

Surgeon-performed Ultrasound-guided Needle Biopsy of the Thyroid: A Safe and Effective Diagnostic Procedure

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ABSTRACT

With the ready availability of good quality portable units, office-based ultrasound (US) is increasingly being utilized by endocrine surgeons in their daily practices, particularly in the management of thyroid patients. Ultrasound-guided fine needle aspiration biopsy (US-FNAB) of thyroid lesions is a useful interventional diagnostic technique which can be readily performed by endocrine surgeons as an office-based procedure offering significant convenience for the patient. A retrospective review of US-FNAB's performed in a single surgeon practice between 2006 and 2008 was undertaken particularly assessing the diagnostic outcomes and complication rates. Factors affecting FNAB outcome were tested using Chi-square test and significance defined as $p < 0.05$. A total of 128 FNABs were performed on 100 patients in the time period under review. Mean lesion size was 22 mm, and the majority were solid on US. US-FNAB had sensitivity of 85%, accuracy 75%. No complications were reported. A total of 14.8% of samples were reported as either malignant, atypical or with Hurthle cell findings. In this series of patients, 22% of cases proceeded to thyroidectomy, 46% of which yielded malignancy. The nondiagnostic rate was only 5.5%. Solid lesions < 2 cm were associated with higher nondiagnostic rate ($p = 0.04$). Surgeon-performed thyroid US-FNAB is a safe and effective procedure which compares favorably to radiologist-performed series and offers a convenient 'one-stop' process for patients. In this series, it was associated with a low nondiagnostic rate and a low complication rate. Surgeon-performed US-FNAB techniques can be easily acquired; however, structured training and appropriate credentialing are important for the maintenance of quality assurance standards.

Keywords: Thyroid, Ultrasound, Fine needle aspiration biopsy, Surgeon-performed.

INTRODUCTION

Fine needle aspiration biopsy (FNAB) is well recognized as an important but safe diagnostic test in the management of thyroid nodules. The development of fine needle aspiration cytology (FNAC) as a diagnostic tool in the workup of tumors, generally, but for thyroid nodules in particular, was greatly enhanced with the development in the 1960s of the specialized Karolinska Institute FNA Cytology Clinic.¹ Since that era, FNAC has become an integral part of the workup of thyroid nodules, and up until a decade ago was traditionally performed by the palpation technique, which was however associated with a significant nondiagnostic rate reported to be as high as 30%.² In recent years, high frequency B-mode ultrasound (US) evaluation of the thyroid gland has also proven to be a valuable and efficient tool, and its additional employment to guide FNAB of thyroid nodules with greater accuracy and has been associated with a decrease in the nondiagnostic rate and false-negative rate.³

Traditionally, ultrasound-guided fine needle aspiration biopsy (US-FNAB) of the thyroid gland has been performed within radiology services by radiologists. However, with more compact and affordable ultrasound machines becoming readily

available, US-FNABs are no longer confined to the realm of the radiology department. Endocrine surgeons with appropriate training and experience are increasingly utilizing office ultrasound in the assessment and workup of thyroid patients, and which is recognized as being associated with greater cost efficiencies and greater convenience for patients.⁴

The aim of this study was to perform a retrospective evaluation of the efficacy and safety of surgeon-performed US-FNAB of the thyroid in a series of patients attending the private rooms of one endocrine surgeon (IB) who has formal Australian Society of Medicine (ASUM) accreditation⁵ in the use of office-based ultrasound and who has 17 years experience in utilizing ultrasound in the management of endocrine patients.

METHODS

A retrospective review of the records of all patients who underwent US-FNAB of the thyroid gland in the private practice of a single surgeon (IB) over a 3-year period (2006-2008) was undertaken. Sonographic features of the thyroid lesions, lesion size, cytology results and complications from the procedures were recorded. Any histopathology result was correlated with the cytology result in instances where patients proceeded to thyroidectomy.

The performance of FNAB was often based on clinical indications, such as for nodules, which demonstrated a dominant size, especially lesions > 1.0 to 1.5 cm; or nodules which had significantly increased in size as well as those lesions displaying potentially suspicious sonographic features, such as irregular shape, blurred margins, a heterogeneous echo pattern, microcalcifications or hypervascularity. Additional clinical indications included larger painful cystic swellings requiring decompression.

All US-FNABs were performed by a single endocrine surgeon (IB) at a private clinic following routine clinical and ultrasound examinations and as part of the patients' routine workup of abnormal thyroid lesions. Ultrasounds were performed utilizing the Terason T 3000 portable unit with a high frequency 12.5 L linear probe (Teratech Corp, Burlington, MA, USA). US images were obtained and characteristics of lesions documented.

