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Diagnostic Accuracy of Fine Needle Aspiration Cytology (FNAC) in Diagnosis of Solitary Thyroid Nodules Taking Histopathology as Gold Standard

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ABSTRACT

Background: Solitary thyroid nodules (STNs) often present in the medical field of otorhinolaryngology. The key to appropriate management is to establish a difference between benign and malignant nodules. FNAC is a first-line test, which is minimally invasive and cost-effective but its accuracy may vary, and histopathology should be compared with it.

Purpose: To assess the diagnosis accuracy of FNAC of solitary thyroid nodule, based on the gold standard of histopathology.

Methods: The study was a cross-sectional study conducted in the Department of ENT, Postgraduate Medical Institute (PGMI) of Shaikh Zayed Hospital, Lahore, in 5 December 2021 and 5 June 2022. 286 patients without any secondary thyroid nodules were recruited. They all went through FNAC and underwent surgery and histopathology of the specimen. FNAC findings were also compared with histology to determine sensitivity, specificity, PPV, NPV, and accuracy in general.

Results: Out of the 286 respondents, 152 (53.1%) were between the ages of 12-40 and 134 (46.9) were between the ages of 41-80; mean age was 39.3 +/-.105 years. Men comprised 41.6% (119) and women 58.4% (167). FNAC was found to give an accuracy of 87.4% sensitivity of 86.1, specificity of 90.6 and PPV of 87.4.

Conclusion: FNAC is a sensitive, specific and a true method of assessment of solitary thyroid nodules. It also aptly distinguishes between benign and malignant lesions providing proper surgical management and minimizing unnecessary surgeries.

Keywords: *Fine Needle Aspiration Cytology, Solitary Thyroid Nodule, Histopathology, Diagnostic Accuracy, Thyroid Neoplasm, Cross-sectional Study*

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1. INTRODUCTION

The thyroid gland is considered among the most important endocrine glands in the human body, which controls metabolism, growth and development through the release of thyroid hormones. The thyroid disorders are prevalent across the globe and amongst these, a solitary thyroid nodule (STN) is one of the most common clinical issues. A solitary thyroid nodule is simply a specific swelling of an otherwise normal thyroid gland which is clinically or radiologically identifiable in relation to the rest of the parenchyma [1]. The frequency of solitary thyroid nodules is geographically and demographically distinct,

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and is more dominant in women and populations with a deficiency in iodine. Though majority of the nodules are benign, a

minor percentage of 5-15 percent is malignant, and this requires proper and early diagnosis in order to be dealt with properly.

The assessment of solitary thyroid nodules has changed over the years significantly. Supportive data is obtained by clinical examination and imaging modalities (e.g., ultrasonography), and none of them alone can clearly distinguish between benign and malignant lesions. FNAC has thus become an easy, harmless, least invasive and cheap diagnostic test of preoperative thyroid nodules [2]. The method involves the removal of cellular material with the help of a fine needle to be studied under a microscope. FNAC has become highly acceptable since it is possible to complete the procedure in an outpatient setting, has a small number of equipment requirements, and the results are quick to obtain with not many complications [3].

FNAC is a critically vital device to be used during the first-line triage of thyroid nodule patients. It assists clinicians in determining whether or not surgery is necessary and, in that case the amount of surgery necessary. Making the right cytological diagnosis would avert surgical interventions in benign cases and encourage early surgical response in malignant cases. In spite of these numerous benefits, FNAC has shortcomings [4]. False-negative or false-positive results can be caused by sampling errors, cystic degeneration and overlapping cytological appearances between follicular adenomas and carcinomas. Hence, as much as FNAC is a valid first-line testing, its results are supposed to be supported by histopathological examination, which is the gold standard of conclusive diagnosis.

The use of histopathology, which involves the microscopic analysis of tissue that has been surgically excised, furnishes accurate architectural and cytological information, which is mandatory to use in making definitive diagnosis and categorization of thyroid lesions [5]. It is essential in separating benign and malign neoplasma of follicles, which cannot be assured with FNAC. As a result, to identify the diagnostic accuracy, sensitivity, specificity and predictive values of FNAC in assessing solitary thyroid nodules, the comparisons between the cytological and histopathological results are mandatory.

A number of studies conducted in other areas have shown that the rates of accuracy of FNAC are variable and depend on the skill of the operator, sufficiency of the aspirated sample, and the interpretive capabilities of the cytopathologist [6]. However, FNAC has always been considered as a priceless screening exam, minimizing the quantity of unnecessary surgery on the thyroid and also allowing the malignant to be detected early.

Considering all these, the diagnostic accuracy of FNAC in a particular clinical and geographical setting should be evaluated using histopathology as the gold standard. Such assessment is not only important in the validation of the local diagnostic quality of FNAC but also in areas where the advancement of the sampling and the interpretation methods should be enhanced [7]. Thus, the current research has been carried out to ascertain the diagnostic effectiveness of FNAC in diagnosing the solitary thyroid nodules, histopathological findings have been used as the gold standard, to evaluate its sensitivity, specificity, positive predictive value, negative predictive value and the overall accuracy in relation to the final histopathological findings [8].

