

Impact of preoperative thyroid ultrasonography on the surgical management of primary hyperparathyroidism

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Background: Primary hyperparathyroidism (PHPT) with coexisting thyroid disease has been considered a contraindication to minimally invasive parathyroidectomy (MIP). This study assessed the impact of thyroid ultrasonography and guided fine-needle aspiration (FNA) biopsy with cytological review of the aspiration in distinguishing patients eligible for MIP from those requiring open parathyroidectomy with thyroid surgery.

Methods: The records of 194 consecutive patients who had minimally invasive or open parathyroidectomy for sporadic PHPT were reviewed retrospectively. Thyroid ultrasonographic findings and FNA results were compared with surgical and pathology records.

Results: A total of 163 patients (84.0 per cent) were eligible for MIP based on ultrasonographic findings with or without FNA results. Ultrasonography detected concurrent thyroid disease in 163 patients (84.0 per cent). Thirty-nine (23.9 per cent) underwent FNA, of whom 16 had benign findings and were eligible for MIP; the remaining 23 had suspicious FNA results and had open parathyroidectomy combined with thyroid surgery. Postoperative thyroid histopathology confirmed malignancy in nine patients, eight of whom had disease detected ultrasonographically. Micronodular thyroid disease (less than 1 cm) accounted for four of nine malignancies.

Conclusion: Most patients with PHPT are eligible for MIP. Experienced ultrasonographers can diagnose coexisting micronodular and macronodular thyroid disease, and identify patients eligible for MIP.

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Introduction

Primary hyperparathyroidism (PHPT) is commonly associated with thyroid disease¹, so preoperative evaluation should include assessment for synchronous thyroid pathology^{2,3}. Surgical planning for PHPT must allow for the possibility of simultaneous parathyroid and thyroid intervention and, if thyroid malignancy is present, more extensive surgical intervention. In contrast to minimally invasive parathyroidectomy (MIP), open parathyroidectomy (PTX) provides the opportunity for intraoperative inspection and palpation of the thyroid.

The presence of coexisting thyroid disease has previously been considered a contraindication to MIP⁴. Nevertheless, the benefits of the minimally invasive approach over bilateral neck exploration, and the high incidence of benign thyroid disease in patients with PHPT, remain attractive reasons for finding a reliable alternative to intraoperative

thyroid examination⁵. The ability to discriminate malignant from benign thyroid disease is usually the deciding factor in choosing MIP rather than PTX.

Ultrasonography with fine-needle aspiration (FNA) biopsy has been used to discriminate between benign and malignant thyroid disease. One study concluded that ultrasonography was more reliable than clinical examination in screening for thyroid cancer, as 94 per cent of thyroid nodules smaller than 1 cm in diameter and 50 per cent of those 1–2 cm in diameter were missed by palpation but detectable by ultrasonography⁶. Sidhu and Campbell⁵ have also discussed the importance of thyroid ultrasonography in patients with PHPT, although they cautioned against MIP in patients with thyroid abnormalities that were focal, subcentimetre (micronodular) or both to avoid the risk of missing a malignancy.

Recent literature documents the routine use of preoperative thyroid ultrasonography by radiologists, surgeons

and endocrinologists in the optimal strategic management of PHPT⁷. The improved resolution of ultrasound technology and the use of ultrasonographically guided FNA biopsy have allowed more precise identification of discrete, subcentimetre thyroid lesions, allowing better preoperative planning. The aim of this study was to assess the ability of experienced ultrasonographers to distinguish patients with PHPT eligible for MIP from those requiring PTX with thyroid resection.

Methods

Patients were identified by retrospective review of the endocrine surgery database after institutional review board approval had been obtained. Patients without available images or who had multiple endocrine neoplasia syndromes or previous thyroidectomy were excluded.

A single ultrasonographer with dedicated expertise in head and neck ultrasonography performed a blinded retrospective review of the ultrasonographic images of 194 consecutive patients who underwent parathyroidectomy (MIP or PTX) for PHPT between January 1999 and February 2006. The images were evaluated for signs of thyroid disease, including thyroiditis, thyroid nodules and abnormal lymph nodes. The size of suspicious or indeterminate nodules, echogenicity, intranodular calcification, vascularity on colour Doppler ultrasonography and biopsy results were recorded. FNA was performed following preparation of the skin with alcohol. Based on the operator's preference, local anaesthesia was administered by instillation of approximately 1–3 ml of lidocaine along the planned needle track. A 20-G needle was then inserted under ultrasonographic guidance obliquely along the scan plane. The tip of the needle was directed towards (and confirmed sonographically to be within) the hypoechoic abnormal cortex of the targeted abnormality. Aspiration was performed. The needle tip was under constant ultrasonographic monitoring during the entire FNA biopsy. The staff cytopathologist on daily clinical assignment interpreted the FNA results.

