Less frequent cardiac and extracardiac findings during ^{99m}Tc-methoxyisobutylisonitrile myocardial perfusion single-photon emission computed tomography with radiological correlates

Abstract

Myocardial perfusion single-photon emission computed tomography (SPECT) as a common imaging procedure in nuclear medicine laboratories may encompass findings in the heart or beyond it, in the thorax or abdomen, which may be related or unrelated to the symptoms of the patients. Sometimes, these findings may be discovered incidentally. In the present article, it is aimed to present some less frequent cardiac and extracardiac findings including radiolabeled emboli, transposition of great arteries, breast prosthesis, breast tissue uptake, pericardial effusion, hiatal hernia, hepatocellular carcinoma, ascites, aortic aneurysm, splenomegaly, and polycystic kidney disease during ^{99m}Tc-methoxyisobutylisonitrile myocardial perfusion SPECT with their radiological correlates.

Keywords: *^{99m}Tc-methoxyisobutylisonitrile, cardiac and extracardiac findings, myocardial perfusion single-photon emission computed tomography*

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Introduction

In this article, less frequent cardiac and extracardiac findings which may be encountered by interpreting physicians during viewing of myocardial perfusion single-photon emission computed tomography (SPECT) images are presented.

Radiolabeled emboli

Myocardial perfusion SPECT of a 40-year-old woman referred for evaluation of recent dyspnea. The stress image was unremarkable. The rest image was repeated later because of interfering intestinal activity. The delayed rest raw projections revealed unexpectedly a focal intense uptake around the right lung hilum just above the level of the heart, which was absent on the initial rest study. The patient experienced no acute symptom of dyspnea throughout the rest phase, during radiopharmaceutical injection or afterward. An unenhanced chest CT was subsequently performed which was negative for any pathology. These findings may be highly confusing to the interpreter or sometimes considered as a magical finding since there is no abnormality in other phases and also no corresponding lesion may be found during radiological imaging. Radiolabeled thrombotic pulmonary emboli dislodged from intravenous line or clot formation during injection is a major mechanism. It is worth noting that a radiolabeled clot embolus originated from an intravenous line can occur during injection or at any time postinjection, as in our patient, as a result of hand movement or unintentional pressure on intravenous line or injection site[1-4] [Figure 1].

Transposition of great arteries

Figure 2 demonstrates the myocardial perfusion SPECT of a 59-year-old female patient who is a known case of congenitally corrected transposition of great arteries (TGA) or levo-TGA presented for preoperative evaluation before cholecystectomy. As can be seen, the left ventricle (LV) is remodeled, i.e., spherical in shape, and shows a nonuniform thickness of the myocardial walls representing as multiple perfusion defects. However, the invasive coronary angiography performed shortly thereafter, revealed normal epicardial coronary vessels. Levo-TGA is a rare congenital anomaly of the heart in which atrioventricular and ventriculoarterial discordance is present. The ventricle

