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Utility of Surgeon-Performed Ultrasound in an Otorhinolaryngology - Head and Neck Surgery Residency Training Program: A Single Institution Analysis

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ABSTRACT

Objective: This two-part study aims to describe our experience in surgeon-performed ultrasound-guided procedures, particularly Fine Needle Biopsy (FNB) and Core Needle Biopsy (CNB) in the ORL-HNS residency training program at the University of Santo Tomas Hospital, and to evaluate procedural outcomes, specifically specimen adequacy as well as secondary diagnostic performance of cytological yields among patients with available surgical histopathology.

Methods:

Design:	Cross-sectional Survey Retrospective Review of Records
Setting:	Tertiary Private University Training Hospital
Participants:	16 ORL-HNS physicians (10 residents, 6 alumni) 246 biopsy results

Results: In Part 1, of 16 ORL-HNS physicians (10 residents, 6 alumni) surveyed, trainees reported a mean confidence of 4.06 ± 0.93 in operating ultrasound equipment, with 13 (81.25%) having attended relevant training courses. Ninety percent (90%) of residents planned to incorporate surgeon-performed ultrasound in practice, while 100% of alumni reported active clinical utilization. In Part 2 (N = 246 biopsies), overall specimen adequacy was 89.02% (n = 219). Specimen adequacy rates showed no statistically significant difference across residency year levels and alumni (ranging from 83.64% to 95.00%, $\chi 2=4.08$, p=.421). Overall cytology yielded 64.23% (n = 158) benign, 24.80% (n = 61) atypical/suspicious/malignant, and 10.98% (n = 27) non-diagnostic (Bethesda I / paucicellular / cyst fluid only) specimens. As a secondary exploratory analysis, cytological results compared against final histopathology in the subset of 53 surgically treated patients, demonstrated a sensitivity of 79.40%, specificity of 57.90%, and an AUC-ROC of 0.69 (95% CI: 0.55–0.82) for cytological diagnosis.

Conclusion: This overview of our institutional experience with surgeon-performed ultrasound demonstrates high trainee engagement, confidence in basic applications, and strong long-term utilization among alumni (Part 1) and confirms favorable procedural outcomes, with an overall specimen adequacy rate of 89.02% across all training levels (Part 2). While residency year level served as a surrogate for training level, specimen adequacy remained consistently high across cohorts. Future prospective studies tracking individual procedure logs and long-term diagnostic performance are recommended to directly evaluate skill acquisition over time.

Keywords: *ultrasound; fine needle biopsy; core needle biopsy; head and neck procedures; ORL-HNS; residency training*

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Ultrasonography is a reliable and safe medical imaging technique that has become an essential point-of-care tool for otorhinolaryngology–head and neck surgeons in evaluating thyroid nodules, lymph nodes, and salivary gland masses.[1-3] Combining ultrasound with fine-needle aspiration biopsy significantly improves diagnostic yield, with reported sensitivity, specificity, and overall accuracy reaching as high as 98.1%, 100%, and 98.8%, respectively.[4] Supported by the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) as a discrete diagnostic procedure rather than a mere extension of the physical examination, surgeon-performed ultrasound combined with needle biopsy substantially enhances diagnostic accuracy and workflow efficiency during initial clinic or bedside evaluations.[5] This diagnostic utility is especially pronounced in challenging scenarios such as the postoperative or post-irradiated neck, making it a valuable tool for surgeons.[6]

Despite its growing clinical utility, the integration of structured ultrasound education into otolaryngology residency programs remains variable and poorly standardized worldwide. A survey by Meister *et al.* revealed that only 50% of otolaryngology training programs in the United States incorporated ultrasound-guided procedures, with informal mentorship serving as the primary modality of resident exposure rather than formal, competency-based instruction.[7] Because ultrasonography demands a high degree of technical expertise, establishing structured training standards is crucial to ensure procedural proficiency and limit improper usage.[1,2,7] In the Philippines, there is currently no uniform ultrasound curriculum mandated for ORL-HNS residency training. This lack of standardized training creates marked variability in procedural exposure and skill acquisition among graduating residents, leaving the diagnostic outcomes and clinical utility of institutional residency-based ultrasound training largely uncharacterized.

