Clinics in Diagnostic Imaging (93)

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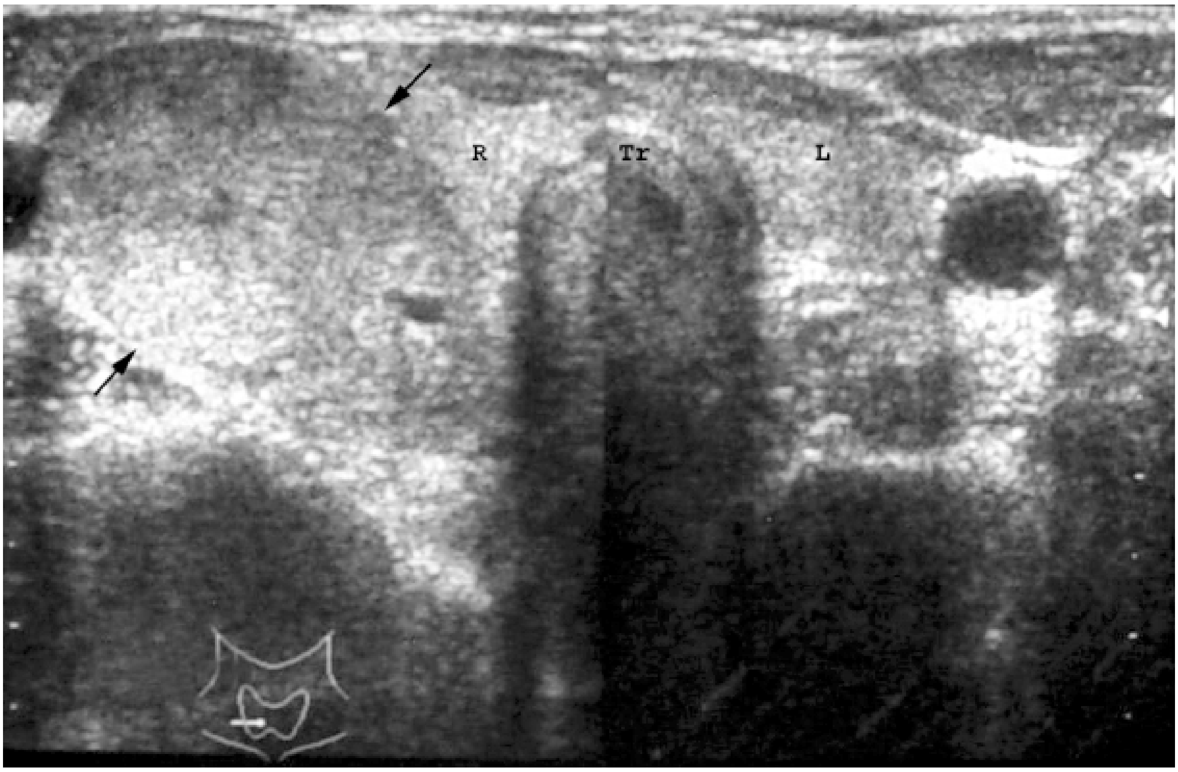

Fig. 1 Transverse US image of the thyroid glands.

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CASE PRESENTATION

A 63-year-old woman was referred to our hospital after sustaining trauma to the right leg one month previously. She sustained a pathological fracture of the right lower tibia and was also found to have hypercalcemia. One year ago, she underwent bone densitometry and was reported to have osteoporosis. She had been on calcium supplement ever since. She also had a history of hypertension for 10 years but no history of renal disease. Physical examination revealed swelling and tenderness of the right lower leg. She also had enlargement of the right lobe of the thyroid gland, with a 3 cm palpable mass in the lower pole. Blood pressure was 160/90 mm Hg. Laboratory investigations revealed a serum haemoglobin level of 9.8 g/dL, haematocrit of 30.3%, white blood cell count of 7.4 x 10^9/dL, creatinine 1.2 mg/dL, calcium 14.9 mg/dL (normal 7-11), inorganic phosphorous 2.5 mg/dL (normal 2.5-4.5), magnesium 1.58 mg/dL (normal 1.5-2.2). Urinalysis was normal. What does transverse ultrasography (US) of the neck show (Fig. 1)? What is the diagnosis?

