# Ultrasound-Guided Fine-Needle Biopsy of First 1000 Consecutive Thyroid Nodules: Single-Surgeon Experience

Jagdish K. Dhingra, MBBS, FRCS[1]

## Abstract

*Objective.* To study the feasibility, safety, and learning curve of ultrasound-guided fine-needle biopsy (USGFNB) performed by a newly trained otolaryngologist in a community office in a setting.

*Study Design.* Collect USGFNB data of all thyroid nodules in a prospective manner.

*Setting.* A dedicated ultrasound clinic in a large community-based practice, operated by a single surgeon with the purpose of providing office-based point-of-care diagnostic ultrasonography and USGFNB.

*Subjects and Methods.* Data on the first 1000 unselected consecutive thyroid nodules that underwent USGFNB over a 3-year period were analyzed. Chi-square analysis was used to assess the statistical significance of characteristics of diagnostic vs nondiagnostic nodules. A multivariate regression analysis was conducted to determine nodule characteristics predictive of adequate sampling. Diagnostic yield and time efficiency data were plotted over a 3-year period to study the learning curve for the USGFNB procedure performed by an operator with no previous experience.

*Results.* A total of 1000 nodules in 734 patients including 142 males and 592 females (age range, 17-87 years) were studied. Of the patients, 188 of 734 had more than 1 nodule biopsied, with a maximum of 4 nodules biopsied in 1 setting. The procedure was successfully completed in all patients, with no major complications. A steep learning curve was observed, and adequate samples were obtained in 91.9% of the patients on the first attempt. The cystic nature of the nodule was the biggest predictor of a nondiagnostic yield.

*Conclusions.* Otolaryngologist-performed USGFNB of the thyroid is safe, effective, and desirable.

## Keywords

thyroid, office-based ultrasound, FNA, USGFNB

Thyroid nodules represent discrete lesions within the thyroid gland that are radiologically distinct from the surrounding parenchyma.[1] Most nodules are nonpalpable and represent incidental findings on imaging studies, with an incidence of over 50% in women after the fifth decade of life.[2] The clinical significance of the nodule is a 5% risk of malignancy.[3] Ultrasound-guided fine-needle biopsy (USGFNB) with cytological analysis is the gold standard for workup of thyroid nodules as it offers a diagnostic accuracy rate of 95%.[4]

In most communities, USFNB is performed by radiologists in a hospital setting. In addition to being inconvenient, this approach leads to unnecessary delays and multiple doctor visits, resulting in increased patient anxiety and additional health care costs.

Recent technological advancements have resulted in affordable and portable ultrasound machines, making it possible to incorporate ultrasonography in the office practice.

Office-based ultrasonography performed by an otolaryngologist–head and neck surgeon has been previously shown to be useful in the accurate localization of parathyroid adenomas and fine-needle biopsy (FNB) of thyroid nodules.[5,6] This approach results in time savings, lesser patient anxiety, and decreased cost. In addition, it leads to better patient care, as the surgeon is able to study the characteristics of the nodule firsthand and, if needed, perform lymph node mapping at the same time.

## Materials and Methods

This study was approved the institutional review board at the Signature Healthcare Brockton Hospital.

[1]Department of Otolaryngology–Head and Neck Surgery Tufts Medical Center, ENT Specialists, Inc, Brockton, Massachusetts, USA

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**Corresponding Author:**
Jagdish K. Dhingra, MBBS, FRCS, Department of Otolaryngology–Head and Neck Surgery Tufts Medical Center, ENT Specialists, Inc, 35 Pearl Street Suite 300, Brockton, MA 02301, USA.
Email: jdhingra@entspecialists.com

In a newly established ultrasound clinic, data on the first 1000 unselected consecutive thyroid nodules in 734 patients studied by USGFNB were prospectively gathered over a 3-year period (September 2013 to November 2016). Procedures were performed by a single otolaryngologist with no prior experience in ultrasonography, other than attendance of American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS)–sponsored American College of Surgeons (ACS) ultrasound course. Hands-on practice sessions were carried out on gel models.

USGFNB was performed using the SonoSite M-turbo portable machine, with variable transducer frequency of 7 to 10 MHz, for guidance. Local anesthesia, 1% lidocaine with 1:100,000 epinephrine, was injected under ultrasound guidance using a 27-gauge needle in all but 3 patients, who requested no local anesthetic. Parallel technique was used for insertion and identification of the needle. The biopsy was performed with a 25-gauge needle connected to a 10-mL syringe by a combination technique—capillary action using a to-and-fro motion of the needle while applying gentle negative pressure on the plunger. Four passes were made per nodule. Samples from the first and third passes were placed in CytoLyt solution (Hologic Inc., MA) for cytological analysis. The second and fourth passes samples were placed in protect RNA medium for Gene Expression Classifier analysis (Afirma test) so that they could be used in case of indeterminate (Bethesda categories 3 and 4) cytology results.