US-FNAB of the area of interest was performed using a standard aspiration technique. A 6 cm long 22 gauge needle mounted on a 10 ml syringe was generally used in conjunction with a pistol grip holder into which the syringe was fitted (Fig. 1). Under ultrasound control, the needle was advanced into the lesion along the longitudinal axis of the probe with continuous visualization of the needle tip during insertion and sampling on the ultrasound monitor (Figs 2 and 3). With suction applied several passes were made through each of the lesions to maximize the amount of material in the specimen, which was then deposited on two glass slides and spread by the usual smear technique. One of the slides was left to air dry and the other fixed with Cytospray (2.5% Carbowax in Ethanol, Fronine Pty Ltd, Riverstone, NSW, Australia). Both slides were then inserted into protective containers and sent for cytological examination with a single private pathology service. Cytologists did not attend the biopsies.

The cytology specimens were forwarded to and analyzed by only one private pathology provider and were classified according to the following cytology criteria (Sullivan Nicolaidis

Pathology, Taringa, QLD, Australia): (1) Nondiagnostic; (2) cyst/cystic degeneration; (3) thyroiditis; (4) benign follicular pattern BFP; (5) atypical follicular pattern AFP; (6) hurthle cell neoplasm and (7) malignant.

Specimens were classified into 'Benign follicular pattern' if they exhibited cytological changes consistent with colloid nodule, nodular hyperplasia and nodular goitre. These corresponded to changes now classified as 'Benign' under the Bethesda classification.⁶ Specimens were deemed inadequate or 'nondiagnostic' if scanty cellularity, no or minimal colloid, poor fixation or poor quality smears were noted.

Sensitivity, specificity, false-negative rates and accuracies were reported for FNAB lesions where surgery was subsequently performed. Factors affecting the FNABs outcomes were tested using Chi-square tests and were considered, if significant and $p < 0.05$.

RESULTS

Between 2006 and 2008, 128 US-FNABs were performed on 100 patients, thus recording an average of 1.3 FNABs per patient. The proportion of female to male patients was 86 and 14% respectively, and the overall mean age was 52.8 years (Table 1).

Majority of the lesions were located in the lower poles (81%) with 13% occurring in the upper poles and only 6% were sited in the isthmus. The average lesion size was 22 mm (range 4-70 mm). On ultrasound, 66% of lesions biopsied were solid in nature with 34% being predominately cystic.

Figure 4 demonstrates the breakdown for the results of the cytology analyses for the complete series of FNAB's performed in this review. Overall 102 cases (79.8%) reported benign cytology (including BFP 47%, cystic 28.1% and thyroiditis 4.7%) and with 19 (14.8%) biopsies showing atypical, Hurtle cell neoplasm or malignant results. Only seven cases (5.5%) were reported as nondiagnostic.



Fig. 1: Equipment useful in the performance of US-FNAB includes the pistol grip syringe holder and 6 cm 22 gauge needle



Fig. 2: Holding the US probe over the thyroid, the fine needle is directed into the lesion along the long axis of the probe and a sample is taken under ultrasound visualization



Fig. 3: Ultrasound image of needle tip entering nodule in left lobe thyroid, transverse cross-section

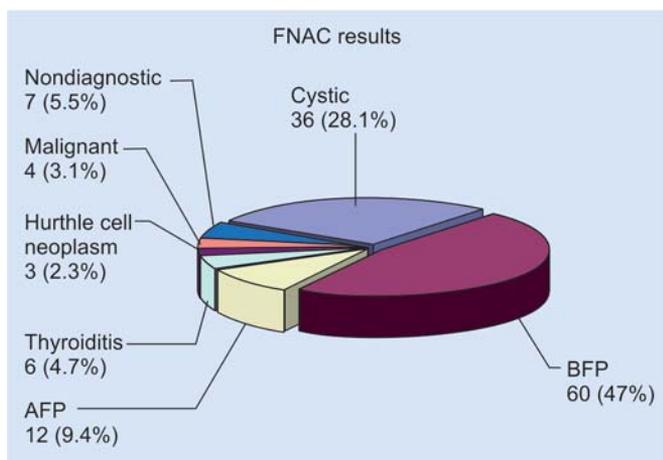


Fig. 4: Cytology results of 128 FNA thyroid biopsies. AFP—atypical follicular pattern; BFP—benign follicular pattern

In terms of the ultrasound appearances, while the usual features of malignancy were looked for such as irregular margins, internal heterogeneity and increased vascularity, there were no particular features which proved more discriminatory than FNAC. In particular, for those 60 patients who returned a BFP result, ultrasound demonstrated completely benign features with 36 (60%) showing a multinodular pattern; 16

(27%) being solitary nodules; and 8 (13%) having an otherwise cystic appearance, and none of the six patients with a BFP result who subsequently underwent surgery were found to have malignancy.