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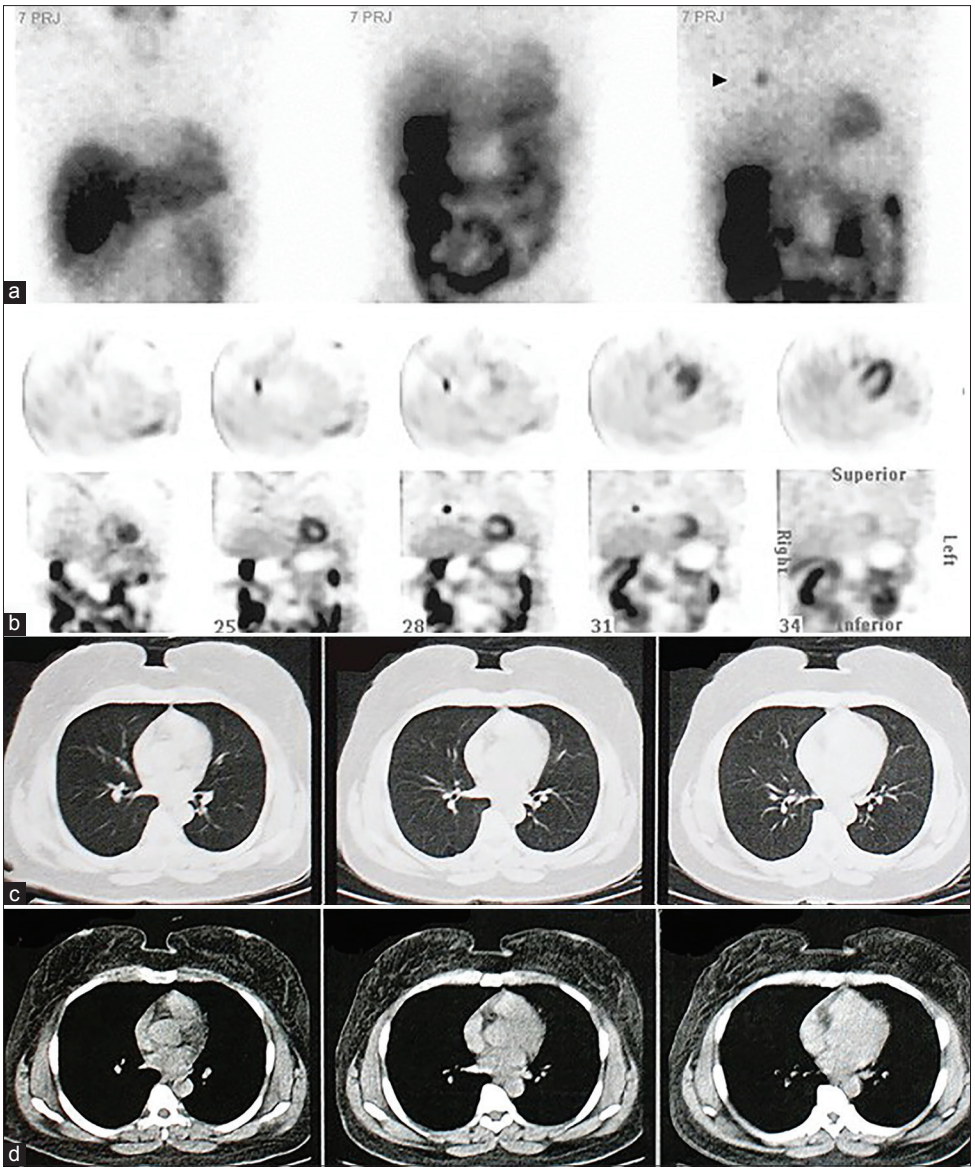

Figure 1: (a) Anterior projections of single-photon emission computed tomography myocardial perfusion imaging at stress (left), rest (middle), and delayed rest (right) phases. The small focus in the right hemithorax is indicated by an arrowhead. (b) Tomographic slices reconstructed in standard transverse (upper row) and coronal (lower row) planes with mild logarithmic adjustment of the brightness of the images show the mentioned focus roughly at the region of right lung hilum. Corresponding slices of unenhanced computed tomography scan (c: Lung window, d: Soft tissue window). No pathology was detected in the corresponding region on the computed tomography scan

located on the right side shows the morphology of LV, i.e., conical in shape with thick walls. However, the opposite one demonstrates the morphology of right ventricle (RV), similar to that in dextrocardia. There might be progressive failure of the LV unrelated to coronary artery disease. The failure of LV results from inappropriate morphology of LV and thus not able to cope with the pressure load of the aorta and inadequate pumping power to circulate the blood systemically. In some occasion, the LV or morphological RV may become hypertrophied, therefore, more prominent on myocardial perfusion SPECT. This pattern is visualized different from that seen in dextrocardia. Though fixed or reversible perfusion defects may exist indicating myocardial infarction or ischemia of noncoronary origin, respectively. Taken together, a multimodality approach is recommended in such patients.[5-9]

