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The precision of ultrasonography and fine needle aspiration cytology in the evaluation of thyroid nodules in correlation with histopathology: A retrospective study

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***Abstract*---**Background and Objectives: The incidence of palpable thyroid nodules is approximately 4%–7% in the population. Most thyroid nodules are benign in nature but malignancy should be ruled out, which is quite less frequent. In such cases, a reliable diagnostic modality to evaluate and differentiate the malignant thyroid nodules is required. This retrospective study was conducted with the objective to evaluate the accuracy of Fine Needle Aspiration Cytology (FNAC) and Ultrasonography (USG) for diagnosis of euthyroid nodules & to differentiate malignant thyroid nodules from the benign nodules in comparison to histopathological diagnosis. Materials and Methodology: It's a retrospective study that included 132 patients who underwent USG and FNAC of thyroid nodules. Only patients with available histopathology were included in the study. The results of USG, FNAC were evaluated and correlated with histopathology report considered as the final diagnosis. Results: Out of 132 patients, USG showed benign lesions in 107(81.06%) patients, out of which histopathology showed benign lesions in 103 (96.26%) patients and malignant lesions in 4 (3.74%) patients. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false-

positive rate, false-negative rate and accuracy of USG of thyroid lesions were 78.95%, 91.15%, 60%, 96.26%, 8.85%, 21.05%, 89.39% respectively. FNAC diagnosis was recorded as per the Bethesda System. Out of 132 patients, FNAC was nondiagnostic/ unsatisfactory due to scanty cellularity in 4(3.03%) patients. Benign nodules were seen in 81(61.36%) patients. On histopathology examination, benign and malignant nodules were seen in 113 (85.60%) and 19 (14.39%) patients respectively. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false-positive rate, false negative rate and accuracy for FNAC was 89.47 %, 73.45 %, 36.96 %, 97.65 %, 26.55 %, 10.53 %, 75.76% respectively. USG and FNAC findings were strongly associated (p-value <0.001). Conclusion: The overall accuracy of USG and FNAC was acceptable in our study in correlation with the previous studies reported in the literature. USG and FNAC are the accurate modalities for the assessment of thyroid nodule variants. The combination of these modalities upsurges the accurateness to rule out malignant nodules so as to decrease the number of avoidable surgeries for benign lesions.

***Keywords*---**thyroid nodule, fine needle aspiration, thyroid ultrasound, thyroid cancer, goiter, accuracy.

Introduction

Thyroid nodules (TNs) are presented commonly in surgical practice. The prevalence of palpable thyroid nodules is 4-7 % in the adult population. The incidence of thyroid nodules discovered incidentally by USG is up to 10-41%. [1], [2] The risk of thyroid malignancy is approximately 7-15 % in thyroid nodules which should be ruled out excluded for a better treatment plan and prognosis. [3] USG and FNAC are the common diagnostic modalities with ease of availability modalities for preoperative diagnosis. Real-time grayscale high-resolution ultrasonography is the foremost and first-line imaging modality for assessing thyroid nodules. The USG and Doppler USG are reliable components for assessing and distinguishing benign and malignant thyroid nodules.[4]

The TRIADS-Thyroid imaging recording and data system is used for classifying thyroid nodules, first proposed by Horvath et al in 2009, later modified by Kwak JY et al.[5],[6] USG can distinguish between benign and malignant TNs based on features such as a solid or mixed solid-cystic lesion, a hypoechoic or non-haloed lesion, or a lesion with stiffer elastic properties.[7] Fine-needle aspiration cytology (FNAC) is a quick, low-cost, and straightforward method of evaluating TNs for malignancy. There are recommendations for performing FNAC in thyroid nodules based on sonological features.[8]

According to recent guidelines, thyroid cytopathology is classified using the Bethesda classification, The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC).[9] Ultrasound in addition to clinical examination and FNAC can be most helpful in the diagnosis of thyroid nodules. There are a few predictive methods for evaluating thyroid nodules to rule out malignancies based

on clinical features (patient size, age, and gender) combined with USG and FNAC.[10],[11] This study was conducted to assess the efficacy of USG and FNAC in the preoperative diagnosis of thyroid nodules and differentiating benign from malignant thyroid nodules in comparison with histopathological diagnosis.