This study aims to describe the current experience in surgeon-performed ultrasound-guided procedures, particularly Fine Needle Biopsy (FNB) and Core Needle Biopsy (CNB) in the ORL-HNS residency training program at the University of Santo Tomas Hospital, and to evaluate procedural outcomes, specifically specimen adequacy as well as secondary diagnostic performance of cytological yields among patients with available surgical histopathology.

METHODS

With research ethics committee approval (REC Protocol Reference No.: 2024-02-023-TR-FR-AP), this study utilized a two-part design to evaluate the utility of surgeon-performed ultrasound. The first part involved a cross-sectional online self-administered survey that considered participation by current trainees and graduates of the Department of Otorhinolaryngology-Head and Neck Surgery from 2021 to 2023. The second part was a retrospective review of patient records. The two components of this study served as complementary assessments of our single-institution experience with surgeon-performed ultrasound. Part 1 explored ultrasound training exposure, self-reported confidence, and subsequent clinical utilization among trainees and alumni. These survey metrics aimed to capture subjective self-efficacy and practice integration, which are distinct from objective measurements of technical proficiency or individual procedural skill. Part 2 analyzed procedural outcomes of ultrasound-guided biopsies performed at our ENT Center, focusing on specimen adequacy. Residency year level was analyzed as a surrogate measure of overall training level rather than individual procedural proficiency of case volume.

A total enumeration approach was used to compute sample size for part one of the study. All eligible participants were considered for inclusion. For the year 2023, we had a total of 10 resident trainees. Additionally, for the years 2021-2022 we had a total of 6 graduates who were able to implement surgeon-performed ultrasound-guided procedures in the head and neck. The part two sample size computation (*a priori*) for one receiver operating characteristic (ROC) curve was conducted using PASS 2008 software, version 08.0.15 (NCSS, LLC, Kaysville, UT, USA). From the study of Poorey and Tyagi,[8] the diagnostic accuracy of ultrasound-guided fine-needle aspiration reached an area under the curve (AUC) of 92.10% (AUC1). A null AUC (AUC0) of 0.80 was employed as recommended by Hamilton.[9] According to Daniel and Cross, a minimum power of 80.00% was necessary to detect true relationships and reduce Type II errors to 20.00%. The same authors also suggested using a default alpha or significance level of 5.00% to identify significant results. By applying a sample allocation ratio of 1 to 1 alongside these parameters, two-tailed calculation determined that a total of 242 respondents was required. Therefore, the target sample size for this research consisted of 242 records.

Following research ethics committee approval, a link to an online personal assessment survey was created using Google Forms (Mountain View, CA, USA) Available from: *https://docs.google.com/forms. (Figure 1).* This survey evaluated the training exposure, self-reported confidence, and clinical utilization of ORL-HNS residents and alumni. Questionnaire items addressed demographic profile, instruction types received, and comfort level with basic ultrasound techniques.

An email invitation was sent to prospective participants. Those who responded with their consent received a link to the personal assessment form. Data were tabulated and compiled using Microsoft® Excel for Mac version 16.113.2 (Microsoft Corp, Redmond WA, USA).

In the second part of the study, a list of patients who received ultrasound-guided FNB/CNB biopsies for head and neck masses was compiled from the ENT Center census and the department's thyroid records and daily OR census. Records of those who underwent the ultrasound-guided FNB/CNB biopsy were reviewed in conjunction with those who had surgical interventions (excision of the mass, lobectomy/ total thyroidectomy, etc.). Information such as patient demographics, the procedure performed, the resident's year level, and cytology/ histopathology results were collected. All 246 biopsies included in

