



ORIGINAL ARTICLE / *Research and innovation*

Combined application of ultrasound and SPECT/CT has incremental value in detecting parathyroid tissue in SHPT patients



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KEYWORDS

SPECT/CT;
Ultrasound;
Secondary hyperparathyroidism;
99mTc-sestamibi;
Chronic kidney disease

Abstract

Purpose: The goal of this study is to investigate whether combined application of ultrasound and 99mTc-sestamibi SPECT/CT had the incremental value in accurately detecting parathyroid tissue in patients with SHPT over either method alone.

Patients and methods: Sixty patients with SHPT on hemodialysis were evaluated preoperatively with parathyroid 99mTc-sestamibi SPECT/CT scintigraphy and ultrasound prior to parathyroidectomy. The sensitivity, specificity and accuracy of 99mTc-sestamibi SPECT/CT scintigraphy, ultrasound and combined application were determined respectively.

Results: The sensitivity, specificity and accuracy of ultrasound were 81% (155/192), 47% (17/36) and 82% (172/228), respectively. The sensitivity, specificity and accuracy of 99mTc-sestamibi SPECT/CT were 85% (163/192), 58% (21/36) and 89% (184/228) respectively. The accuracy of 99mTc-sestamibi SPECT/CT in the diagnosis of parathyroid tissue in patients with SHPT is significantly higher than that of ultrasound. The sensitivity, specificity and accuracy of combined application of ultrasound and 99mTc-sestamibi SPECT/CT were 93% (178/192), 61% (22/36) and 97% (200/228). The sensitivity, specificity and accuracy of combined application of ultrasound and 99mTc-sestamibi SPECT/CT were higher than those of either ultrasound or 99mTc-sestamibi SPECT/CT.

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Conclusions: The combined application of ultrasound and ^{99m}Tc -sestamibi SPECT/CT had incremental value in accurately detecting parathyroid tissue in patients with SHPT over either method alone.

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Secondary hyperparathyroidism (SHPT) is a common and major complication of patients with end stage renal disease (ESRD) [1]. Current medicine interventions in treating SHPT have the potential to improve biochemical profiles and other surrogate markers [2]. However, some patients would present resistance to these medicines. Uncontrolled SHPT is associated with an increased risk of fractures and mortality. Parathyroidectomy (PTX) is reserved for medically refractory and severe SHPT. PTX increases long-term survival in ESRD patients, decreases the risk of fracture [3]. However, the rate of persistent and recurrent disease after parathyroidectomy is ranged between 10% and 30% [4]. The principal cause of surgical failure still remains the incomplete intraoperative identification and excision of all hyperplastic parathyroid glands [5]. Therefore, it is very important to correctly locate all parathyroid tissues preoperatively.

Different imaging methods have been used in the preoperative localization of parathyroid tissue. However, it is still an argument of which diagnostic method is the best to preoperatively localize parathyroid tissue in patients with SHPT, including ultrasound, ^{99m}Tc -sestamibi scintigraphy, intraoperative quick intact parathyroid hormone (iPTH) assay [6]. Accurate localization of abnormal parathyroid gland, especially ectopic parathyroid, may be very useful to guide the surgery, especially in high-risk patients. Previous studies have investigated the role of ultrasound and ^{99m}Tc -sestamibi parathyroid scan in the diagnosis of hyperparathyroidism [7,8]. However, these studies investigated the role of planar image, or dual phase planar scintigraphy, or dual tracer planar parathyroid scintigraphy combined with ultrasound, did not investigate the role of parathyroid SPECT/CT tomographic scintigraphy combined with ultrasound in SHPT. The goal of this study is to investigate whether combined application of ultrasound and ^{99m}Tc -sestamibi SPECT/CT had the incremental value in accurately detecting parathyroid tissue in patients with SHPT over either method alone.

Materials and methods

Patients

The study population included 60 consecutive ESRD patients between January 2011 and December 2014 on hemodialysis who underwent preoperative evaluation with ^{99m}Tc -sestamibi SPECT/CT scintigraphy and ultrasound prior to parathyroidectomy for SHPT at our hospital. Thirty-nine

patients were female, 21 patients were male. The average age was 68.1 ± 8 years old. The mean PTH concentration was greater than 600 pg/mL and calcium concentration was greater than 10.4 mg/dL. Preoperatively, all patients underwent dual phase ^{99m}Tc -sestamibi SPECT/CT scintigraphy and ultrasound. Our institutional review board provided approval for the procedures of this study.

Dual phase ^{99m}Tc -sestamibi scintigraphy with SPECT/CT

Patients were injected intravenously with 740 MBq (range, 718–763 MBq) of ^{99m}Tc -sestamibi. The image acquisitions were performed on a dual head gamma camera equipped with 5/8 inch NaI crystals and multidetector (4 row) spiral CT (Symbia T2; Siemens Medical Solutions). Early phase SPECT/CT and delayed phase SPECT images of the neck were obtained at 15 and 120 minutes after injection, respectively. The image acquisition method is same with the previous studies [9,10]. At delayed SPECT/CT phase, only SPECT data was acquired for SPECT/CT. CT acquisition data of early phase can be used for delayed phase SPECT/CT.

The interpretation of ^{99m}Tc -sestamibi scintigraphy was performed in consensus by 2 experienced nuclear medicine physicians. The image findings were classified as positive or negative. If the images showed persistent high tracer thyroid uptake at delayed phase, the physician would attach more attention to the CT images. A scintigraphy was recognized as positive if there was a definite focus of increased or separate ^{99m}Tc -sestamibi uptake relative to the uptake in the thyroid tissue of neck or mediastinum on either early or delayed SPECT/CT images. Precise location of each focus was also reported. Scintigraphy was negative when focal uptake in the neck or mediastinum was absent on both early and delayed phase SPECT/CT studies. Agreement between the two physicians was achieved in all patients [11].

Ultrasound

The patient was examined in a supine position with the neck hyperextended. Ultrasound was performed using linear transducers (7 to 12 MHz) for cervical examination in a field extending from the angles of the mandible to the sternum notch. Transversal and longitudinal views were obtained. Images of regions of interest were recorded on film reproducing video images. The radiologist interpreted each study together with the surgeon, because some patients had previous operations, such as parathyroid radiofrequency ablation, thyroidectomy, which may influence the result of these scans

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