

# Thyroid Nodules Cytopathology Applying the Bethesda System with Histopathological Correlation

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## Abstract

**Background:** Fine-needle aspiration cytology remains a valuable screening tool for preoperative management of thyroid nodules. However, the rates of false-negative and false-positive diagnosis remain a challenge for pathologists.

**Objectives:** To assess the value of thyroid fine-needle aspiration as a screening tool and its accuracy of diagnoses relative to final histological diagnoses.

**Patients and Methods:** A chart review was conducted of all adult patients who underwent fine-needle aspiration of thyroid nodule(s) and were subjected to thyroid surgery at King Abdulaziz Medical City, Jeddah, Saudi Arabia, between January 2007 and June 2014. The fine-needle aspiration results were correlated with final histopathology results.

**Results:** Of the 408 aspirates from 373 patients, the Bethesda System for Reporting Thyroid Cytology (BSRTC) diagnostic categories were as follows: nondiagnostic in 26 aspirates (6.4%); benign in 128 (31.4%); atypia/follicular lesion of undetermined significance in 52 (12.7%); follicular neoplasm/suspicion for a follicular neoplasm in 83 (20.3%); suspicious for malignancy in 23 (5.6%) and malignant in 96 (23.5%). The comparative histopathological diagnoses were benign in 192 (47.1%) and malignant in 216 (52.9%) aspirates. The calculated risk of malignancy in the fine-needle aspiration categories was 34.6% in diagnostic category (DC) I, 15.6% in DC II, 50% in DC III, 52% in DC IV, 95.7% in DC V and 100% in DC VI. The sensitivity of fine-needle aspiration with BSRTC was 88.9%, specificity was 75.6%, positive predictive value was 79.7%, negative predictive value was 84.4% and accuracy was 81.5%.

**Conclusion:** The results of this retrospective study demonstrated higher risks of malignancy in DC I, DC II, DC III and DC IV than that of the original BSRTC definition, along with a higher specificity and positive predictive value for cancer diagnosis, and a lower sensitivity and negative predictive value.

**Keywords:** Bethesda, correlation, cytopathology, histopathology, thyroid nodules

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## INTRODUCTION

Thyroid malignancy is a common problem in Saudi Arabia, particularly among the female population, in which it constitutes 12% of all malignancies.<sup>[1]</sup> According to the 2014 National Saudi Cancer Registry data, the age-standardized incidence rate of thyroid cancer is 7.8/100,000 in females and 2.5/100,000 in males.<sup>[2]</sup> According to the 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer, fine-needle aspiration (FNA) remains an important screening method.<sup>[3]</sup>

Historically, a lack of consistent usage of terminology by cytopathologists affected the sensitivity and specificity of FNA. This led to the introduction of the Bethesda System for Reporting Thyroid Cytopathology (BSRTC) to improve communication between pathologists and clinicians.<sup>[4]</sup> BSRTC classifies all FNA results into six categories: nondiagnostic (diagnostic category [DC] I), benign (DC II), atypia/follicular lesion of undetermined significance (DC III), follicular neoplasm/suspicion for a follicular neoplasm (DC IV), suspicious for malignancy (DC V) and malignant (DC VI).<sup>[4]</sup> The BSRTC classification is used to recommend the different courses of clinical management including repeating FNA (DC I and DC III), clinical follow-up (DC II), surgical lobectomy (DC IV) and total thyroidectomy (DC V and DC VI).<sup>[4]</sup>

Since the BSRTC system was implemented in 2007, only a few studies have been conducted in Saudi Arabia to assess the accuracy of FNA as a diagnostic tool.<sup>[5,6]</sup> Therefore, the current study aimed to evaluate the accuracy of FNA in triaging patients with thyroid nodules by comparing BSRTC with the gold-standard histopathological diagnosis of surgically removed nodules. A further aim was to determine the risk of malignancy in the BSRTC categories to guide future clinical management.