Personal Assessment Survey Form	
Questions	**Choices**
Resident Level/Alumni year	1st year to 4th year, Alumni 1 or 2*
On a scale of 1 to 5, how confident are you in using ultrasound equipment?	Rate from 1 to 5 (1: not confident – 5: extremely confident)
On a scale of 1 to 5, how comfortable are you in identifying the head and neck anatomy using an ultrasound?	Rate from 1 to 5 (1: not comfortable – 5: extremely comfortable)
On a scale of 1 to 5, how confident are you at diagnosing head and neck pathology using ultrasound?	Rate from 1 to 5 (1: not confident – 5: extremely confident)
Have you attended any head and neck ultrasound courses in the past?	Yes/No *If yes, how many times
Are you comfortable with your current knowledge regarding basic surgeon-performed ultrasound techniques in the head and neck?	Yes/No *If no give your reason
Number of years doing ultrasound-guided procedures (FNAB/core needle biopsy) for head and neck pathology.	Less than one year One to three years Three to five years More than five years
Estimate total number of ultrasound-guided procedures (FNAB/core needle biopsy) in the head and neck done during the total years of practice.	1-10, 11-20, 21-30, 31-40, 41-50 50 and above
For the resident trainee: "Do you intend to use ultrasound technology in your practice once you graduate?"	Yes/Maybe/No * If no give your reason
For the Alumni: Are you currently practicing surgeon-performed ultrasound or ultrasound-guided procedures in your practice?	Yes/No *If no, why?
Do you think formal training in using ultrasound would be useful for ENT-HNS residents?	Yes/Maybe/No

* Alumni 1 = 2022 graduates, Alumni 2 = 2021 graduates

Figure 1. Personal Assessment Survey Form

Part 2 were performed between 2021 and 2023, coinciding with the official initiation of surgeon-performed ultrasound in our department using portable systems. Biopsies categorized under 'alumni' reflect procedures performed by trainees while they were active residents during the study window prior to graduation: 'alumni 2' (2021 graduates) performed procedures as senior residents in 2021, while 'alumni 1' (2022 graduates) performed procedures as 3rd- and 4th-year residents across 2021–2022. Deidentified data was subjected to statistical analysis.

The statistical analyses were performed using STATA MP Parallel Edition Statistical Software, Version 18 (STATA Corp LLC, College Station TX, USA). A p-value ≤ .05 was considered statistically significant. Descriptive statistics included means and standard deviations for normally distributed, continuous data; medians and interquartile ranges for ordinal and non-normal, continuous data; and frequencies and percentages for categorical data. Data normality was tested using Shapiro-Wilk's test. Comparative analysis of the sample adequacy according to year level was conducted using chi-square test of homogeneity, while cross-tabulations between specimen adequacy status and cytological diagnostic categories were evaluated using descriptive frequencies and percentages.

For the secondary exploratory subgroup with available surgical histopathology (n = 53), the diagnostic performance of cytological yields in predicting malignancy was evaluated against final histopathology as the reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (+LR), negative likelihood ratio (-LR), and the area under the receiver operating characteristic curve (AUC-ROC) with 95% confidence intervals were calculated using STATA MP Version 18 (STATA Corp LLC, College Station TX, USA).

RESULTS

For the first part of the study, 16 ORL-HNS participants were included. Ten (10) of them were residents, and six were alumni.

Table 1 summarizes the survey responses of these 16 participants. Among the 10 resident participants surveyed, three each were first- and second-year residents, two each were third- and fourth-year residents. An additional six participants were alumni, yielding a total sample of 16 ORL-HNS physicians. The mean confidence in using ultrasound equipment was 4.06 (SD=0.93), while the mean comfort in identifying head and neck anatomy using ultrasound was 4.06 (SD=0.85). The mean confidence in diagnosing head and neck pathology using ultrasound was 3.63 (SD=0.96). A total of 13 (81.25%) had attended a course on ultrasound for the head and neck, with a median number of 2 courses (IQR = 1 to 3). The majority (14; 87.50%) felt comfortable with their knowledge of basic surgeon-performed ultrasound techniques for the head and neck, while only two (12.50%) were not too comfortable primarily due to the lack of experience or exposure to such procedures and the need for more courses. Among the residents, nine (90.00%) intended to use surgeon-performed ultrasound procedures, while all six alumni used the approach in their current practice (100.00%).