Materials and Methodology

This was a retrospective observational study conducted at Al-Ahli Hospital Doha, which included 150 patients with nodular goiter. The study was conducted over a period of 3 years from Jan 2017 to Jan 2020.The clinical data and demographic features were collected according to the protocols. As it was a retrospective chart review, patients were identified and the need for informed consent was waived. Ethical approval was taken from the hospital ethical committee. All the patient data was collected with the investigations done as per the protocol with Thyroid profile, Ultrasound of the neck (USG) with USG guided Fine Needle Aspiration Cytology (FNAC). Patients with the histopathological diagnosis were included in the study.

Out of 150 patients, 18 patients were excluded due to abnormal thyroid profile, unavailability of records/histopathology results, those operated with the past history of thyroid malignancy or with the previous history of thyroid surgery. Assessment of thyroid nodules for consistency (solid/cystic/mixed), nodule size, margins, echo texture, presence of halo, calcification, or vascularity on Color Doppler study was done using USG. The lesions were categorized into benign, suspicious, and malignant.

The ultrasound-guided FNAC was performed as per the recommended guidelines using a 23 G needle with a 20-cc syringe. The FNAC results were reported as per Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) which included the following grades: -

- Bethesda I-Non diagnostic / unsatisfactory
- Bethesda II-Benign
- Bethesda III- AUS / FLUS (AUS / FLUS- Atypia of undetermined significance/follicular lesion of undetermined significance.)
- Bethesda IV-Follicular neoplasm / Suspicious of neoplasm
- Bethesda V- Suspicious for malignancy
- Bethesda VI-Malignant

Hemi thyroidectomies/Total/Near total thyroidectomies were performed as per the indications after the evaluation of all the investigations based on American Thyroid Association guidelines.[12] The sensitivity, specificity, positive and negative predictive values, and accuracy of USG and FNAC findings were evaluated by correlating them with histopathology. All suspicious lesions in USG were included in the malignant category for statistical analysis because they are considered malignant in management unless proven otherwise. In addition, in the FNAC diagnosis analysis, all lesions reported as AUS / FLUS (Atypia of undetermined significance/follicular lesion of undetermined significance), Follicular neoplasm / Suspicious of neoplasm / malignancy were included in the malignant group because they are typically treated as malignant.

Patients were categorized as:

- True negative (TN) - Cases with benign FNAC / USG and benign Histopathology.
- True Positive (TP) - Suspicious lesions on USG or FNAC with Follicular neoplasm / suspicious for Follicular neoplasm / suspicious for malignancy and malignant cases confirmed on Histopathology.
- False Positive (FP) - Cases with Suspicious lesions on USG or FNAC result of Follicular neoplasm / Suspicious of neoplasm / malignancy, but benign on Histopathology.
- False negative (FN)-Cases benign on USG / FNAC but malignant on Histopathology.

The following formulae were used to calculate the diagnostic performance:

Sensitivity = TP/ (TP + FN)
Specificity = TN/ (TN + FP)
PPV = TP/ (TP + FP)
NPV = TN/ (TN + FN)
False positive rate = FP/ (FP + TN)
False negative rate = FN/ (FN + TP)
Accuracy = (TP + TN)/ (TP + TN + FP + FN)

Statistical analysis

Obtained data were entered in MS Excel software and analyzed using STATA/MP-13 software. Frequency and percentage were obtained for categorical data. Sensitivity, Specificity, PPV, NPV, FP Rate, FN Rate, and Accuracy were calculated for USG and FNAC (Considering Histopathological Diagnosis as gold standard). A Chi-square test was obtained to check the association between Histopathological diagnosis with USG and FNAC. Statistical significance was set at 5% level.

Results

In this study, 132 patients were included out of which 111(84.09%) were females and 21(15.90%) were males. The age group ranged from 15-70 years, with average age groups 31- 40 years (28.79%), 21-30 years (23.48%), and 41-50 years (22. 73%) as shown in [Table 1]. All the patients were subjected to USG and FNAC and the results were correlated with the histopathological findings. Depending upon the ultrasound characteristics of thyroid nodules they were categorized as benign, suspicious, and malignant as shown in [Table 2].