Breast prosthesis

Breast prosthetic implants are increasingly used either for esthetic reasons or for patients undergoing mastectomy following prior breast cancer. Silicone breast implants, lied on the LV during myocardial perfusion SPECT, impose more degree of attenuation on the photons emitting from the myocardium toward the detector than nonprosthetic breasts, the latter mainly composed of fatty tissue. Furthermore, in contrast to natural breast tissue which is easily moveable on the chest not to intervene the LV and the detector, and also compressible to flatten uniformly on the chest, prosthetic

implants are rigid in structure and somewhat fixed in location. Maneuvers to overcome the attenuation effect of the breast on the LV would be limited. This issue causes interpretative and diagnostic impediments. Mostly, perfusion defects created are fixed or constant in severity and location from stress to rest phases. Anterior or anterolateral walls are mainly affected, like that seen in the myocardial perfusion SPECT of a 65-year-old female presented in Figures 3a and b. Another useful feature of perfusion defects created by prosthetic implants is an abrupt transition across the boundary between the defect and normal myocardium (indicated by a small arrow in Figure 3a). In general, the

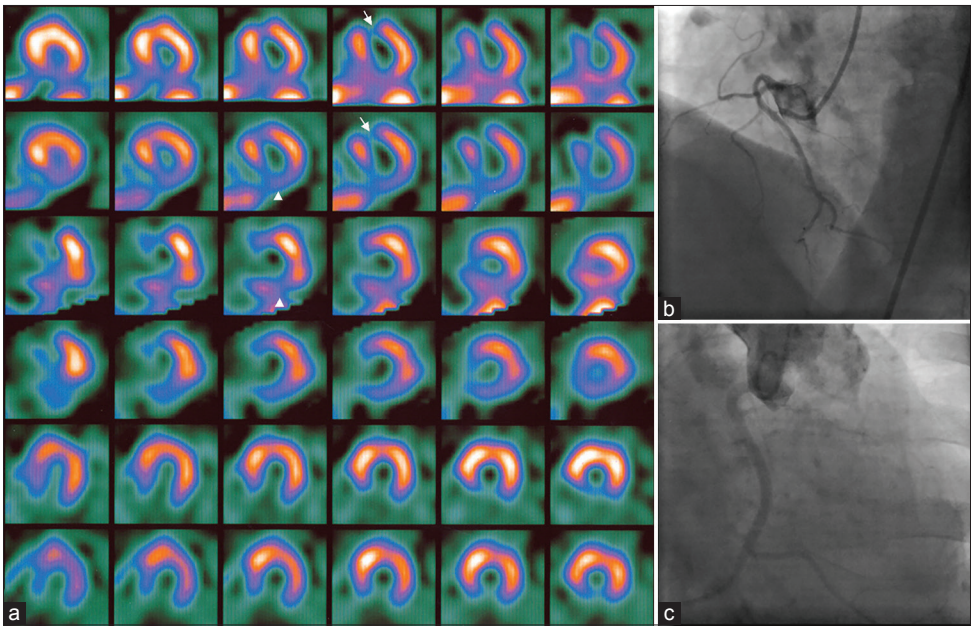

Figure 2: (a) Myocardial perfusion single-photon emission computed tomography in short-axis, vertical and horizontal long-axis slices in stress (upper row in each panel) and rest (upper row in each panel) phases. A few fixed perfusion defects (small arrows and arrowheads in stress and rest slices) as well as spherical configuration of the left ventricle are evident. (b and c) invasive coronary angiography reveals normal coronary flow or insignificant coronary lesions