Fig. 2 Lateral radiograph of the left tibia shows multiple lytic lesions with sclerotic areas, representative of healing brown tumours, and callus formation at the pathological fracture site (arrow).

Fig. 3 Radiograph of the right hand shows subperiosteal bone resorption of the phalanges, best seen on the radial aspect of the middle phalanges (arrows).

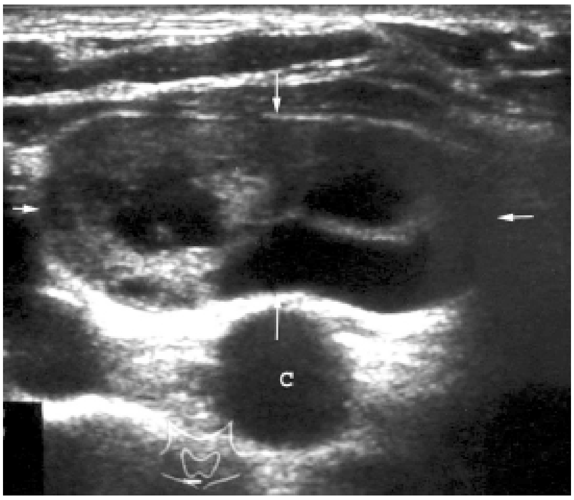


Fig. 4 Transverse US image of a parathyroid adenoma (arrows) with cystic component. [C= carotid artery].

IMAGE INTERPRETATION

Transverse US scan shows a well-circumscribed heterogeneously-hypoechoic mass (arrows), posterolateral to the right lobe of thyroid gland. The left thyroid lobe (L) and trachea (T) are normal.

DIAGNOSIS

Parathyroid adenoma.

CLINICAL COURSE

As parathyroid adenoma was diagnosed to be the cause of hypercalcemia, the patient underwent parathyroidectomy. The diagnosis of parathyroid adenoma was confirmed histopathologically. She made a good post-operative recovery. Ten days after operation, a serum calcium level fell to 6.1 mg/dL. A follow-up radiograph of the right leg (Fig. 2) at three months post-operation showed healing of the lower tibial fracture. The pathological fracture had occurred through a Brown's tumour of the lower tibia.

DISCUSSION

Primary hyperparathyroidism is a major clinical disorder of the parathyroid glands. The cause of primary hyperparathyroidism is a solitary parathyroid adenoma in approximately 80% of patients, with other causes being parathyroid hyperplasia in 15%, multiple parathyroid adenomas in 3-5%, and carcinoma in 1%[1]. Clinical manifestations involve primarily the kidneys and the skeletal system. As a result of hypercalcemia, the patients have a high incidence of renal lithiasis, and nephrocalcinosis. The classic bone manifestation of hyperparathyroidism is osteitis fibrosa cystica. Histopathological alterations consist of osteoclastic and osteolytic resorption, with fibrous tissue replacement (osteitis fibrosa cystica, Recklinghausen's disease of bone). The bone is decreased in density, exhibits defective lamellar structure and Haversian system development, producing a soft, fragile bone. Occasionally, the accumulations of fibrous tissue containing numerous osteoclastic giant cells produce localised cyst-like destructive bone lesions that appear brown in colour ("brown tumours") in pathological examination (Fig. 2). Other bone changes include resorption of the phalangeal tufts and replacement of the usually sharp cortical outline of the digits by an irregular outline (subperiopsteal resorption). Subperiosteal bone resorption of the phalanges is the most sensitive radiological sign of primary hyperparathyroidism[2]. It is appreciated best on the radial side of the middle phalanges (Fig. 3). Similar bone changes may be present in the skull in the form of a motheaten or salt-and-pepper pattern. Non-specific generalised skeletal demineralisation is sometimes evident in the absence of these other bony features of hyperparathyroidism.