Out of 132 patients, USG has reported benign lesions in 107(81.06%) patients viz. colloid goiter, multinodular goiter (MNG), and cystic nodules. Thyroid nodules showing ill-defined margins, hypo-echogenicity, and increased vascularity were labeled as suspicious nodules, detected in 14 (10.60%) patients. Highly Suspicious TNs showing marked hypo-echogenicity, irregular margins, and micro calcifications were seen in 11(8.33%) patients.

FNAC diagnosis was recorded with the help of Bethesda System. Out of 132 patients, FNAC was nondiagnostic / unsatisfactory due to scanty cellularity in 4 (3.03%) patients. Benign nodules were seen in 81 (61.36%) patients. The distribution of patients according to cytological diagnosis by FNAC is shown in [Table 3]. FNAC has shown suspicion for malignancy and malignant in 7 (5.30%) and 9 (6.81%) patients respectively. All were the type of papillary carcinoma of the thyroid.

All the operative specimens were subjected for histopathological examinations and histopathology reports were evaluated for variations as shown in [Table 4]. Out of 132 histopathology reports, benign and malignant tumors were seen in 113 (85.60%) and 19 (14.39%) patients respectively. The most common benign lesion was colloid nodular goiter as seen in 83 (62.88%) patients and the most common malignant lesion was papillary carcinoma as seen in 12 (9.09%) patients. USG has shown benign lesions in 107 (81.06%) patients, out of which histopathology has shown benign lesions in 103 (96.26%) patients and malignant lesions in 4 (3.74%) patients. 2 lesions were reported as colloid nodules and other 2 lesions were multinodular goiter. One cystic nodule turned out to be papillary carcinoma on histopathology. USG correlation with histopathological diagnosis along with true and false positivity and negativity rate is as shown in [Table 5].

14 (10.60%) patients showed mildly/moderately suspicious nodules, eight (57.14%) patients showed benign tumor and six (42.86%) patients had malignancy (three papillary carcinomas, two follicular variants of papillary carcinoma, and one follicular carcinoma). Highly suspicious nodules were seen in 11 (8.33%) patients, out of which two (18.18%) had a benign tumor and nine (81.82%) patients had malignancy (five papillary carcinomas, one follicular variant of papillary carcinoma, and three follicular carcinomas).

For statistical analysis, mild, moderate, and highly suspicious cases were considered as malignant as they were treated like malignancy. For USG True Positive, True Negative, False Positive, and False Negative were 15 (60 %), 103 (96.26%), 10 (40%), and four (3.74%) cases respectively. Table 6 shows the correlation of FNAC diagnosis with histopathological diagnosis. Seven patients (5.30%) showed TNs suspicious for malignancy in FNAC, out of which four, two, and one were papillary carcinoma, follicular adenoma, and colloid nodular goiter respectively on the final histopathology report.

Nine (6.81%) patients showed malignant TNs in FNAC, out of which 6were papillary carcinoma, one follicular adenoma, one follicular carcinoma, and one follicular variant of papillary carcinoma on histopathology analysis. FNAC-Histopathological correlation with true and false positivity and negativity rate is shown in [Table 7].

For statistical analysis, non-diagnostic/unsatisfactory lesions were grouped together with benign lesions. 85 (64.39 %) patients showed benign lesions on FNAC, 83 (97.64%) patients and two patients (2.35%) showed benign lesion (true negative) and malignant lesions (false negative) respectively on histopathology. One case showed papillary carcinoma and the other was a follicular variant of papillary carcinoma. 38 (28.79%) patients showed atypia of undetermined

significance follicular lesion of undetermined significance (AUS / FLUS) plus suspicious lesions like neoplasm/Malignant, 29 (76.32%) were benign (false positive) and nine (23.68%) were malignant (true positive) out of which five were papillary carcinoma, one was a follicular variant of papillary carcinoma and three were follicular carcinoma. Out of nine (6.82%) patients, malignant cases in FNAC were reported as papillary carcinoma, eight (88.89%) cases were positive for papillary carcinoma (true positive), but one case was benign (11.11%) false positive.