## PATIENTS AND METHODS

A chart review was performed following the approval of the Institutional Review Board at King Abdullah International Medical Research Center (Reference No. IRBC/010/17) on January 5<sup>th</sup>, 2017. Data were collected from medical records at King Abdulaziz Medical City, Jeddah, Saudi Arabia, between January 2007 and June 2014. All adult patients (i.e., aged  $\geq 18$  years) who underwent FNA of single or multiple thyroid nodules and were subjected to thyroid surgery were included in this study. Patients who did not have surgery and patients with incomplete data were not included in this study. Data, including

that on demographics, FNA results and histopathology results, were collected from the patients' files and from the electronic medical record system. FNA adequacy is defined as presence of at least five groups of follicular cells each with 12 cells. The FNA results were then compared with histopathology results.

The rates of true-positive, false-positive, true-negative and false-negative results by FNA were calculated, along with the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy. For the purpose of these calculations, FNA results of DC IV, DC V and DC VI were considered a positive diagnosis of malignancy, so that a sample with a histopathological diagnosis of malignancy was a true positive. DC II was considered a negative diagnosis of malignancy, so that a sample with a benign diagnosis on histopathology was a true negative. Two sets of calculations were performed: once with DC II, DC V and DC VI and once with DC II, DC IV, DC V and DC VI. The frequency of different histopathological outcomes in each of the FNA categories was also determined.

Simple descriptive statistics were produced using SPSS version 20 (IBM Corporation, Armonk, NY, USA). Percentages were reported for qualitative data, and means and standard deviations were used for normally distributed quantitative data. A two-tailed, Pearson chi-square test was used to determine the association between gender (as an independent variable) and biopsy outcome (as a dependent variable).  $P < 0.05$  was considered statistically significant.

## RESULTS

A total of 408 FNA biopsies were performed on 373 patients, of whom 300 (80.4%) were female and 73 (19.6%) were male. The mean age of the patients was  $44.3 \pm 17.2$  years. A total of 386 (94.6%) FNA biopsies were adequate and 22 (5.4%) were inadequate. Of the 373 patients, 247 (66.2%) underwent total thyroidectomy, 124 (33.2%) underwent hemithyroidectomy and a tissue biopsy was obtained for 2 (0.5%).

The BSRTC DC was DC I in 26 (6.4%) FNA biopsies, DC II in 128 (31.4%), DC III in 52 (12.7%), DC IV in 83 (20.3%), DC V in 23 (5.6%) and DC VI in 96 (23.5%) [Table 1].

Among the final histopathology samples, 192 (47.1%) led to a benign diagnosis and 216 (52.9%) to a malignant diagnosis [Table 1]. Multinodular goiter was the most common benign histopathology diagnosis and was

seen in 137 (33.6%) histopathology samples. Papillary carcinoma, the most common malignancy, was seen in 96 (23.5%) histopathology samples, while the follicular variant of papillary carcinoma was seen in 93 (22.8%). Of the different FNA categories, the risk of malignancy determined by comparison with histopathology samples was 34.6% for DC I, 15.6% for DC II, 50% for DC III, 52% for DC IV, 95.7% for DC V and 100% for DC VI [Table 2].

Among the 128 aspirations that led to a DC II diagnosis, follow-up histopathology showed that 88 (68.8%) were associated with multinodular goiters, 9 (7%) with Hashimoto's thyroiditis and 11 (8.6%) with follicular adenoma. Ten patients (7.8%) were initially counted as having papillary carcinoma, and 10 (7.8%) were counted as having the follicular variant of papillary carcinoma on excision. Therefore, the number of true negatives was initially calculated as 108 (84.4%) and the number of false negatives as 20 (15.6%).

Among the 96 aspirations with a cytological diagnosis of malignancy (DC VI), the two most common

histopathological diagnoses were papillary carcinoma in 63 (65.6%) patients and the follicular variant of papillary carcinoma in 25 (26%) patients. None were diagnosed as benign. Among the 23 aspirates with an FNA diagnosis of DC V (suspicious for malignancy), 10 (43.5%) had a histopathological diagnosis of the follicular variant of papillary carcinoma, 9 (39.1%) of papillary carcinoma and 1 (4.3%) was diagnosed as a false-positive, nonmalignant follicular adenoma on surgical excision [Table 3].