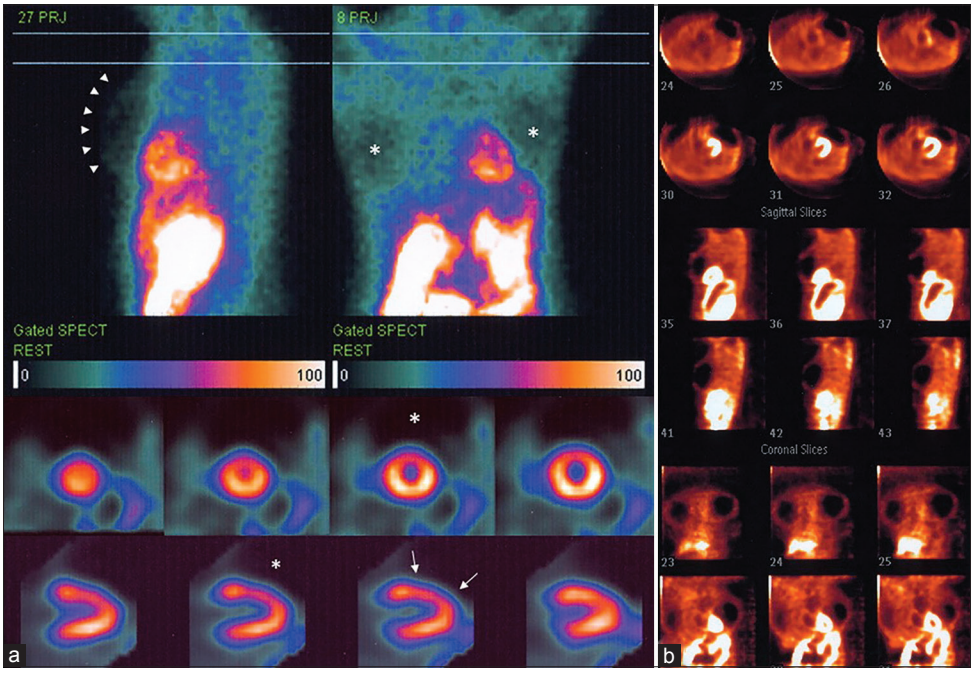

Figure 3: (a) Lateral and anterior projections of myocardial perfusion single-photon emission computed tomography with corresponding short-axis and vertical long-axis slices. Owing to a thin layer of soft tissue over the silicone breast, the border of the breast is subtly more active than central parts (shown by arrowheads). The attenuation pattern in projections (asterisks) are also round in shape and also intense in severity. (b) single-photon emission computed tomography image reconstructed in standard (transverse, sagittal, and coronal) planes. The breasts are visualized hollow inside encircled by an active periphery

pattern of attenuation generated by prosthetic implants is more predictable, in terms of location and severity in both phases.[10,11]

Breast tissue uptake

The glandular tissue in the breast, in most circumstances, takes up ^{99m}Tc-methoxyisobutylisonitrile (MIBI) to a very low level. However, in other physiological or nonphysiological conditions, a much higher accumulation may be observed due to hormonal stimulation and tissue proliferation. A common cause of uptake in the breast is ongoing lactation. Occasionally, the uptake may be unilateral in one breast that is used for feeding of the infant. However, nonlactation related causes, for example, induced by medications or even physiological reasons, show a bilateral and symmetrical uptake as is noted in a 65-year-old woman [Figure 4]. This issue does not bear a malign effect on the image quality but may signify a clinically important situation. However, workup for verifying malignant lesions is necessary, particularly in localized focal hyperactivities.[12-14]

Pericardial effusion

Pericardial effusion (PF) is accumulation of fluid in the pericardial space. Various etiologies, infectious, or noninfectious have been identified for development of PF. In severe cases, symptoms like dyspnea may arise; but, in less severe ones, the condition may remain undiagnosed and discovered incidentally during cardiac or thoracic imaging. On myocardial perfusion SPECT, moderate to severe PFs may be observed as a photopenic halo around the whole heart on planar projections. However, the finding is more distinct in tomographic slices as that seen in Figure 5.[15-17]

