles. Finally, the Y-90-labelled particles were suspended in sterile normal saline, autoclaved and administered into the joints. Prior to the injection of Y-90 HA, depomedrol (40 mg in 1 mL) was injected into the joint in order to reduce the risk of acute radiation induced synovitis and to avoid skin radiation necrosis. Subsequently, 370 MBq of Y-90 HA particles dispersed in 1 mL of sterile, apyrogenic normal saline was administered intra-articularly and then the needle was

Figure 1: Photographic picture of the swelling in the left knee joint

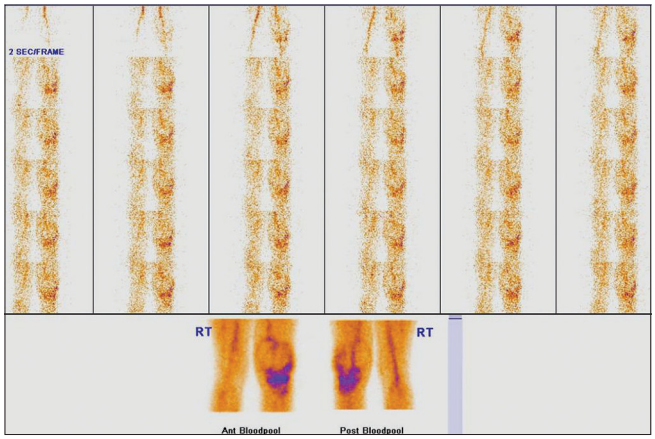

Figure 3: Three phase bone scintigraphy of knee joint. Perfusion (a) and anterior and posterior blood pool (b) images demonstrates increased perfusion and blood pool concentration in left knee joint consistent with synovitis

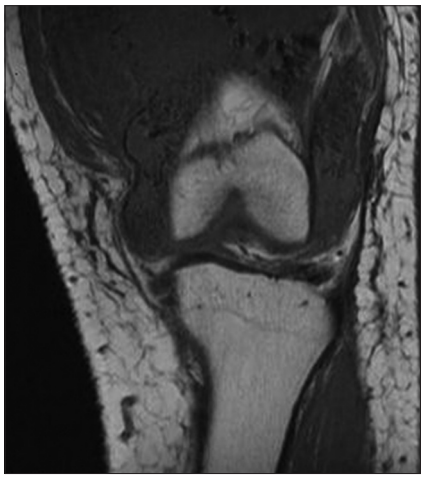

Figure 2: Magnetic resonance imaging of the left knee joint showing numerable finger like projections appearing hypointense in all pulse sequence is seen diffusely along the synovial membrane of left knee joint, more in suprapatellar synovial recess with tense joint effusion

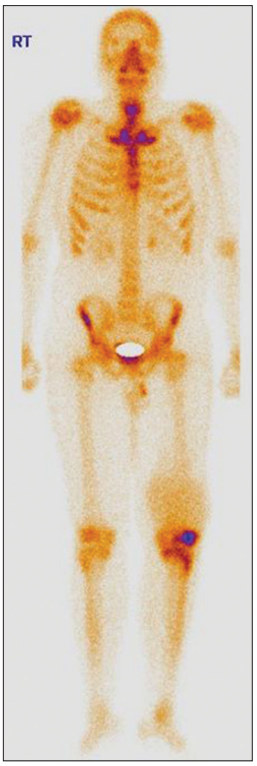

Figure 4: Whole body images (a) showing increased tracer uptake in the left knee joint

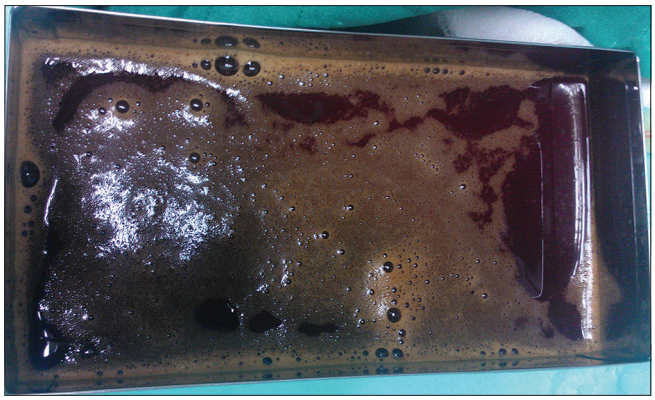

Figure 5: Joint aspiration revealing hemorrhagic fluid

flushed with 2–4 mL of normal saline. An orthopedic bandage was applied as a semi rigid splint. Imaging of bremsstrahlung of Y-90 activity distribution with a dual head gamma camera showed appropriate homogeneously intra-articular distribution of the radionuclide within the joint space [Figure 6]. He had no side effects of leakage or febrile reactions. He was followed up after 3 months with pain relief, decrease in joint swelling and increase in joint mobility.