Results of ultrasonography with or without FNA biopsy were assessed by comparing original and retrospective image interpretations with surgical results. The potential impact of ultrasonographic findings on surgical planning was also analysed. PHPT was managed according to the algorithm described by Milas and colleagues⁷. Patients were considered eligible for MIP if there was no evidence of thyroid disease and when parathyroid localization studies suggested single-gland disease.

All patients underwent ultrasonography with a high-resolution scanner (XP 128 and Elegra: Siemens Medical Solutions, Mountain View, California, USA; Prosound 5500: Aloka, Tokyo, Japan) equipped with high-frequency

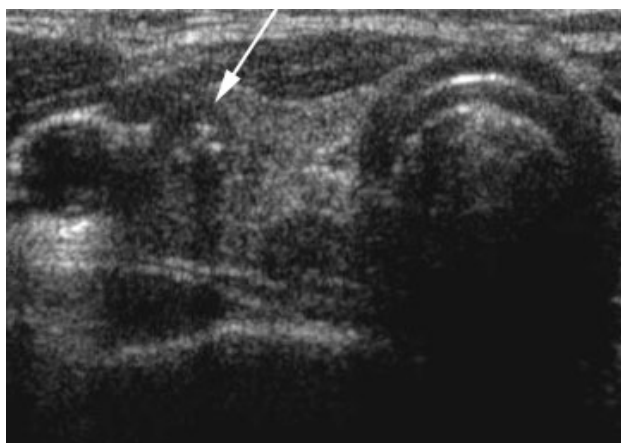
(7–13 MHz) linear-array transducers with colour and power Doppler capability. Ultrasonography technologists performed an initial scan of the soft tissues of the neck, and radiologists performed ultrasonography with or without FNA if necessary. Ultrasonography was carried out according to a standard protocol for patients with PHPT and included examination of the thyroid, lymph nodes in the anterior jugular territories and the traditional locations of the parathyroid glands. The soft tissues of the neck were assessed for parathyroid adenoma in the traditional locations. Size, echogenicity and colour Doppler flow results were recorded. Hypoechoic and complex nodules in the infrathyroid or suprathyroid positions were considered suspicious for parathyroid adenoma. If ultrasonographically guided FNA biopsy was considered, the cytologist was alerted to the possibility of parathyroid adenoma so that the aspirate could be evaluated appropriately to distinguish parathyroid from thyroid tissue or lymph nodes. Ultrasonographically guided FNA was performed when 'suspicious' nodules were seen, defined as solid or complex thyroid nodules with calcifications⁸ or intranodular vascular flow. Thyroid nodule size was not a factor in evaluation for a suspicious nodule. Benign nodules were defined as those that were not complex, with no intranodular vascular flow or calcifications. When multiple discrete nodules were identified, the dominant nodule was targeted for FNA biopsy. Suspicious thyroid micronodules (smaller than 1 cm) were biopsied routinely.

Results

No patient developed thyroid malignancy during a mean follow-up of 24 months.

A total of 163 (84.0 per cent) of 194 patients with PHPT were considered eligible for MIP, 147 (75.8 per cent) based on ultrasonographic findings alone and 16 (8.2 per cent) based on benign FNA cytology. PTX combined with thyroid resection was required in 29 patients (14.9 per cent) based on FNA cytology (23 patients), surgeon decision (five) and ultrasonographic findings alone (one). Two required PTX based on ultrasonographic findings of non-thyroid pathology, including parotid sialolithiasis (one) and lymph node anthracosis (one).

A total of 163 patients (84.0 per cent) had coexisting thyroid disease based on review of ultrasonographic findings. These 163 patients are not the same as the 163 who were eligible for MIP. In 123, the scan was initially interpreted as showing benign thyroid disease. Of these, 118 were eligible for MIP. There was no histopathological confirmation of the ultrasonographic findings as there was no lesion of concern targeted for biopsy or surgical resection. The remaining five patients had PTX and thyroid surgery



a Papillary carcinoma



b Needle placed in lesion

Fig. 1 Ultrasonographic images in the transverse plane demonstrating **a** a subcentimetre (0.4 cm) papillary carcinoma (arrow) with internal calcification and **b** the needle (arrowheads) placed in the centre of the lesion during fine-needle aspiration biopsy for preoperative documentation of a malignant nodule

without FNA cytology after intraoperative visual inspection by the surgeon raised concern about malignancy. Four had benign disease, and one had papillary thyroid carcinoma that had been missed when the scan was interpreted initially but identified during blinded retrospective review.

Forty patients (20.6 per cent) had coexisting thyroid disease with sonographically suspicious features, of whom 39 had FNA biopsy. A single pass was performed in 37 patients and a second pass was required by the cytologist in two. There were no complications associated with the FNA.