The statistical values of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false-positive rate, false-negative rate, and accuracy are shown in [Table 8]. In this study the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false positive rate, false negative rate and accuracy of USG of thyroid lesions were 78.95%, 91.15%,60%, 96.26%, 8.85%, 21.05%, 89.39% respectively and the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false positive rate, false negative rate and accuracy for FNAC were 89.47%, 73.45%, 36.96%, 97.65%, 26.55%, 10.53%, 75.76% respectively.

Table 1: Age and gender wise distribution of the patients

Gender	11-20y	21-30 y	31-40 y	41-50 y	51-60 y	61-70 y	Total (%) [n=132]
Female	7	26	32	27	14	5	111(84.09)
Male	2	5	6	3	2	3	21(15.90)
*Total (%)	9(6.82)	31(23.48)	38(28.79)	30(22.73)	16(12.12)	8(6.06)	132(100)

Table 2: Ultrasound Diagnosis

Category	USG Findings	Type of thyroid nodule	Number of cases	Total (%) [n=132]
Benign	Iso-echoic nodule, Well-defined margins	Colloid goiter	53	107(81.06)
		MNG	45	
		Cystic nodule	9	
Mildly /Moderately Suspicious	lll-defined margin, hypoechoic solid nodule, increased vascularity.	Suspicious Nodule / MNG	14	14(10.60)
Highly Suspicious	Markedly hypoechoic nodule Irregular margins and Micro Calcifications	Mixed echogenicity	11	11(8.33)
Total			132	132 (100)

Table 3: Cytological Diagnosis by FNAC as per Bethesda System for Reporting Thyroid Cytopathology (TBSRTC)

Category	Type of thyroid nodule	Number of patients (%) [n=132]	
I-Non diagnostic / unsatisfactory	Scanty cellularity /non diagnostic	4(3.03)	
II-Benign	Nodular goiter	47(35.60)	81(61.36)
	Adenomatous nodule	15(11.36)	
	Colloid nodule	12(9.09)	
	Cystic nodule	4(3.03)	
	Thyroiditis	3(2.27)	
III- AUS / FLUS	AUS / FLUS	7(5.30)	
IV-Follicular neoplasm / Suspicious of neoplasm	Follicular neoplasm / Suspicious of neoplasm	24(18.18)	
V-Suspicious for malignancy	Papillary carcinoma	7(5.30)	
VI-Malignant	Papillary carcinoma	9(6.81)	
Total	--	132(100)	

Table 4: Histopathological diagnosis variations

Histopathological diagnosis	Number of patients (%) [n=132]	
Colloid nodular goiter	83(62.88)	Benign 113(85.60)
Follicular adenoma	18(13.64)	
Thyroiditis	4(3.03)	
Colloid nodule with cystic changes	7(5.30)	
Hurthle cell adenoma	1(0.76)	
Papillary carcinoma	12(9.09)	Malignant 19(14.39)
Follicular variant of Papillary carcinoma	3(2.72)	
Follicular Carcinoma	4 (3.03)	
Total	132 (100)	

Table 5: USG correlation with histopathological diagnosis

USG Diagnosis		Histopathological Diagnosis	
Diagnosis	*No. of cases (%)	*Benign (%)	*Malignant (%)
Benign	107(81.06)	103 (96.26) TN cases	4 (3.74) FN cases
Mildly /Moderately Suspicious	14(10.60)	8 (57.14) FP cases	6 (42.86) TP cases
Highly Suspicious	11(8.33)	2 (18.18) FP cases	9 (81.82) TP cases
Total	132(100)	113(84.92)	19(15.07)

(TN-True Negative, FN-False Negative, FP-False Positive, TP-True Positive)
*Values are presented as n (%).