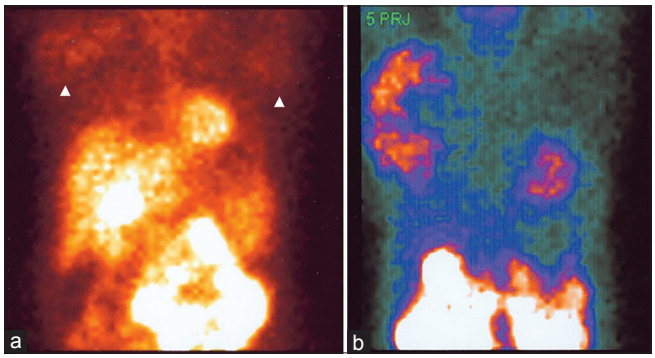

Figure 4: (a) Mild diffuse uptake in the breasts bilaterally (indicated by arrowheads). (b) Unilateral intense uptake in right breast indicating lactations. The level of uptake is so low that does not bear a deteriorating effect on the image quality

Hiatal hernia

Hiatal hernia is a rare complication of gastrointestinal tract in that part of the stomach protrudes into the thoracic cavity through esophageal foramen of the diaphragm. Proximity to the LV may interfere with contouring of myocardial walls by segmentation and edge detection algorithms and thus, scaling artifact may arise. This finding may also be concerning of an intrathoracic neoplastic process. In Figure 6, a large zone of activity accumulation is evident behind the LV in an 85-year-old woman without marked prior gastroesophageal complaint. Except the location of the activity behind the LV hinting at its nature, the finding should be confirmed with radiological modalities. Here, anterior and lateral radiographs of the chest revealed and confirmed the presence of a hiatal hernia.[18,19]

Hepatocellular carcinoma

Primary neoplastic lesions of the liver are not a rare occurrence. Mostly, because of intense uptake in the hepatic parenchyma, lesions with lower avidity for ^{99m}Tc-MIBI are more likely to be noticed. In this, 76-year-old man with a known history of hepatocellular carcinoma and high levels of serum alpha-fetoproteins and cancer antigen 19-9 presented for a myocardial perfusion SPECT [Figure 7]. In cinematic images, a zone with heterogeneously lower uptake compared to normal hepatic parenchyma was noted.[20]

Ascites

Patients with advanced hepatic failure and cirrhosis are occasionally referred for cardiac evaluation before operation for liver transplant. This is not a rare finding and do not interfere with the perfusion status of the LV myocardium. On projections of raw data [Figure 8], a photopenic halo surrounds the liver, spleen, and bowels. Sometimes, loops of bowels may be seen as well separated. However, it is important to verify the presence of ascites mimics such as intraperitoneal dialysate.[15-21]

Aortic aneurysm

A 73-year-old male was presented for cardiac assessment before operation for large abdominal aneurysm. The

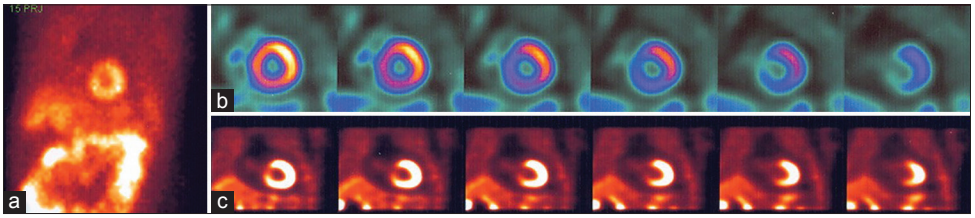

Figure 5: (a) Left anterior oblique projection shows a subtle photopenic halo around the heart. The photopenic halo is distinctly visualized in short-axis (b) and coronal (c) slices

patient underwent a dipyridamole stress–rest myocardial perfusion SPECT. On raw cinematic display, a large intra-abdominal photon-deficient zone was observed, which correlated with the large aneurysm in abdominal aorta. Aortic aneurysms are a life-threatening condition affecting mostly the elderly and results in higher rates of morbidity and mortality if left untreated. Treatment options are surgical repair or placement of grafts. The diagnosis and preoperative evaluation are mainly based on anatomical modalities including CT. Rarely, a finding related to this problem may be found incidentally. This case emphasizes paying meticulous attention to photopenic defects in mid abdomen, particularly in patients without pertinent history[22,23] [Figure 9].