The diagnosis of hyperparathyroidism is made primarily on clinical examination, and imaging is usually not requried in this disorder. The use of preoperative imaging of the neck for primary hyperparathyroidism is controversial. Because of the high success rate of parathyroidectomy performed by expert endocrine surgeons, imaging has been considered unnecessary, especially in the context of cost-conscious health care management[3]. However, surgical failures may occur from ectopic adenoma, multiglandular hyperplasia, an incomplete excision or the presence of supernumerary glands, patients with distorted neck anatomical structure from previous surgery or radioiodine therapy for thyroid disease[4,5]. Localisation studies were developed to improve operative success by precisely locating the abnormal and/or ectopic parathyroid glands and to reduce the complications by limiting the extent of the operative procedure. Parathyroid adenomas can be localised by many imaging methods including selective angiography, US, computed tomography (CT), magnetic resonance (MR) imaging, and scintigraphy. Angiography is relatively invasive and expensive to be used as the initial imaging modality, and are reserved for very difficult cases. CT and MR imaging are not used routinely in the localisation of parathyroid adenomas because of high accuracy and wide availability of US and scintigraphy. Both CT and MR imaging are however more sensitive than US and scintigraphy for localisation of ectopic parathyroid gland in the mediastinum[6].

US is the least expensive and noninvasive method for preoperative localisation of parathyroid adenoma[6,7]. Normal parathyroid glands are difficult to visualise on US due to their small size and similar echogenicity to the adjacent thyroid and surrounding tissues. Parathyroid adenoma appears as an oval solid mass, less echogenic than thyroid tissue, and is located along the posterior surface of the thyroid gland. Some adenomas may have internal cystic components due to cystic degeneration[6,7] (Fig. 4). Although not always seen, a peripheral vascular arc surrounding a portion of the gland is a useful adjunctive finding that improve the diagnostic specificity of a parathyroid adenoma[8]. The sensitivity of US for localising parathyroid adenomas varies by institution, but is approximately 70% to 80%[6].

Scintigraphy can be performed with either single or dual radiotracers. Dual-isotope scintigraphy with Thallium-201 (Tl-201) chloride and Technetium-99m (Tc-99m) pertechnetate subtraction method is based on the differential localisation of tracer. Tl-201 will be taken up by both thyroid and parathyroid tissues, whereas pertechnetate is selectively taken up by the thyroid tissue. Separate Tl-201 and Tc-99m pertechnetate images are obtained in a single session without moving the patient. After normalisation, the pertechnetate image is then subtracted from the thallium image. Any remaining activity represents abnormal parathyroid tissue, such as parathyroid adenoma, hyperplastic parathyroid gland, and parathyroid

