Sports activity done five days before PET/CT results in augmented FDG uptake in skeletal muscles

Case Report

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ABSTRACT

Increased metabolic activity in muscle secondary to excessive muscle activity during the uptake phase and shortly before FDG injection is a known phenomenon. We present FDG PET/CT findings in a young male, known case of carcinoma maxilla His scan showed diffuse increased metabolic activity in multiple skeletal muscle groups. There was history of unaccustomed, strenuous sports activity of skiing five days before the scan and no history of other known factors known to enhance skeletal muscle FDG uptake. After carefully eliminating all other known factors causing augmented FDG uptake in muscles, we attributed this uptake to be the persistent effect of sports activity of skiing. Though the exact mechanism remains unclear, our case suggests; the effect of exercise causing increased FDG uptake in skeletal muscles may persist for longer period than previously proposed and reported.

Key words: FDG uptake in skeletal muscle; FDG PET/CT; FDG uptake phase; Exercise induced FDG uptake.

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INTRODUCTION

Skeletal muscle activity is a common reason for interpretative pitfall which is related to physiological FDG uptake. Increased metabolic activity in muscle secondary to excessive muscle activity during the uptake phase and shortly before FDG injection is a known phenomenon. We present an unusual occurrence in which sports activity done five days before PET/CT resulted in augmented FDG uptake in skeletal muscles.

CASE REPORT

Thirty year-old Indian male, case of carcinoma right maxilla underwent surveillance whole body FDG PET/CT scan in our department. His treatment history included surgery for primary tumor, followed by radiotherapy nine months ago. This was his third PET/CT scan after the diagnosis of malignancy and patient had knowledge of pre-PET/CT preparation. He was fasting overnight for the scan and his blood glucose level at the time of FDG injection was 78 gm/ml. Patient had no history of diabetes and he was not receiving any medications at the time of scan.

One hour after injection, patient was scanned on dedicated 16 slice PET – CT. Whole body CT scan was obtained as part of PET CT protocol on a multislice CT with 3.5 mm slice thickness.

The PET/CT showed diffuse increased FDG uptake in multiple skeletal muscle groups as shown in the MIP image (Figure 1A, arrows) as well as PET and fused PET/CT images (Figure 1B-E). There was no evidence of abnormal FDG uptake anywhere else in the body. Patient was retrospectively questioned for history of food intake or strenuous muscle activity before the scan. He revealed that he did take part in strenuous, unaccustomed sports activity of skiing five days before the scan. After this activity, there was no history of increased muscle activity. He did not have any history of trauma, muscle pain or fever. After carefully eliminating all other known factors causing augmented FDG uptake in muscles, we attributed this uptake to be the persistent effect of sports activity of skiing.

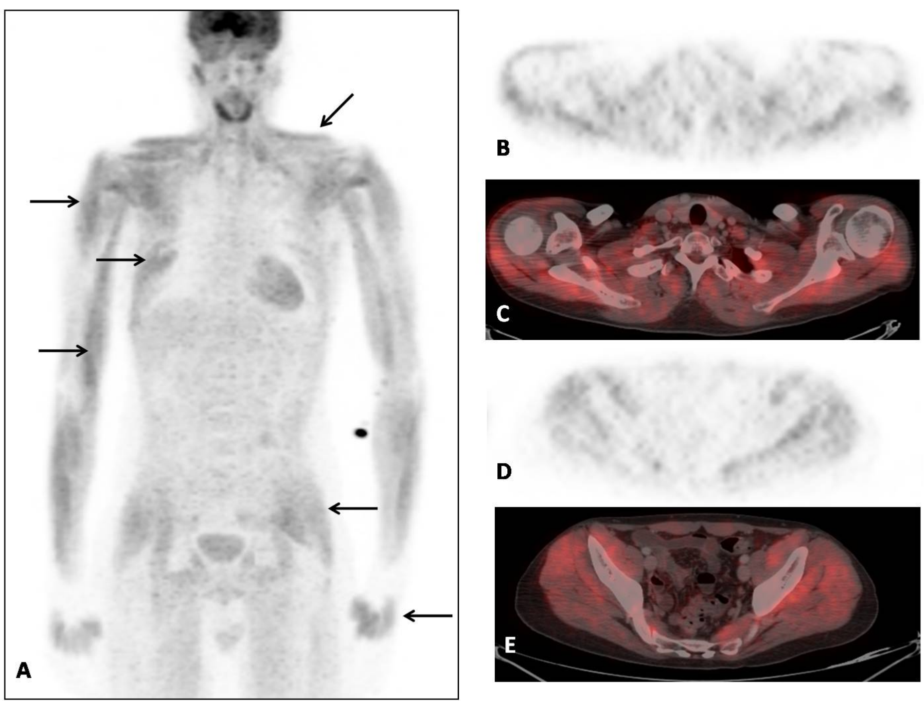

Fig 1. Thirty year-old Indian male, case of carcinoma right maxilla underwent surveillance whole body FDG PET/CT scan in our department. His treatment history included surgery for primary tumor, followed by radiotherapy nine months ago. The PET/CT showed diffuse increased FDG uptake in multiple skeletal muscle groups as shown in the MIP image [figure 1A, arrows] as well as PET and fused PET/CT images [figure 1B-E]. There was no morphological abnormality in these muscles on CT. There was no evidence of abnormal FDG uptake anywhere else in the body.