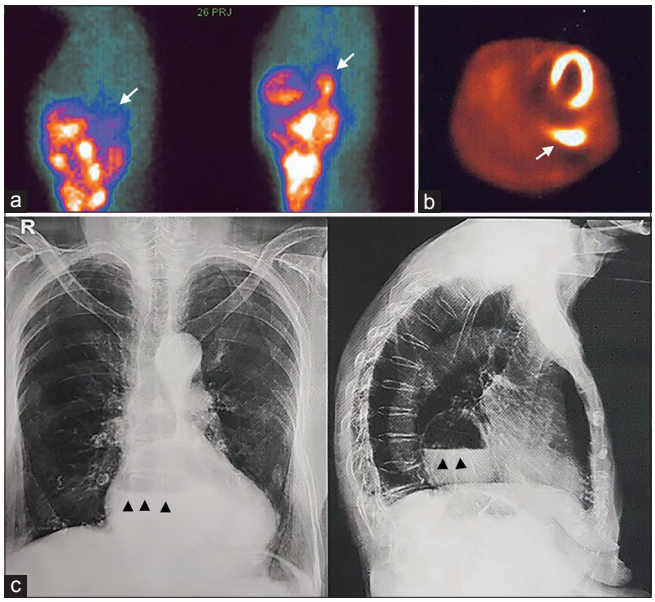

Figure 6: (a) In stress image (lateral projection), a zone with faint activity is visible posterior to the left ventricle; but, in rest image, the activity is accumulated to higher level (shown by small arrows). (b) a transverse slice through the left ventricle; the bright zone is located posterior to the region of left atrium (indicated by small arrow). (c) In posteroanterior and lateral views of chest X-ray, air-fluid level is evident (arrowheads) and thus the finding in the single-photon emission computed tomography image is confirmed

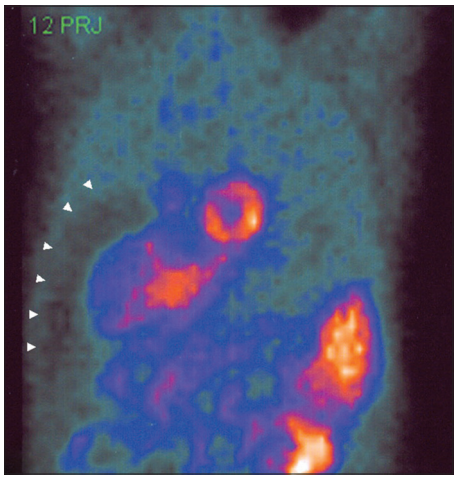

Figure 8: Anterior projection of myocardial perfusion single-photon emission computed tomography shows shrinking of the liver with heterogeneous parenchymal activity. A photon-deficient halo is noticeable surrounding the liver (shown by arrowheads)

Splenomegaly

A 74-year-old woman with a long history of chronic myeloid leukemia presented for a myocardial perfusion SPECT. During inspecting raw images [Figure 10], a huge spleen with marked uptake was seen. The splenomegaly, itself, cause less interference with visual and semi-quantitative interpretation unless very close to the LV. Contrary to other causes of subdiaphragmatic activity in vicinity to the LV, the negative effect of this issue on LV inferior wall cannot be eliminated by routine strategies.[24]

Polycystic kidney disease

Polycystic kidney disease (PCKD) is a rare autosomal dominant disorder that affects adults. Formation of numerous enlarging cysts causes progressive loss of function by replacing functional tissue in kidneys. When kidneys are severely involved, huge photopenic zones would be seen at the region of the kidneys, like those visible in myocardial perfusion SPECT [Figure 11] of a 40-year-old woman who is an extreme case of PCKD,