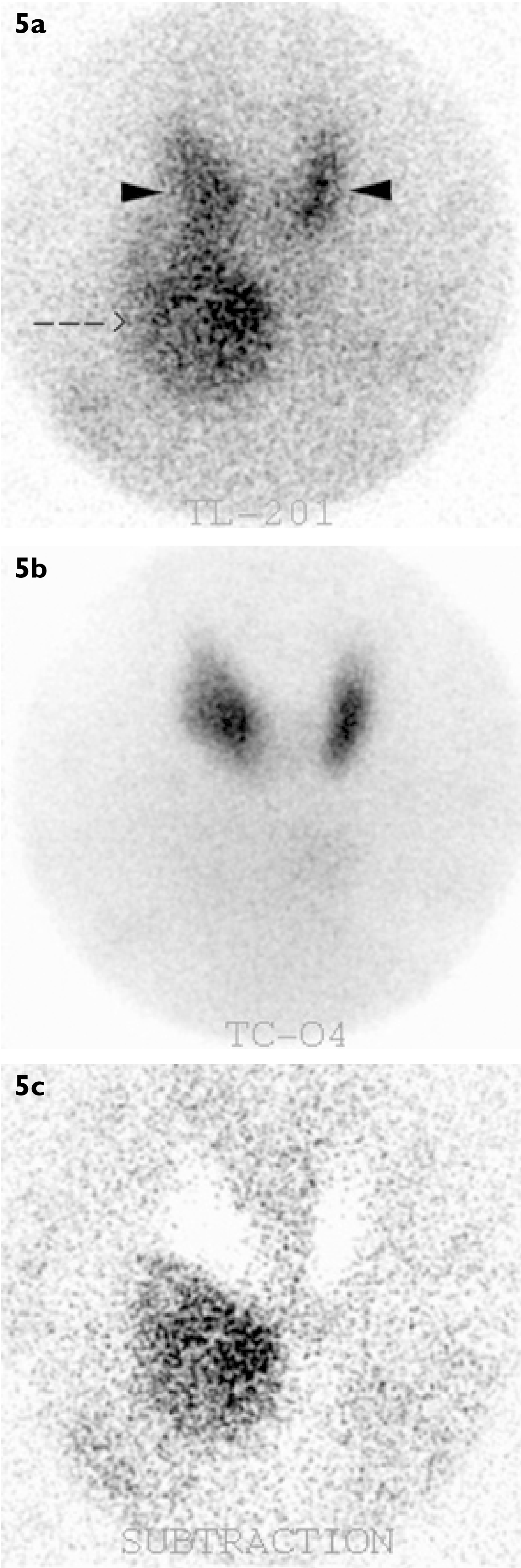


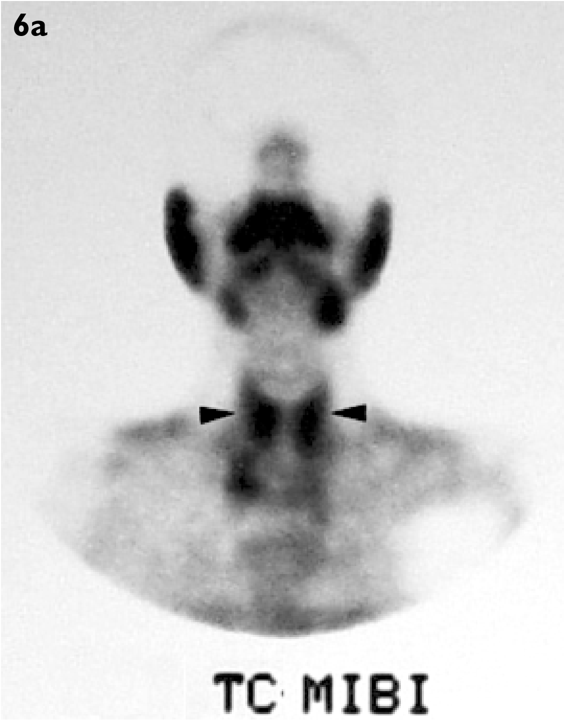
Fig. 5 Parathyroid adenoma. (a) Tl-201 scintigraphical image shows normal thyroid uptake (arrowheads) and an area of increased thallium activity adjacent to the lower pole of the right lobe of the thyroid gland (arrow). (b) Tc-99m pertechnetate scintigraphical image shows homogeneous thyroid uptake. (c) Subtraction image confirms the presence of an area of focal increased uptake at the right lower neck region.

carcinoma (Fig. 5). Hauty et al reported a sensitivity rate of 82 %, and an overall accuracy rate of 78% for this method[9]. Disadvantages of this method include the inherent low-energy photons of thallium causing poor quality images and prolonged patient immobilisation.