Sixteen patients with benign cytological findings were eligible for MIP, whereas 23 had suspicious FNA cytology and had PTX with thyroid resection. Postoperative thyroid histopathology confirmed benign disease in 16 patients and papillary carcinoma of the index lesion in seven.

Of 39 patients with thyroid disease requiring FNA biopsy, ultrasonography identified micronodules in 13 (6.7 per cent of all patients). All 13 suspicious micronodules were sampled successfully by ultrasonographically guided FNA (*Fig. 1*). Based on cytology findings, six of these patients were eligible for MIP and seven proceeded to PTX with thyroid resection. The micronodules ranged in size from 0.4 to 0.9 (mean 0.6) cm. Postoperative pathology assessment of the surgical specimen confirmed that four of the micronodules were malignant, with diameters of 0.4, 0.7, 0.7 and 0.9 cm.

Discussion

Preoperative ultrasonography and ultrasonographically guided FNA can be used in patients with PHPT to identify coexisting thyroid disease and select patients eligible for MIP.

Preoperative ultrasonography allows optimal planning for both MIP and PTX with thyroid resection. It provides details of the location of parathyroid adenomas, including their relationship with surrounding structures. Such anatomical information may affect decisions regarding patient positioning, operative approach, incision placement, manipulation of the thyroid gland to improve exposure, the need for frozen-section analysis and the use of intraoperative parathyroid hormone measurement. Combined with FNA biopsy, ultrasonography can also be used to diagnose synchronous thyroid disease requiring preoperative medical intervention. For example, the increased thyroid vascularity associated with Hashimoto's thyroiditis may necessitate preoperative treatment such as beta-blockade or anti-inflammatory medication to reduce the risk of bleeding.

Preoperative ultrasonography and FNA biopsy in patients with PHPT may avoid unnecessary thyroid surgery and its associated complications. Previously, a nodule detected by intraoperative inspection required a partial or complete thyroid lobectomy for diagnostic evaluation, whereas a preoperative diagnosis of benign disease makes thyroid manipulation and resection largely unnecessary.

The present results confirm previous findings that ultrasonography and guided FNA biopsy effectively distinguishes patients eligible for MIP from those requiring PTX with thyroid resection⁷. The success of this approach in identifying benign thyroid disease is often overlooked. In three-quarters of the present patients, the ultrasonographic characteristics of benign disease, including clinically silent Hashimoto's thyroiditis, simple cysts and colloid nodules, were sufficient to recommend MIP without further investigation. Ultrasonographically guided FNA identified further eligible patients. In all, 84.0 per cent of the patients

with PHPT and 82.2 per cent with coexisting thyroid disease were eligible for MIP based on ultrasonographic and cytological findings. Such information should be incorporated into discussions of cost-effectiveness and the impact of additional surgical procedures on morbidity and mortality in patients with PHPT and coexisting thyroid disease.

There is no single imaging parameter on which to base the determination of thyroid malignancy, although lesions with intranodular vascularity or calcifications are currently considered suspicious^{9,10}. The literature recommends that solid thyroid nodules larger than 1 cm on ultrasonography should be sampled by FNA to assess for malignancy⁷, but recent studies indicate that smaller nodules (micronodules) may be as biologically aggressive as larger ones^{11–14}. Consensus conference guidelines suggest that nodules larger than 1 cm should be biopsied if microcalcifications are present, or 1.5 cm nodules if solid or calcified¹⁵.

At this institution, FNA cytology is performed routinely on all suspicious thyroid nodules if the patient is being evaluated for a cervical operation for concomitant hyperparathyroidism. It is worth noting that ultrasonography and ultrasonographically guided FNA biopsy successfully detected and diagnosed 13 micronodules, the smallest only 0.4 cm in size. Six of 13 patients with suspicious micronodular thyroid disease were eligible for MIP based on FNA findings. Four of the remaining seven patients had papillary thyroid carcinoma. These findings provide evidence that subcentimetre thyroid lesions should be treated as highly suspicious but do not necessarily contraindicate MIP if ultrasonographically guided FNA biopsy is successful.

The efficacy of ultrasonographically guided biopsy is significantly operator-dependent because FNA requires manual skill both to image and to sample the tissue in question. Only one patient was misdiagnosed by ultrasonography in this study, but blinded retrospective review by a more experienced ultrasonographer readily identified the papillary carcinoma. This emphasizes the importance of preoperative evaluation by an experienced practitioner, and is particularly important if thyroid microcarcinomas are targeted for FNA biopsy.

An aggressive approach to rule out concomitant thyroid malignancy when a cervical operation for parathyroid disease is planned seems appropriate.

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