The nondiagnostic rate of US-FNABs correlated primarily with the size of the lesion (Table 2). Lesions less than 21 mm in size were more likely to yield nondiagnostic results (9.2 vs 5.5%, $p = 0.04$). The location of the lesion which may affect the level of difficulties in obtaining adequate material did not appear to affect nondiagnostic rate. In our series, all initially nondiagnostic biopsies were repeated, all of which yielded satisfactory results.

The FNABs were well tolerated and no complications were reported with a follow-up period of 2 to 24 months. There are no known instances of any patient who had benign biopsy result subsequently going on to develop malignancy of that same lesion.

Twenty-eight biopsied lesions proceeded to thyroidectomy (22%), half of which were total thyroidectomies. All cases showing malignant or atypical cytology results were operated on, and this was the most frequent indication for surgery (57% of cases). Other indications for surgery included retrosternal goitre, rapid enlargement of a lesion and discordance between cytological and imaging findings.

Of the 28 patients who underwent surgery, malignancy was identified on histology in 13 cases (46.6%), 12 of which were of papillary carcinomas and one was follicular in type. Sensitivity, specificity, false-negative rate and accuracy of the FNAB in predicting malignancy were 85, 67, 15 and 75% respectively.

DISCUSSION

Endocrine surgeons are confronted daily with the problem of managing thyroid nodules which are in fact extremely common, with palpable nodules being present in 4 to 7% of the population and with over 50% of adults reported to have thyroid nodules detected on sonography.⁷ The dilemma for the surgeon is the correct management of those nodules which he or she cannot palpate and for which important clinical judgements need to be made. In recent years, both ultrasound and FNAB have proven integral to the safe and efficient management of thyroid nodules providing useful diagnostic imaging criteria and cytological lesion evaluation. Furthermore, ultrasound-guided FNAB has

Table 1: Patient and ultrasound features

Demographics		
Number of patients		100
Number of US-FNABs		128
Mean patient age (years)		52.8
Sex distribution	Female	86 (86%)
	Male	14 (14%)
Average lesion size (mm)		22 (range 4-70)
Distribution of lesion		
Isthmus		7 (5.5%)
Right upper pole		11 (8.5%)
Right lower pole		49 (38.3%)
Left upper pole		6 (4.7%)
Left lower pole		55 (43%)
Ultrasound characteristics		
Solid		85 (66.4%)
Cystic		43 (33.6%)

Table 2: Factors affecting nondiagnostic rate

Factors	Nondiagnostic rate	p-value
Size (mm)	1-20	9.2%
	≥ 21	0%
Location	Isthmus	0%
	Right upper pole	8.2%
	Right lower pole	0%
	Left upper pole	3.6%
	Left lower pole	16.7%

been shown to be more reliable than palpation guided FNAB, with recent literature demonstrating improved sensitivity, specificity and accuracy for US-FNAB compared with palpation-guided FNAB.² US-FNAB has also been shown to decrease the rate of nondiagnostic aspirates in patients with small (< 1 cm)⁸ and cystic nodules.⁹ Generally, speaking FNABs performed by palpation alone carry a nondiagnostic rate of 9 to 32%.² In our series where ultrasound guidance was used, there was a significantly lower nondiagnostic rate of 5.5%. In a review of US-guided versus palpation FNABs by Morris et al³ US-FNAB consistently showed lower nondiagnostic rates in the order of 4 to 21%. This may also translate to a lower surgical intervention rate. Our series reported a surgery rate of 22%, with 46.6% of those cases yielding malignant histology. This compares favorably to most series of palpation performed FNABs where the malignant yield is often only approximately 20%.³

Traditionally, most US-guided biopsies have been performed by radiologists due to specific sonographic knowledge and access to ultrasound equipment. With the increasing popularity of high quality smaller portable units, more and more US-FNABs are performed by surgeons in the office setting.¹⁰ Table 3 documents the nondiagnostic rates from various surgeon performed series which range from 3.6 to 13% which compare favorably to the results of this study and also quite favorably to a series of radiologist performed results with a range of 8 to 23%.^{9,11-19} It has been recommended that in order to maintain satisfactory standards, US-FNABs should be carried out by dedicated groups of clinicians.^{20,21} Our series demonstrated that with appropriate training, thyroid surgeons are well placed to perform such procedures in the office setting due to their sound understanding of the anatomy and pathology of thyroid gland, and their considerable experience gained from large caseload numbers of patients with thyroid nodules. Although the number of patients who went to surgery in this series was only small, this present study of surgeon-performed US-FNAB has demonstrated a high sensitivity of 85% and an accuracy of 75%.

Another advantage of surgeon-performed US-FNAB is that of convenience to the patient. Milas²² found that patients are generally more satisfied if clinical workup can be performed in a single visit, the so-called 'one-stop shop' scenario.