Tc-99m sestamibi (MIBI) has recently been introduced for parathyroid imaging. There are two methods of scanning, namely: subtraction scanning and dual-phase imaging. For the Tc-99m MIBI subtraction technique, either I-123 or Tc-99m pertechnetate is used to outline the thyroid gland, and then this image is subtracted from the Tc-99m MIBI image. Tc-99m MIBI is better than Tl-201 because it has higher differential uptake between thyroid tissue and parathyroid adenoma (higher target-to-background activity) and greater retention of Tc-99m MIBI by parathyroid adenoma (Fig. 6). This technique has been shown to have a sensitivity of about 89% in the detection of parathyroid adenomas[10]. Dual-phase sestamibi imaging technique is based on the differential washout of Tc-99m MIBI of the thyroid and parathyroid tissue. The rate of washout from abnormal parathyroid tissue, such as parathyroid adenoma, is much slower than that of normal thyroid tissue. An area of persistent tracer activity on the delayed images is therefore suggestive of the presence of hyperfunctioning parathyroid tissue. The advantages of dual-phase technique over dual-radionuclide imaging include simplified handling of a single radiotracer, dual-phase acquisition capability, and the capability for three-dimensional with single photon emission computed tomography (SPECT) assessment[1]. False-negative examinations result from small gland size or deep or ectopic glands. False-positive studies occur because of adjacent thyroid disease, lymph node or patient motion[6]. Overall, dual- phase sestamibi imaging has a sensitivity of between 45 to 95% (average 73%) and specificity between 85 to 100%[10]. Each of the localising studies has its own advantages and disadvantages. None of these studies are yet specific enough in most cases to differentiate between adenoma and the rare parathyroid carcinoma[6].

ABSTRACT

A 63-year-old woman was found to have pathological fracture of the right lower tibia through a brown tumour, hypercalcemia, and a soft tissue mass at the lower pole of the right lobe of thyroid gland. US scan of the neck showed a well-circumscribed heterogeneously-hypoechoic mass with displacement of the right lobe of thyroid gland. Diagnosis of parathyroid adenoma was



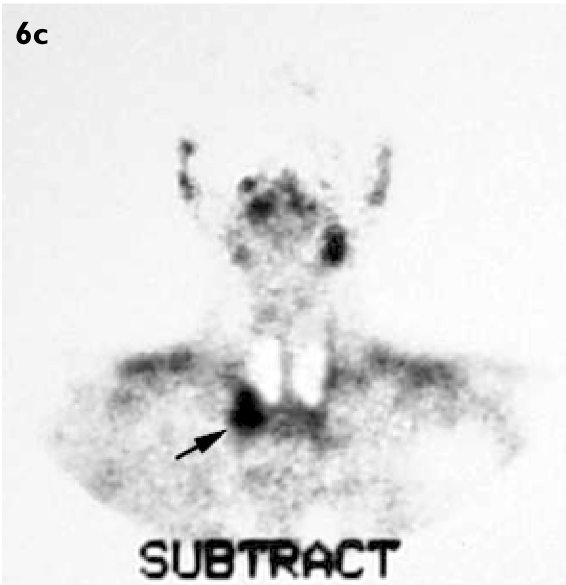


Fig. 6 Parathyroid adenoma. (a) Tc-99m MIBI image shows normal thyroid uptake (arrowheads) and a focal area of increased uptake at the inferior aspect of the right lobe of the thyroid gland (arrow). (b) Tc-99m pertechnetate scintigraphical image shows homogeneous thyroid uptake. (c) Subtraction image confirms an abnormal area of focal increased activity at the right lower neck region (arrow).

confirmed on histopathological examination of the excised specimen. The cause and clinical manifestations of primary hyperparathyroidism are discussed. Imaging methods of parathyroid gland are presented.

Keywords: brown tumour, hyperparathyroidism, parathyroid gland, parathyroid imaging, parathyroid neoplasms

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ERRATUM

The SMJ would like to apologise for inadvertently missing out the name of a reviewer "Dr Tan Siah Heng James" in the Reviewers' List published in the December 2003 issue.