Table 6: FNAC diagnosis correlation with Histopathology

FNAC Diagnosis	Histopathological Diagnosis							
	Colloid nodular goiter	Follicular adenoma	Colloid nodule with cystic changes	Thyroiditis	Hurthle cell adenoma	Papillary carcinoma	Follicular Carcinoma + Follicular variant of Papillary carcinoma	Total (%) [n=132]
I-Non-diagnostic	2	1	0	1	0	0	0	4(3.03)
II-Benign	66	8	4	1	0	1	1	81(61.36)
III-AUS / FLUS	3	2	1	1	0	0	0	7(5.30)
IV-Follicular neoplasm / Suspicious of neoplasm	11	4	2	1	1	1	4	24(18.18)
V-Suspicious for malignancy	1	2	0	0	0	4	0	7(5.30)
VI-Malignant	0	1	0	0	0	6	2	9(6.81)
Total (%)	83(62.88)	18(13.64)	7(5.30)	4(3.03)	1(0.76)	12(9.09)	7 (5.75)	132(100)

FNAC-Fine Needle Aspiration Cytology, (AUS / FLUS- Atypia of undetermined significance / follicular lesion of undetermined significance.)

Table 7: FNAC-Histopathological correlation with true and false positivity and negativity rate

FNAC Diagnosis	Histopathological Diagnosis		Total (%) [n=132]
	Benign (%)	Malignant (%)	

Benign +Non diagnostic cases *	83 (97.64) -TN	2 (2.35)-FN	85(64.39)
#AUS+FLUS+ follicular neoplasm+ Suspicious Neoplasm/Malignant	29 (76.32) -FP	9 (23.68) -TP	38 (28.79)
Malignant	1(11.11)- FP	8(88.89) -TP	9 (6.82)
Total	113 (85.60)	19 (14.39)	132 (100)

AUS / FLUS- Atypia of undetermined significance / follicular lesion of undetermined significance.

for statistical analysisAUS+FLUS+ Suspicious cases are included in the malignant category as considered as malignancies during management.

* Non diagnostic cases are included in benign category for statistical analysis

TN-True Negative, FN-False Negative, FP-False Positive, TP-True Positive

Table 8: FNAC and USG Values in detecting malignant thyroid nodules

Statistical values (%)	USG	FNAC
Sensitivity	78.95	89.47
Specificity	91.15	73.45
PPV	60	36.96
NPV	96.26	97.65
False positive rate	8.85	26.55
False negative rate	21.05	10.53
Accuracy	89.39	75.76
Mc Nemar test	p-value=0.179	p-value <0.001
TP	15	17
FP	10	30
TN	103	83
FN	4	2
Total	132	132

Table 9: Statistical variables of USG compared to previous studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
De D et al. [18]	80	90	86	86	85
Kwang MK et al.[23]	96.0	86.7	47.7	99.4	66.0
Antonio RF et al. [24]	89.3	46.3	56.8	84.6	65.3
Li Tingting et al. [25]	86.9	77.8	76.9	87.5	82.0.
Present study	94.74	79.65	43.90	98.90	81.82

Table 10: Statistical variables of FNAC compared to previous studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
De D et al. [18]	80	47.2	51.28	77.27	61
Deniz N et al.[27]	43	80	80	72	73
Muratli A et al [28]	87.1	64.6	76.1	79.5	77.3

Jieli L et al [29]	86.93	89.68	88.39	88.36	88.37
Yanli Z et al [30]	98.3	30.9	94.9	58.3	93.5
Present study	89.47	73.45	36.17	97.65	75.76

Discussion

There is an overall increase in cases of thyroid malignancies worldwide with a prevalence rate of 5-15%.[13] This increase in the prevalence of thyroid malignancies is due to the increased use of ultrasound neck with its easy availability and awareness. [14] Hence, it is imperative to detect malignant thyroid nodules from benign nodules by various modalities during the assessment. This is required to avoid unnecessary surgical interventions. High-resolution ultrasound has an important role in the differential diagnosis of thyroid nodules. [15]

FNAC is the best-preferred method for the early evaluation of thyroid nodules with high sensitivity and specificity. It aids in accurate preoperative diagnosis for better patient management. [16] The use of FNAC has a vital role in decreasing the number of non-essential thyroid surgeries and also increases the percentage of detection of malignant thyroid nodules. Although FNAC is counted as an important diagnostic tool with high sensitivity and specificity, it is not completely precise as false positive and false negative numbers are seen with significant results variations [17]

In the present study mean age range of subjects was 37.8 +/- 13 SD. The majority of patients were in the age range of 31-40 years (28.79%) followed by the age range of 21-30 years (23.48%) and later in the age range 41-50 years (22.73%). Females predominantly showed a higher incidence of thyroid nodules, 111(84.09%) patients were females and 21 (15.90%) were males in this study. This was in accordance with the previous study published by De D et al. [18] showing highest number of cases (54%) were reported in the 21–40 years age group and female predominance in the study group.