For the second part of the study, a total of 246 biopsy results were included. While overall Part 2 biopsy enrollment (N = 246) satisfied this sample size calculation for overall cohort estimation, the subgroup with surgical histopathological correlation (n = 53) did not meet the calculated ROC sample size target of 242 cases. The demographic and clinical characteristics of the patients from whom the biopsies were obtained are shown in *Table 2*. The median age was 47.50 years old (IQR = 32.50 to 59.00), and the majority were females (82.43%). Most participants had fine-needle aspiration biopsy (95.53%), particularly of the thyroid (73.98%). Most specimens were considered adequate in sampling (89.02%), and most specimens were considered benign upon cytology analyses (64.23%). The most common surgical intervention was total thyroidectomy (14.63%). Among the 53 surgically removed specimens sent for histopathology examination, 64.15% were confirmed to be malignant.

Table 3 illustrates sample adequacy after the ultrasound-guided procedure according to the year level of the ORL-HNS physician. The rate of sample adequacy ranged from 83.64% to 89.62% for first-year

Table 1. Descriptive Statistics among the Medical Doctor Participants (N = 16)

Characteristics	Mean (SD) or Median (IQR)	Frequency (f) (%)
Confidence in using Ultrasound Equipment ($\bar{x}$, SD)	4.06 (0.93)	
Comfort in Identifying Head and Neck Anatomy using Ultrasound ($\bar{x}$, SD)	4.06 (0.85)	
Confidence in Diagnosing Head and Neck Pathology using Ultrasound ($\bar{x}$, SD)	3.63 (0.96)	
Attended Head and Neck Ultrasound Courses (f, %)		
No		3 (18.75)
Yes		13 (81.25)
Number of Attended Head and Neck Ultrasound Courses (Md, IQR)	2 (1 – 3)	
Comfortable with Current Knowledge on Basic Surgeon-Performed Ultrasound Techniques in the Head and Neck		
No		2 (12.50)
Yes		14 (87.50)
Duration doing Ultrasound-Guided Procedures for Head and Neck Pathology ($\bar{x}$, SD)	2.13 (0.72)	
Number of Ultrasound-Guided Procedures in the Head and Neck during Medical Practice (Md, IQR)	3 (2 – 4)	
Intention to Use Ultrasound Technology in Practice (For Residents; f, %)		
No		0 (0.00)
Maybe		1 (10.00)
Yes		9 (90.00)
Currently Practicing Surgeon-Performed Ultrasound or Ultrasound-Guided Procedures (For Alumni)		
No		0 (0.00)
Maybe		0 (0.00)
Yes		6 (100.00)
Perception that Formal Training in Ultrasound would be Useful		
No		0 (0.00)
Yes		16 (100.00)

Table 2. Demographic and Clinical Characteristics of the Patient Participants (N = 246)

Characteristics	Median (IQR)	Frequency (*f*)	Percentage (%)
Age (Years; Md, IQR)	47.50 (32.50 – 59.00)		
Sex (f, %)			
Male		42	17.57
Female		197	82.43
Procedure (f, %)			
Core Needle Biopsy		11	4.47
Lymph Node Specimen		5	2.03
Thyroid Specimen		1	0.41
Other Specimen		5	2.03
Fine Needle Aspiration Biopsy (FNAB)		235	95.53
Lymph Node Specimen		16	6.50
Thyroid Specimen		182	73.98
Parotid Specimen		16	6.50
Submandibular Specimen		9	3.66
Other Specimen		12	4.88
Specimen Adequacy (f, %)			
Inadequate		27	10.98
Adequate		219	89.02
Year Level of Resident (f, %)			
First Year		27	10.98
Second Year		106	43.09
Third Year		55	22.36
Fourth Year		40	16.26
Alumni		18	7.32
Cytology Results (f, %)			
Benign		158	64.23
Atypical or Suspicious or Malignant		61	24.80
*Inadequate or Nondiagnostic**		27	10.98
Surgical Intervention (f, %)			
Excision of Mass or Gland		4	1.63
Lobectomy		5	2.03
Neck Dissection		3	1.22
Parotidectomy		5	2.03
Total Thyroidectomy		36	14.63
Histopathology Results (f, %; N = 53)			
Benign		19	35.85
Malignant		34	64.15