No on-site analysis of sample adequacy was performed. All specimens were analyzed by a liquid-based preparation technique. All samples were interpreted by the same group of thyroid cytopathologists with extensive thyroid cytology experience. All results were reported based on the Bethesda classification system.[7] Cytopathology data were analyzed for various Bethesda categories and compared to national standards. Bethesda 1 (nondiagnostic) results were further analyzed for ultrasound characteristics of the nodules.

The learning curve for performing USGFNA was plotted using 2 variables: average time taken to perform the procedure as a measure of efficiency and positive diagnostic yield as a measure of patient outcome.
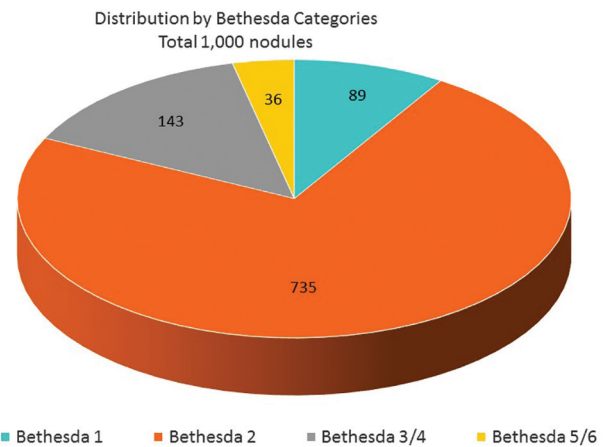
## Results

A total of 1000 nodules in 734 patients, including 142 males and 592 females (age range, 17-87 years) were studied. Of the patients, 188 of 734 patients had more than 1 nodule biopsied, with a maximum of 4 nodules biopsied in one setting (**Figure 1**).

All patients tolerated the procedure well. Thirty-three patients experienced brief vasovagal episodes, all of which were self-limiting and resolved spontaneously. Only 1 procedure had be abandoned due to patient anxiety and was successfully completed 1 week later using premedication with lorazepam. Two patients complained of persistent local discomfort 2 days after the procedure; 1 patient was treated empirically with antibiotics due to the presence of significant erythema, and the second responded to local heat application.
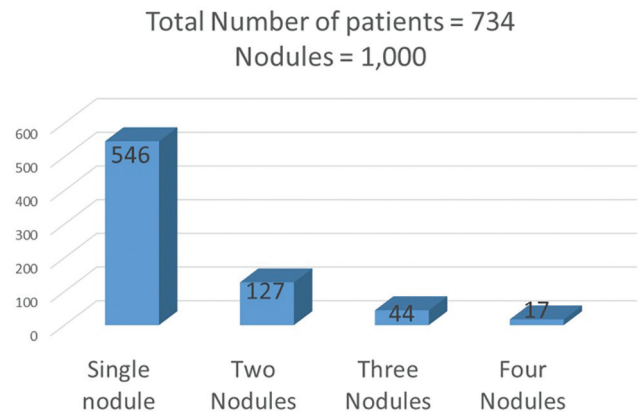


**Figure 1.** Patient distribution based on the number of nodules biopsied.



**Figure 2.** Distribution of nodules based on cytopathology results.

Cytology results, reported using the Bethesda system, are summarized in **Figure 2**. Cytopathological distribution using the Bethesda system was comparable to a meta-analysis of 25,445 nodules (**Figure 3**). A total of 89 nodules (8.9%) were reported as being nondiagnostic (Bethesda 1), compared to 13% in the meta-analysis.[7] Indeterminate results (Bethesda 3 and 4) were reported in 14.3% as compared to 20%, resulting in potentially fewer diagnostic surgeries or need for molecular testing (**Figure 3**).

Characteristics of all nondiagnostic nodules were then analyzed by a retrospective review of the diagnostic ultrasound report. Properties studied included laterality, size, location, and cystic vs solid nature of the nodule. Results are summarized in **Figure 4**. In a multivariate regression analysis, cystic and complex nodules (>75% cystic) had a statistically significant higher nondiagnostic result compared to solid and predominantly (>75%) solid ($P < .001$). There was no statistically significant difference in diagnostic yield between nodules measuring 1.5 cm and smaller, compared to nodules larger than 1.5 cm.
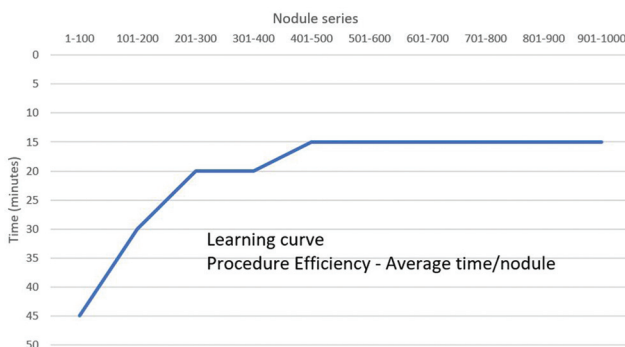
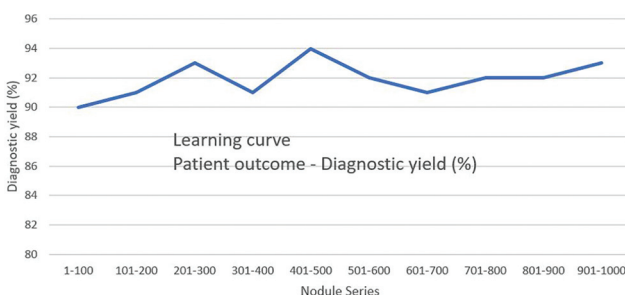Results of the learning curves are summarized in **Figures 5** and **6**.
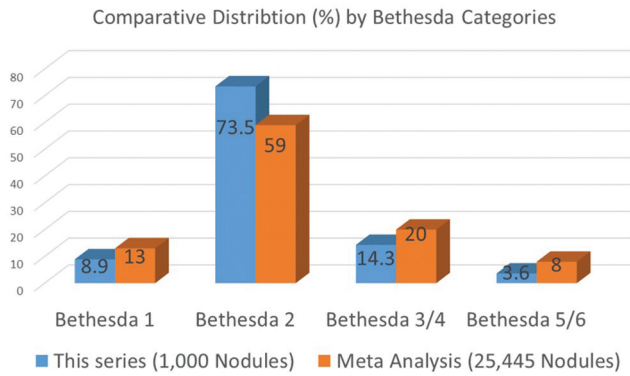
**Figure 3.** Bethesda distribution. This series was compared to the meta-analysis.