Thyroid nodules are commonly seen in surgical practice and many a times there exists diagnostic dilemmas. The important aim of pre-operative assessment of thyroid nodules is to rule out malignancy from the benign nodules in order to avoid any unwarranted surgeries. This study was conducted with the aim to evaluate the accuracy and efficacy of thyroid USG and FNAC in correlation with the final histopathological diagnosis.

In this study, out of 132 patients, USG diagnosis confirmed that 91 (68.93%) patients had benign thyroid nodule lesions like colloid, cystic nodules, or adenomatous nodular goiter. The characteristic features like well-defined margins, isoechoic nodules, and the absence of microcalcifications for diagnosing benign lesions have been reported in other studies. [19], [20]

Mild to moderately suspicious nodules showed the following features - hypoechoic solid/mixed nodule, ill-defined margins, and increased vascularity as seen in 26 patients (19.69%). Highly suspicious thyroid nodules were seen in 15 patients (11.36%) suggestive of malignancy like marked hypo-echogenicity, irregular

margins and microcalcifications. Similar results were seen in studies published in the literature.[21]

Kwak et al reported that the ultrasound findings like marked hypoechogenicity, irregular margins, micro calcifications, and lesions taller than wide shape are significantly associated with malignancy.[6] A number of studies have been conducted to define the ultrasound characteristics to differentiate between malignant and benign in thyroid nodules. [22] In our study, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false-positive rate, false-negative rate, and accuracy of Ultrasound of thyroid lesions was 78.95%, 91.15%, 60%, 96.26%, 8.85%, 21.05%, 89.39% respectively. This was in accordance with the previous studies, [18], [23], [24],[25] as shown in [Table 9].

Ultrasound-guided FNAC is found to be the most convenient, effective, and safest modality for the assessment of thyroid nodules.[12] The studies reported in the literature showed increased efficacy of FNAC under USG guidance.[17], [26] In our study the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), false positive rate, false negative rate and accuracy for FNAC were 89.47%, 73.45%, 36.96%, 97.65%, 26.55%, 10.53%, 75.76% respectively. This was in correlation with the results of studies reported in the literature, shown in the [Table 10].[18], [27], [28], [29], [30]

In our study, we found that out of 132 cases, the total number of patients showing benign and malignant histopathology were 113 (85.60%) and 19 (14.39%) respectively. This was in accordance with study reported by Sorrenti S et al.[31] showing benign lesions in 82.42 % and malignant in 17.6%. Our study had limitations like selective bias due to retrospective study. The sample size was comparatively small which can lead to an inaccurate appraisal of the study results. The ultrasonography and FNAC are mostly operator-dependent investigations and thus the results may vary from person to person.

Conclusion

The sensitivity, specificity, and diagnostic accuracy of ultrasound and FNAC in this study were consistent with previous research. Ultrasonography and FNAC are the best modalities for assessing and diagnosing thyroid nodules, yielding satisfactory results for both assessing and diagnosing malignant nodules. As evidenced by evidence-based literature reports, no single investigation is completely precise in diagnosing malignant thyroid nodules. Clinicians should combine these modalities after clinical evaluation of thyroid nodules in order to reduce a large number of unnecessary thyroidectomies without missing the malignant nodules for the benefit of the patients.

Highlights

- Thyroid nodules are commonly presented in clinical practice and due to increased use of imaging, the incidence of thyroid nodules is increasing in the general population.
- Fine needle aspiration and ultrasound are the best modalities for the evaluation of thyroid nodules.

- In this study the overall sensitivity, specificity, and accuracy of Ultrasound was (94.74%, 79.65%, and 81.82% respectively) and for FNAC (89.47%, 73.45%, and 75.76%).
- Fine needle aspiration and ultrasound in combination can result in the higher accuracy in the evaluation of thyroid nodules
- It should be emphasized to rule out malignant nodules to avoid unwarranted thyroid surgeries.

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