* Inadequate/nondiagnostic specimens (n=27, 10.98%) are presented as an independent procedural category to prevent false-negative misclassification. Overall procedural diagnostic yield was 89.02% (n=219).

to third-year residents, while fourth-year residents and alumni had a sample adequacy rate of 95.00% and 94.44%, respectively. However, the sample adequacy rates among the different levels of ORL-HNS physicians were not significantly different ($\chi 2=4.08$, $p=.421$).

The cross-tabulation of specimen adequacy status with cytological diagnostic categories (N=246) is presented in *Table 4*. Among the 219 adequate specimens (89.02%), cytological evaluation identified 158 benign diagnoses (72.15% of adequate samples) and 61 atypical, suspicious, or malignant diagnoses (27.85% of adequate samples). All 27 inadequate specimens (10.98%) consisted of non-diagnostic paucicellular material or cyst fluid only (Bethesda I). Retaining non-diagnostic specimens as an independent category demonstrated that specimen adequacy was a necessary procedural prerequisite for assigning a cytological diagnosis, avoiding artificial 2x2 groupings and false-negative misclassification.

Finally, as a secondary exploratory analysis, *Table 5 and Figure 2* present the diagnostic performance of cytological yields in predicting malignancy among the subset of 53 patients who underwent surgical

Table 3. Between-Group Comparisons of Sample Adequacy among the Patient Participants according to Year Level of Medical Doctor (N = 246)

Sample Adequacy	Medical Doctor Year Level					p-value (Two-Tailed)
	First Year	Second Year	Third Year	Fourth Year	Alumni	
Frequency	n (%)	n (%)	n (%)	n (%)	n (%)	
Inadequate	4 (14.81)	11 (10.38)	9 (16.36)	2 (5.00)	1 (5.56)	.421
Adequate	23 (85.19)	95 (89.62)	46 (83.64)	38 (95.00)	17 (94.44)	

*Significant at 0.05

Table 4. Association of Sample Adequacy from Ultrasound-Guided Procedure with Cytology Results among the Patient Participants (N = 246)

	Sample Adequacy (N = 246)	
	Inadequate	Adequate
Cytology Results (N = 246)	n (%)	n (%)
Benign	0 (0.00)	158 (72.15)
Atypia or Suspicious or Malignant	0 (0.00)	61 (27.85)
*Inadequate or Nondiagnostic**	27 (100.00)	0 (0.00)

*Inadequate specimens (n=27, 10.98%—comprising Bethesda I, paucicellular, or cyst fluid only) are maintained as a distinct non-diagnostic procedural category rather than being combined with benign results. Specimen adequacy represents a technical prerequisite for cytological interpretation.

Table 5. Diagnostic Capacity of Ultrasound-Guided Procedure Cytology Results
Analyses of the Diagnostic Capacity [Accuracy, Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Likelihood Ratios (LR)] of Ultrasound-Guided Procedure Cytology Results in Determining or Predicting Malignancy using Histopathology (Gold Standard) (N = 53)