2. MATERIALS AND METHODS

The study was done in the ENT Department, Postgraduate Medical Institute (PGMI), Shaikh Zayed Hospital, Lahore, in a duration of six months between 5 0 December 2021, and 5 June 2022. The objective was to establish the diagnostic accuracy of Fine Needle Aspiration Cytology (FNAC) in solitary thyroid nodules (STNs) and as such was compared to the gold standard of histopathology.

A total of 286 patients that presented to the ENT outpatient department with clinically palpable solitary nodules of thyroid were included in the study population. All men and women between the ages of 20 and 70 years were eligible. Diffuse goiter, recurring thyroid swelling, history of thyroid surgery, inability to undergo thyroid surgery, or unwillingness to have the histopathologic examination were our exclusion criteria.

Prior to the study, all participants were informed on the purpose of the study and provided informed consent in writing. An elaborate clinical history was established, the length of the swelling, including the presence of pain, dysphagia, hoarseness, rapid swelling, and family or radiation exposure. An overall head-neck examination was done to evaluate nodule size, consistency, mobility and lymphadenopathy.

FNAC was conducted using a 22 or 23 gauge needle with a 10ml disposable syringe under an aseptic condition. Repeat sampling provided satisfactory sampling. A smear was placed on the slides, fixed immediately in 95 0 ethanol, and stained with Papanicolaou and Hematoxylin -and-Eosin (H&E). Cytology was categorized as per the Bethesda System: non - diagnostic, benign, atypia/follicular lesion of undetermined significance (AUS/FLUS), follicular neoplasm or suspicious of follicular neoplasm, suspicious of malignancy, and malignant.

Surgical excision was then performed on all patients either lobectomy or total thyroidectomy depending on clinical and cytological results. The histopathology team examined the specimens microscopically on the conventional staining of H&E which gave the final diagnosis.

The findings of FNAC were contrasted with histopathology. The sensibility, specificity, positive predictive value (PPV),

the negative predictive value (NPV), and the general diagnostic accuracy were computed. Any discordant cases were collectively examined by a cytopathologist and a histopathologist to determine the cause like poor sampling or similar cytological phenotypes.

The SPSS version 25 was used to enter and analyze the data. Quantitative variables such as age were stated in mean plus standard deviation; qualitative variables such as gender, cytological diagnosis as well as histopathological diagnosis were in frequencies as well as percentages. FNAC and histopathology results were compared by cross-tabulating and diagnostic indices were obtained in the form of 2 x 2 contingency tables.

The Institutional Review Board of PGMI, Shaikh Zayed Hospital, Lahore approved the ethical choice. All the procedures were ethically sound, and the Helsinki Declaration, and patients' information was kept confidential.

3. RESULTS

This was a study with 286 participants of solitary thyroid nodules and all of them underwent FNAC and proceeded to surgical excision and histopathological analysis which is the gold standard in final diagnosis. The main goal was to determine the accuracy of FNAC in the differentiation of malignant and benign thyroid nodules.

Table 1: Distribution of Cases According to FNAC and Histopathological Findings (n = 286).

Diagnosis Type	FNAC Findings (n)	Percentage (%)	Histopathology Findings (n)	Percentage (%)
Benign lesions	228	79.7%	220	76.9%
Malignant lesions	58	20.3%	66	23.1%
Total	286	100%	286	100%

Table 2: Comparison of FNAC with Histopathology Results (n = 286)

FNAC Result	Histopathology Positive (Malignant)	Histopathology Negative (Benign)	Total
Positive (Malignant)	60 (True Positive)	4 (False Positive)	64
Negative (Benign)	6 (False Negative)	216 (True Negative)	222
Total	66	220	286

Statistical Analysis

Sensitivity: (TP / [TP + FN]) × 100 = (60 / [60 + 6]) × 100 = 90.9%

Specificity: (TN / [TN + FP]) × 100 = (216 / [216 + 4]) × 100 = 98.2%

Positive Predictive Value (PPV): (TP / [TP + FP]) × 100 = (60 / [60 + 4]) × 100 = 93.8%

Negative Predictive Value (NPV): (TN / [TN + FN]) × 100 = (216 / [216 + 6]) × 100 = 97.3%

Diagnostic Accuracy: ((TP + TN) / Total) × 100 = ((60 + 216) / 286) × 100 = 96.2%

The current research established that the use of fine-needle aspiration cytology (FNAC) was a stable, easy, and economical test to evaluate single nodules in the thyroid glands. Of 286 cases, FNAC determined 228 (79.7) cases as benign and 58 (20.3) as malignant. This was confirmed by histopathology of 220 benign and 66 malignant lesions (76.9 and 23.1 respectively). The minor variations in the two techniques indicate that FNAC was rather underestimating malignancies.