DISCUSSION

FDG uptake in muscles can be confused with brown fat or pathological uptake in lymph nodes or on PET alone images [1, 2]. However availability of CT and fused PET/CT images can resolve this problem as in our case. The uptake of FDG in brown fat in the neck adipose tissue is typically bilateral, symmetric, intense, and more often multifocal than linear. Also it is associated with uptake in other areas of brown fat such as around the large vessels in the mediastinum, the axillae, the perinephric regions, and in the intercostal spaces along the thoracic spine and characterized by low CT Hounsfield units (HUs) fat tissue in PET/CT [3,4]. Availability of fusion imaging of PET and CT in our, accurately localized the tracer uptake in skeletal muscles and differentiated it from lymph nodal or brown fat FDG uptake. Pathological FDG uptake in muscles can be seen in cases of metastatic deposits in muscles, but the uptake in such cases is usually focal and associated with CT demonstrable lesions with enhancement on contrast administration [5, 6].

Diffuse increased muscle uptake has incidence of 1% and it can be problematic for interpreting the PET study, particularly in patients with melanoma or soft tissue malignancies [7]. In patients undergoing PET/CT, FDG uptake in muscle is observed in patients with recent food intake, diabetic patient following administration of insulin, surgical intervention, muscle activity or following immunosuppressive therapy [8]. In our case except for the muscle activity done five days before the scan [in form of skiing], other above-mentioned causes of augmented muscle FDG uptake were absent.

Muscle FDG uptake due to muscle activity is seen in voluntary processes such as talking, chewing, exercise or involuntary muscle activity like laboured breathing or stress induced muscle spasms [9-11]. Exercise induces IL-6 production that protects against muscle damage by maintaining glucose uptake in the muscle following prolonged exercise [12]. Glucose uptake by skeletal tissue is insulin-dependent via recruitment of the GLUT4 [glucose transporter] from the interior of the cell to the plasma membrane. In human skeletal muscle, exercise increases GLUT-4 and hexokinase II and glycogenin gene expression. Nevertheless, in-vivo study revealed that one hour of moderate intensity exercise increases Hexokinase II transcription mRNA and protein levels up to 3 hours after the end of exercise [12]. In our case the gap between sports muscle activity and increased FDG uptake is longer than this period.

Another possible mechanism that could have been explained such uptake is delayed onset muscle soreness [DOMS], which is muscle inflammation that starts 24 hrs after the muscle activity. DOMS often result from unfamiliar predominantly eccentric exercise, such as downhill running. Symptoms are variable and include muscle pain, loss of strength, swelling in muscles and fever that starts 24 hours after exercise, with peaking on 2nd or 3rd day. Recovery of DOMS can take upto 10 days. The underlying mechanism iseccentric exercise results in injury to the muscle cell membrane, setting off an inflammatory response that leads to prostaglandin [prostaglandin E2] and leukotriene synthesis. This leads to sensation of pain as well as recruitment of neutrophils

at the inflammatory site [13]. Such inflammation could have been cause of FDG uptake, but absence of any of the above-mentioned symptoms made DOMS as unlikely reason for FDG uptake in muscles in the described case. Ultimately asymptomatic muscle injury and inflammation resulting in augmented FDG uptake remained the possibility. Muscle biopsy which is considered best means of confirming muscle injury was not performed for obvious ethical reasons.

In past, two case reports demonstrated increased FDG uptake in muscles due to exercise done 24 hours and 48 hours prior to PET/CT respectively [14,15]. The authors proposed continued asymptomatic rhabdomyolysis after heavy exercise as a possible cause of FDG uptake [14]. Rhabdomyolysis is reported to be a relatively common sequela of strenuous exercise [12]. This was substantiated by a large screening involving more than 300 military recruits whose blood were sampled during their first six days of conditioning which revealed that an approximately 40% of the subjects have some degree of rhabdomyolysis [16]. Though we do not have objective evidence of rhabdomyolysis in form of blood levels of creatinine kinase or urine myoglobin levels; similar phenomenon might have resulted in FDG uptake in the skeletal muscles. Jackson et al evaluated muscle uptake in 146 patients in their study and recommended to instruct the patient to avoid any excessive physical activity at least 48 h before injection as well as to not exert muscle activity during the uptake phase [7]. Our case suggests the impact of exercise on muscles possibly persists longer than this suggested period.

CONCLUSION

A careful, detailed history and knowledge of causes of increased FDG uptake in muscles is crucial for reporting physician, for accurate interpretation of such uptake.

Our case demonstrates increased FDG uptake in skeletal muscles five days after the muscle activity.

Though the exact underlying mechanism remains unclear, this finding indicates effect of exercise causing increased FDG uptake in skeletal muscles may persist for longer period than previously proposed and reported.

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