Ultrasound-Guided Procedure Cytology Results	Histopathology (Gold Standard)		
	Positive (Malignant)	Negative (Benign)	Total
Positive (Suspicious of Malignancy or Malignant)	27 (79.41%)	8 (42.11%)	35
Negative (Benign)	7 (20.59%)	11 (57.89%)	18
Total	34	19	53
Accuracy (95% CI)	= 0.69 (0.55 – 0.82)		
Sensitivity (95% CI)	= 79.40% (62.10% – 91.30%)		
Specificity (95% CI)	= 57.90% (33.50% – 79.70%)		
Positive Predictive Value (95% CI)	= 77.10% (59.90% – 89.60%)		
Negative Predictive Value (95% CI)	= 61.10% (35.70% – 82.70%)		
Positive Likelihood Ratio (95% CI)	= 1.89 (1.08 – 3.28)		
Negative Likelihood Ratio (95% CI)	= 0.36 (0.17 – 0.76)		

intervention, using final histopathology as the reference standard. In this selected subgroup (which demonstrated a 64.15% histopathological malignancy rate), cytology results yielded an AUC-ROC of 0.69 (95% CI = 0.55 to 0.82), a sensitivity of 79.40%, and a specificity of 57.90%. These figures reflect the performance of the cytological diagnosis in surgically verified cases rather than the technical diagnostic accuracy of the ultrasound scan itself, and cannot be generalized to the overall unoperated cohort.

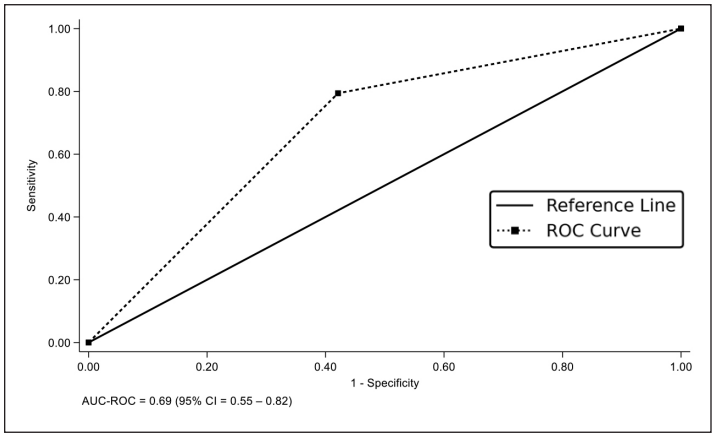


Figure 2. Area under the receiver operating characteristic curve (AUC-ROC) for cytology results

DISCUSSION

This study aimed to describe our single-institution experience with surgeon-performed ultrasound training among ORL-HNS residents and alumni and to evaluate procedural outcomes, specifically specimen adequacy. The first part of the study demonstrated a generally high level of self-reported confidence among participants, with mean confidence in equipment operation and anatomic identification rated at 4.06 (SD=0.93 and SD=0.85, respectively). While self-reported confidence reflects perceived self-efficacy and familiarity with basic ultrasound techniques, it represents a subjective self-assessment rather than an objective verification of clinical proficiency. Nevertheless, this level of confidence aligns with prior research that suggests structured ultrasound training can significantly enhance practitioners' proficiency.[7,10] The high percentage (81.25%) of participants who had attended at least one course on ultrasound emphasizes the value of continuing education in supporting trainee confidence and procedural familiarity in this area.[7,10-12]

Among the participants, only 12.50% reported lack of confidence with their ultrasound knowledge, primarily due to limited exposure. This highlights a critical gap in hands-on training opportunities, which is echoed in the literature, where authors have noted that practical experience is a major determinant of confidence and skill in performing ultrasound.[7,11,13] To address this, procedural performance by junior residents (first and second year) is conducted under a structured supervisory framework: biopsies performed by junior trainees are directly supervised by attending consultants or senior residents to ensure procedural quality and patient safety. Notably, first-year residents achieved an 85.19% specimen adequacy rate, which did not differ significantly from more senior trainees. These results suggest that the institution's combination of formal training and direct supervision may contribute to minimizing differences in procedural adequacy

across residency levels, helping support consistent sample yields even during the earlier stages of training.