**Figure 4.** Ultrasound characteristics of nodules that yielded nondiagnostic results (total = 89).



**Figure 5.** Learning curve for procedure efficiency.



**Figure 6.** Learning curve for diagnostic yield.

## Discussion

Ultrasonography and USGFNB are essential tools in the diagnosis and management of thyroid nodules.[2] Availability of compact ultrasound machines and training opportunities has made it possible to incorporate ultrasound in an office practice. Office-based ultrasonography offers significant benefits by reducing time to diagnosis and thereby patient anxiety. In addition, it results in cost savings. Furthermore, the surgeon is able to study firsthand the characteristics of the nodule(s) and thus has the opportunity to perform screening for lymphadenopathy, resulting in overall better patient care.

This article analyzes the results of USGFNB performed by a single surgeon, with no prior clinical ultrasonography experience, on the first 1000 consecutive nodules to study the learning curve and safety for this procedure. Adequacy and accuracy of the testing were tracked by analyzing the cytological results by Bethesda categories and further studying the proportion of nodules that resulted in a nondiagnostic result. These were compared to published results.[7]

Unsatisfactory results can be due to lack of experience, poor technique, patient anatomy, or intrinsic characteristics of the nodules.[8]

Select previous studies have reported a pronounced and steep learning curve in the performance of USGFNB.[9,10] McIvor et al[10] reported a nondiagnostic rate of 31.4% within the first 3 months of establishing a USGFN clinic, with a sharp decline over the next 6 months resulting in a nondiagnostic rate of 6.1% in 9 months' time. In our experience, the learning curve is steep, hitting the plateau with the first 20 nodules sampled (**Figure 5**), with an overall nondiagnostic rate of 8.9%. This compares favorably with hitherto published data (**Figure 3**).

Intrinsic factors can affect the adequacy of the fine-needle biopsy cytology.[8] We studied the ultrasound characteristics of the nodules that resulted in a nondiagnostic result. Results are summarized in **Figure 4**. In our series, the most important unfavorable ultrasound characteristic was the cystic nature of the nodule. Small size (<1.5 cm) was not associated with a higher nondiagnostic rate compared to larger nodules. In our experience, nodules located along the inferior pole and mid-pole nodules with a posterior location appeared to have a higher nondiagnostic rate.

Some studies have concluded that on-site adequacy of US-guided FNA sampling decreases nondiagnostic results.[11,12] However, this approach is not feasible in most community settings due to limited staffing. Moreover, it is dependent on the experience of the cytopathologist and is associated with a higher cost.[13,14]

In a study of 271 FNAs, Seiberling et al[6] reported satisfactory cytology in 220 nodules (81.2%). In the same study, 9.6% of the specimens were unsatisfactory and 9.2% were limited due to contamination by blood or due to hypercellularity. Such factors may be technique dependent. A larger needle size is associated with a higher rate of nondiagnostic sample. One previous study has shown that a needle size of 24 gauge or smaller provides a higher rate of satisfactory

samples.[15] Moreover, a liquid-based technique using CytoLyt reduces the artifact introduced by blood and poor smear techniques.[16]

In our experience, despite nonutilization of on-site adequacy, we were able to achieve a low nondiagnostic rate of <9%. Our experience is similar to that of Bhatki et al,[17] who reported a similar nondiagnostic rate of 7.4% in a study of 447 specimens, without using an on-site cytopathology service.

## Summary

USGFNB is easily learned and can be safely performed and easily incorporated in an otolaryngology office setting. Adequate sampling can be obtained with results comparable to those obtained by experienced operators in other specialties. In addition, USGFNB performed by an otolaryngologist–head and neck surgeon offers better patient care at reduced health care costs.

## Author Contributions

**Jagdish K. Dhingra**, concept, data acquisition and analysis.

## Disclosures

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