Furthermore, preoperative surgeon-performed US has the potential to more likely detect other possible pathologies such as parathyroid disease or cervical nodal metastases, thus facilitating appropriate surgical planning. The convenience to patients of being able to have their definitive diagnostic procedure performed at the same occasion as their specialist consultation without the need to visit another clinician or radiology service should not be underestimated. Additionally, the benefits in terms of cost-effectiveness are appreciable.⁴

In this report, the nondiagnostic rate of US-FNABs was shown to be related to the size of the lesion being needled. Smaller lesions have been reported in several series including this one to be associated with higher nondiagnostic rates.²³ When lesion size was divided into two groups; less than 20 mm and over 20 mm; a 9.2% nondiagnostic rate was reported in the former group versus 0% for the larger lesion ($p = 0.04$) (Table 2). The location of the lesion did not appear to affect nondiagnostic rate although lesions which are more deeply located or in close proximity to vascular structures can pose special technical challenge during biopsy. It has been suggested that the nondiagnostic rate can be reduced by measures such as increasing the number of passes during aspiration²⁴ and the selective use of an on-site assessment of cytologists.²⁵ However, routine attendance of cytologists is not always necessary. Nondiagnostic rates reported from studies with on-site assessment range from 0.7 to 13%,²⁵⁻²⁷ whereas the results from other studies without on-site assessment are certainly comparable, and in our series in which on-site cytology was not used the nondiagnostic rate was 5.5%. On-site cytology availability also requires prior arrangement for cytologists to attend biopsies and hence patients need to set-up additional appointments for dedicated biopsy sessions after their initial assessment, negating the potential convenience afforded by office-based ultrasound.⁴ O'Malley²⁷ estimated that biopsies attended by a cytologist took over 3.5 times longer than nonattended ones. However, there may be a role for on-site cytology arrangements for those surgeons who are less experienced and who wish to improve their technique by gaining immediate feedback as to the adequacy of their US-FNAB.

Although the complication rate in relation to US-FNAB is not widely reported, we believe that it is an extremely safe procedure. No complication was recorded in the 128 biopsies

Table 3: Comparison of nondiagnostic rates for radiologist and surgeon-performed US-FNABs

Author, year published	Number FNAB's	Nondiagnostic rate (%)	Operator
Khurana, 1998 ¹¹	119	8	Radiologist
Tambouret, 1999 ¹²	290	15	Radiologist
Mittendorf, 2002 ¹³	66	23	Radiologist
Mehrotra, 2006 ¹⁴	102	17	Radiologist
Sabel, 1998 ⁹	79	4	Surgeon
Eedes, 2002 ¹⁵	331	13	Surgeon
Seiberling, 2008 ¹⁶	271	9.4	Surgeon
Bhatki, 2008 ¹⁷	446	3.6	Surgeon
Takashima, 1994 ¹⁸	268	3.7	Surg*/Rad#
Carmeci, 1996 ¹⁹	497	13.9	Surg/Rad

*Surg: Surgeons performed series; #Rad: Radiologists performed series

performed in our series (0%). Overall reported complications range from 0 to 8%.²⁸ The most commonly reported complication is hematoma, but other rare complications including needle tract seeding of malignancy, tracheal injury, temporary vocal cord palsy and nodule infarction have also been reported.²⁹ Ultrasound guidance has the advantage of being able to identify relations of thyroid lesions to important anatomical structures, such as vessels and trachea, minimizing the chance of inadvertent injuries.

Most thyroid surgeons are familiar with FNABs by palpation technique and proficiency in US-FNAB can be easily acquired through training courses,^{10,20} such as those conducted by Radiological Society of North America and American Association of Clinical Endocrinologists. In Australia, the Australian Society for Ultrasound in Medicine (ASUM) in conjunction with the Royal Australasian College of Surgeons has now established a curriculum and training guidelines for a certificate for clinician performed ultrasound (CCPU) for both breast and endocrine surgeons.⁵

Training workshops in ultrasound are now conducted in Australia subject to the accreditation approval of ASUM. Attendance in structure workshops has been shown to improve operator confidence and skills and minimize complications.^{30,31} Furthermore, structured workshops should form part of the curriculum for training accreditation and recertification which is vital in maintaining performance standards in thyroid US-FNAB.

CONCLUSION

Surgeon-performed office-based US-FNAB is an effective diagnostic tool. It has comparable diagnostic success to that of radiologist-performed US-FNAB and is associated with low complication and nondiagnostic rates. It imparts great convenience to both patients and surgeons and is cost-effective. It is easily taught to specialist thyroid surgeons and trainees but structured training and on-going recertification are important in maintaining proficiency.

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