The 90% intent among residents and 100% usage among alumni reflect a successful local integration of ultrasound into clinical practice. This trend is in line with recent trends in surgical training, where ultrasound is increasingly recognized as a vital tool for real-time imaging in procedures like head and neck mass biopsies. To support this integration, our Department of Otorhinolaryngology–Head and Neck Surgery (ORL-HNS) of the University of Santo Tomas Hospital has actively organized and conducted ultrasound lectures, hands-on workshops, and in-house training since 2015, featuring a multi-modal curriculum that combines hands-on mentorship and bedside experience with ultrasound-guided procedures. The training program that residents participate in consists of a set of lectures on ultrasound neck anatomy, ultrasound physics and artifacts, practical knobology, techniques in ultrasound-guided (USG) fine needle biopsy (FNB) and core needle biopsy (CNB) with demonstration and return demonstration of skills in ultrasound transducer handling and knob adjustment, ultrasound identification of neck anatomy in a volunteer subject, and USG FNB and CNB of an olive-and-meat model. Residents also benefit from guided instruction during pre-operative or pre-procedural assessment of patients with neck masses and for whom they are oftentimes tasked with performing biopsies during their rotation at our ENT Center. All program components emphasize the application of ultrasound in the head and neck, ensuring our medical staff and trainees gain the essential skills and knowledge needed to effectively use this diagnostic tool in clinical practice. When viewed alongside the growing popularity of ultrasound technology in Philippine otorhinolaryngology, these findings suggest that structured institutional training is successfully fostering a new standard of care, helping to fill the current gap created by the lack of a uniform national ultrasound curriculum.

In the second part of the study, a total of 246 patients were included, revealing a median age of 47.50 years and a predominantly female demographic (82.43%). The high proportion of fine-needle aspiration biopsies (95.53%), particularly for the thyroid (73.98%), reflects common clinical practice patterns and reinforces the relevance of ultrasound guidance in these procedures.[14-17] The analysis revealed that the majority of specimens were adequate for cytological analysis (89.02%), suggesting the effectiveness of ultrasound guidance in obtaining high-quality samples, which is consistent with existing research on the efficacy of ultrasound-guided FNA in head and neck surgery.[17-18] In terms of clinical outcomes, cytology identified a majority of specimens as benign (64.23%). Among the subset of 53 patients who underwent surgical intervention, (most frequently total thyroidectomy in 36; 14.63%), final histopathological analysis confirmed malignancy in 34 (64.15%). Inadequate or non-diagnostic specimens accounted for 27 (10.98%), consisting primarily of Bethesda I paucicellular samples or cyst fluid. Reporting non-diagnostic specimens as an independent category rather than combining them with benign results avoids misclassification bias and accurately reflects the role of ultrasound guidance in securing the sufficient cellular yield necessary for definitive pathological evaluation.

As a secondary exploratory outcome, we evaluated the diagnostic performance of cytological results against surgical histopathology in the 53 patients who underwent surgical intervention. While ultrasound guidance facilitated the harvest of adequate cellular material, the diagnostic performance of the resulting cytological interpretation demonstrated an AUC-ROC of 0.69 (95% CI = 0.55 to 0.82), with 79.40% sensitivity and 57.90% specificity. These metrics reflect the inherent diagnostic challenges of cytological interpretation in head and neck pathology rather than the technical execution of the ultrasound-guided procedure.

The comparative analysis of sample adequacy across different levels of ORL-HNS participants (from 1st year to alumni) showed that residents in their later years (4th year residents) and alumni had higher sample adequacy rates (94.44% to 95%), although these differences were not statistically significant. Crucially, the similar specimen adequacy rates across residency levels should not be interpreted as equivalent individual operator competency. Because junior trainees perform biopsies under direct supervision from attending staff and senior residents, these findings may reflect the effectiveness of a supervised training framework and standardized procedural protocols in maintaining high diagnostic yields. Moreover, because residency year level served as a structural surrogate for overall training stage rather than an individual log of procedural volume or technical skill, similar sample yields across cohorts demonstrate institutional procedural safety and reliability rather than equal operator proficiency.[10-11]

Our findings showed the importance of continued training and exposure to ultrasound-guided procedures in residency programs. While ORL-HNS residents and alumni generally report confidence in performing basic ultrasound techniques, advanced diagnostic and procedural skills, especially those required for accurate pathology diagnoses, may benefit from additional focused training and mentorship. Given that the study participants demonstrated strong intentions to integrate ultrasound into their practice, further investment in hands-on ultrasound training, coupled with supervised clinical practice, may help support trainee confidence and procedural yields.