DISCUSSION

Pigmented villonodular synovitis is a rare proliferative disorder of the synovial membrane, exhibiting benign behavior from a biological point of view. This kind of synovial hyperplasia leads to the formation of villi and nodules characterized by deposit of intracellular hemosiderin.[1] It primarily involves young adults, the peak age being between the second and fourth decade of life. It may appear either in a diffuse or a localized (nodular) form.[2] The joint most affected is the knee and diffuse PVNS is the most common form. Diagnostic imaging techniques, particularly MRI, allow lesion identification, suggesting a diagnosis. MRI will show the effusion, and the hemosiderin-laden soft tissue masses will be seen as areas of low signal intensity on T1 and especially on T2 sequences. This is more pronounced on gradient echo than on spin-echo images.[6] Complete excision of the mass in the affected joint is the treatment of choice in the localized form. In extensive diffuse cases, total synovectomy is needed, but to carry out this procedure without joint damage is difficult and in many cases, almost impossible to achieve.[7] Hence, intra-articular injection of 90Y have been tried and shown to be effective in reducing the rate of local recurrence with acceptable joint damage. The main long-term goal is to eradicate the synovial disease, while avoiding the need for joint replacement in this characteristically young patient population.

Radiation synovectomy is a local intra-articular injection of radionuclides in colloidal form. RS may relieve synovitis, joint pain, knee flexibility and joint effusion in about 60–80% of the cases.[8] Radioisotopes with emission of β radiation have the capacity to diminish the inflammatory process and ablate the inflamed synovial membrane (pannus) with

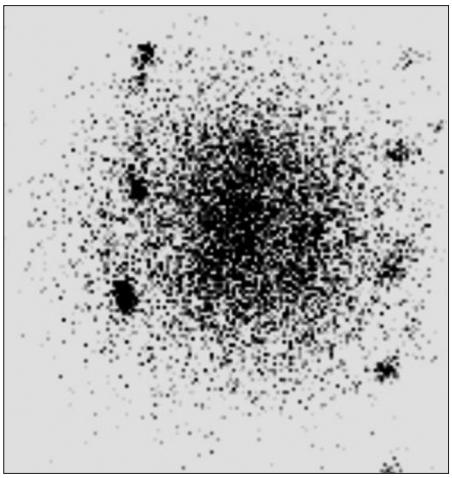

Figure 6: Yttrium-90 hydroxyapatite bremsstrahlung images of knee joint showing good tracer distribution in the left knee joint

subsequent fibrosis. Three radionuclides are currently in use: Yttrium-90 (Y-90 silicate/citrate), Rhenium-186 (Re-186 sulfide), and Erbium-169 (Er-169 citrate), which have been indicated for large, medium, and small joints, respectively.[4,8] An ideal agent for RSV Radiosynovectomy would be one which the radionuclide is irreversibly attached to preformed particles of appropriate size. HA, one of the preferred particulates for use in RS applications, is a naturally occurring mineral form of calcium apatite, mainly found in bone and teeth.[5]

Y-90 - HA can be potentially used as an ideal agent for radiosynovectomy of the joints. The choice of this radionuclide was made based on the optimal penetration of beta radiation in the synovium. Koca *et al.* injected 5 mCi Y-90 citrate colloid into joint of diffuse recurrent PVNS with good results.[9] We used 10 mCi of Y-90 HA as used by Shabat *et al.*[10] as the patient had more joint effusion and large swelling of the joint. The side effects of intra-articular injection of 90Y are few, predictable and avoidable.[11] These include radionecrosis of the extraarticular soft tissues, febrile and local painful reactions, and leakage of radioactivity from the affected joint to the entire body via the lymph nodes. Our patient has no side effects of leakage or febrile reactions. Our case describes the first application of Y-90 HA in the knee joint PVNS as the primary modality of treatment.

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