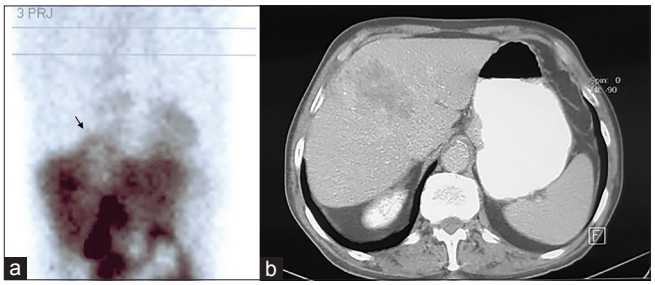

Figure 7: In anterior projection of myocardial perfusion single-photon emission computed tomography (a), a relatively large zone with lower activity compared to that of normal parenchyma bulging the diaphragmatic surface of the liver is evident (small arrow). On contrast-enhanced computed tomography(b), the large hypodense lesion is seen in the corresponding region

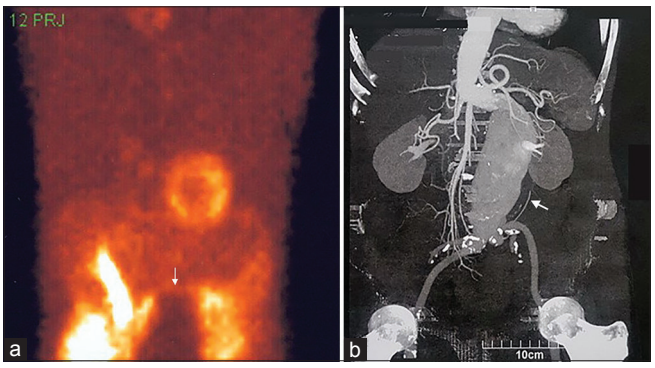

Figure 9: Anterior projection of myocardial perfusion single-photon emission computed tomography (a) demonstrates a large photopenic defect (arrow) in mid abdomen pushing the bowels aside. Computed tomography angiography (b) reveals a large aneurysm in abdominal aorta (arrow)

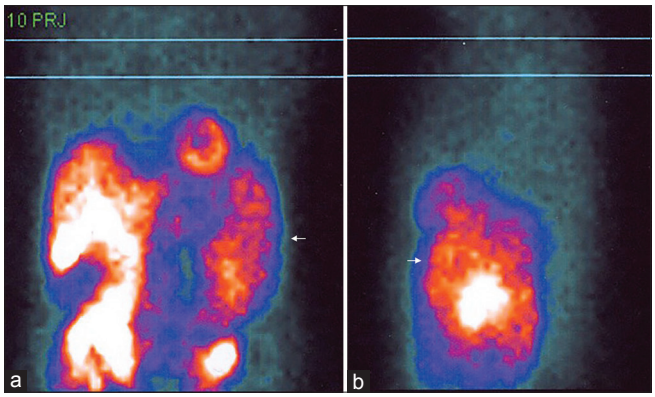

Figure 10: Anterior (a) and lateral (b) projection of raw data show a huge spleen (indicated by arrows) just touching the inferior wall of the left ventricle

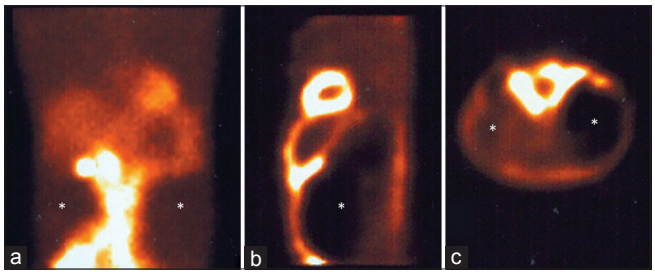

Figure 11: Anterior projection of raw images (a), sagittal (b) and transverse (c) standard slices show large zones deficient in activity in the abdomen (shown by asterisks), compatible with polycystic kidney disease

where the bowels are bilaterally pushed into the middle of the abdomen.[25]

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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