Our study is subject to several limitations; one significant limitation being the relatively small sample size for each year level. This constraint arises from the fact that the surgeon-performed ultrasound-guided procedures with the use of a portable ultrasound system within the department of our institution were only initiated in 2021, which restricts the available data for analysis and may affect the generalizability of our findings. To address the limitation of the relatively small sample size for each year level in our study, it is recommended that future

research efforts focus on expanding the data collection timeframe. By continuing to gather data on surgeon-performed ultrasound-guided procedures over the coming years, we can increase the sample size and enhance the validity of our findings. Additionally, collaborating with other institutions that perform similar procedures could help increase data, thereby improving the generalizability of the results. Implementing a multi-center approach may also provide broader insights and strengthen the overall conclusions of future studies.

Another limitation of our study is the lack of pre-procedural and/or pre-operative ultrasound findings. To enhance the robustness of the results, future studies should prioritize including comprehensive pre-procedural and/or pre-operative ultrasound findings, including mass echogenicity, margin regularity, and vascularity patterns; as these features provide the critical clinical context necessary to interpret biopsy outcomes. Furthermore, such data would facilitate a more granular assessment of the clinician's learning curve in both the interpretation of findings and the technical execution of the procedure within this user-dependent modality.

Additionally, our secondary analysis of cytological diagnostic performance is limited by the small subgroup size (n=53) and inherent selection bias, as histopathological confirmation was only available for patients who met clinical or cytological criteria for surgical intervention. Patients managed conservatively without surgery lacked histopathological correlation, which may influence the observed sensitivity and specificity. Consequently, these exploratory diagnostic parameters evaluate cytological yield in a high-prevalence surgical subset and should not be generalized to the broader biopsy population or interpreted as an index of ultrasound imaging accuracy. Additionally, the n = 53 surgical subgroup did not reach the calculated ROC sample size target of 242 cases, limiting statistical power and resulting in wider 95% confidence intervals (0.55 to 0.82).

Moreover, Part 1 of this study relied on self-administered survey data regarding confidence and utilization. Self-reported metrics are inherently subjective and susceptible to recall or social desirability bias; they reflect perceived comfort and career integration rather than objective, standardized evaluations of procedural proficiency or diagnostic competence (e.g., direct observation of procedural skills or practical examinations). Future educational evaluations should incorporate objective competency assessment tools alongside survey metrics.

Lastly, to enhance patient documentation and data integrity, the investigators suggest creating a digitalized form or an electronic medical record (EMR) system. This system should consist of user-friendly digital forms that are easily accessible and can be updated in real-time.

In conclusion, this study demonstrates that integrating surgeon-performed ultrasound into an ORL-HNS residency training program is feasible. Part 1 highlights strong trainee engagement, high confidence in basic diagnostic applications, and 100% clinical adoption among alumni in independent practice. Part 2 confirms reliable procedural outcomes, with an overall specimen adequacy rate of 89.02% maintained across all training levels under direct supervision. Although our secondary analysis was limited by a small surgically correlated cohort (n = 53), future prospective studies recruiting larger cohorts (N ≥ 242) to achieve the calculated ROC sample size target will be valuable for definitive diagnostic performance validation. Ultimately, these findings demonstrate that structured ultrasound instruction equips head and neck surgical trainees with high procedural confidence and high procedural yield, supporting its formal incorporation into standardized otolaryngology residency curricula.

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