In Table2, the cross-tabulation of FNAC with histopathology is presented. Among the 66 malignant cases that were successfully tested by histology, FNAC had 60 true positives and was zero false negative. FNAC correctly identified 216 of 220 of the cases (true negatives) and false positives were 4 out of 220 cases (false positives).

The sensitivity was 90.9 per cent, and it implies that FNAC was able to detect most of the malignant lesions, but some of the malignant lesions were missed by sampling or interpretative limits. FNAC had a specificity of 98.2 per cent, which shows that it has a high aptitude in the accurate diagnosis of benign lesion and consequently decrease unnecessary surgery. The positive predictive value stood at 93.8 per cent and negative predictive value was 97.3 per cent and this indicates high

reliability of the results of FNAC when compared with the gold standard.

With a total diagnostic accuracy of 96.2% this indicates that FNAC is virtually in line with the histopathological findings.

False-negative cases consisted of mostly follicular carcinomas, in which there is a problem of differentiating benign and malignant follicular patterns on cytology. False-positive cases were uncommon and normally to atypia in benign nodules, e.g. Hashimoto thyroiditis or adenomatous hyperplasia.

4. DISCUSSION

This paper compared the diagnostic reliability of Fine Needle Aspiration Cytology (FNAC) with solitary thyroid nodules compared to the gold standard method, which is histopathology. FNAC was found to be dependable, affordable and least invasive to start with. The accuracy, sensitivity, specificity, and predictive values were similar to other previous studies and indicated the usefulness of FNAC in the differentiation of both benign and malignant lesions.

FNAC was highly sensitive and specific, and could identify the true positives and negatives. These findings were consistent with Gupta et al. (2013) and Baloch et al. (2018) who had comparable accuracy. It is also the best tool to use in preoperative assessment as it is less invasive and avoids time, allowing clinicians to make the right management decisions.

Benign nodules predominantly colloid nodules and nodular goiters were the most prevalent cytological diagnosis and aligned with histopathology. It correlates with the finding of Mondal et al. (2016) and Al-Abbadi et al. (2017), who as well detected the majority of nodules as benign ones. Malignancy lesions were less frequent yet correctly diagnosed and showed that FNAC had high values in identifying malignant cancers like papillary and follicular carcinoma.

There were certain differences between FNAC and histopathology. The false negatives and positives are probably caused by the sampling errors, low cellular yield, or impossibility of the interpretation, particularly in follicular neoplasms. FNAC, as a single method, will not be able to differentiate between follicular adenoma and carcinoma; malignancy must have evidence of capsular or vascular infiltration, which is determined only through histopathology. As Bagga and Mahajan (2010) noted, FNAC is a very good screening method but histopathology is required in borderline cases to make a definite diagnosis.

The Bethesda System of Reporting Thyroid Cytopathology (BSRTC) enabled the standardisation of FNAC reporting, enhanced inter-observer reliability, and enhanced cytopathology-clinician communication. BSRTC in this study enabled improved diagnosis and reduced unclear or inconclusive reports. Better consistency and direction of management were also in support of the BSRTC by Cibas and Ali (2017).

In spite of the few drawbacks, FNAC minimized unnecessary surgical operations by precisely diagnosing benign lesions, which minimized morbidity and costs of health care in patients. The negative predictive value was high which meant that patients who had benign FNAC outcome could be under conservative management with frequent follow-ups and ultrasound monitoring.

To conclude, FNAC was found to be very accurate, safe and useful in assessing lone thyroid nodules. The histopathology is conclusive, but FNAC gives crucial preoperative data upon which clinical decisions are made. The findings support the significance of FNAC as a primary solution, particularly in the conditions of the resource scarcity when simplicity, affordability, and dependability of the method become essential. Further advancements in sampling and interpretation will also increase its diagnostic performance and clinical usefulness.

5. CONCLUSION

The current research came to the conclusion that Fine Needle Aspiration Cytology (FNAC) is a useful, accurate, and least invasive diagnostic method of assessing solitary nodules of the thyroid when it is compared to the histopathology, as the latter is a golden rod. FNAC has a high sensitivity, specificity, and overall diagnostic accuracy to differentiate benign and malignant thyroid lesion. The statistical significance between the FNAC and the histopathological results is significant and it means that FNAC is a valuable pre-operative information which assists in the proper clinical management. Despite some limitations being evident (including sampling and interpretational errors), the general efficiency of the FNAC method to decrease unwarranted surgical procedures is impressive. Thus, the FNAC still plays a significant role as a first-line diagnostic tool in solitary thyroid nodules and it guarantees early cost-effective diagnosis and reduces patient morbidity, and enhances therapeutic decision-making.

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