Excluding all FNA diagnoses in DC I, DC III and DC IV, the 247 aspirates consisted of 1 false positive, 20 false negatives, 118 true positives and 108 true negatives [Table 4]. These results yielded an estimated FNA sensitivity of 85.5%, specificity of 99.1%, PPV of 99.2%, NPV of 84.4% and accuracy of 91.5% [Table 5]. However, when the aspirates in DC IV were included, the total number of false positives was 41 and true positives was 161 [Table 4]. This addition resulted in an FNA sensitivity of 88.9%, specificity of 75.6%, PPV of 79.7%, NPV of 84.4% and accuracy of 81.5% [Table 5]. The follicular variant of papillary carcinoma constituted the most common malignancy in those with cytological diagnoses of DC III (34.6% of 52 DC III aspirates) and DC IV (33.7% of 83 DC IV aspirates) [Table 6].

## DISCUSSION

FNA cytology remains a valuable screening tool for preoperative management of thyroid nodules. However, the rates of false negative and false positive diagnosis remain a challenge for pathologists. The recently published BSRTC adopted in this study has played a pivotal role in triaging thyroid nodules for surgical management. The risk of malignancy according to the initial definition of BSRTC<sup>[4]</sup> for the nondiagnostic DC I is 1%–4%, and the clinical management recommendation for this diagnosis is to “repeat FNA with ultrasound guidance.”<sup>[4]</sup> In the current study, 26 (6.4%) of the FNAs were nondiagnostic, of which 9 (34.6%) were found to be malignant on histopathological analysis. This finding is comparable with that reported

**Table 1: Diagnostic categorization of thyroid nodules by fine-needle aspiration and histopathology**

Diagnosis	n (%)
<b>FNA</b>	
Nondiagnostic (DC I)	26 (6.4)
Benign (DC II)	128 (31.4)
AUS/FLUS (DC III)	52 (12.8)
FN/SFN (DC IV)	83 (20.3)
Suspicious for malignancy (DC V)	23 (5.6)
Malignant (DC VI)	96 (23.5)
Total	408
<b>Histopathology</b>	
Multinodular goiter	137 (33.6)
Hashimoto's thyroiditis	18 (4.4)
Follicular adenoma	37 (9.1)
Papillary carcinoma	94 (23)
FVPC	93 (22.8)
Other carcinomas	29 (7.1)
Total	408

AUS/FLUS – Atypia/follicular lesion of undetermined significance; DC – Diagnostic category; FN/SFN – Follicular neoplasm/suspicious for follicular neoplasm; FNA – Fine-needle aspiration; FVPC – Follicular variant of papillary carcinoma

**Table 2: The risk of malignancy among fine-needle aspiration diagnostic categories**

Cytological diagnosis	Total	Percentage of total	Benign histology		Malignant histology	
			n	Percentage of BSRTC category	n	Percentage of BSRTC category
Nondiagnostic (DC I)	26	6.4	17	65.4	9	34.6
Benign (DC II)	128	31.4	108	84.4	20	15.6
AUS/FLUS (DC III)	52	12.7	26	50	26	50
FN/SFN (DC IV)	83	20.3	40	48	43	52
Suspicious for malignancy (DC V)	23	5.6	1	4.3	22	95.7
Malignant (DC VI)	96	23.5	0	0	96	100
Total	408	100	192		216	

AUS/FLUS – Atypia/follicular lesion of undetermined significance; DC – Diagnostic category; FN/SFN – Follicular neoplasm/suspicious for follicular neoplasm; BSRTC – Bethesda System for Reporting Thyroid Cytology

**Table 3: The cytological-histopathological correlation of 119 aspirates with a diagnosis on fine-needle aspiration of malignant or suspicious for malignancy**

Histopathology	FNA category	
	Suspicious for malignancy (DC V), n (%)	Malignant (DC VI), n (%)
Benign		
Follicular adenoma	1 (4.3)	0
Malignant		
Papillary carcinoma	9 (39.1)	63 (65.6)
Follicular variant of papillary carcinoma	10 (43.5)	25 (26)
Anaplastic carcinoma	0	1 (1)
Hürthle cell carcinoma	3 (13)	2 (2.1)
Medullary carcinoma	0	1 (1)
Poorly differentiated thyroid carcinoma	0	4 (4.2)
Total	23	96

DC – Diagnostic category; FNA – Fine-needle aspiration

**Table 4: Correlation between fine-needle aspiration diagnosis and histopathology diagnosis, excluding atypia/follicular lesion of undetermined significance**

FNA	Histopathology		
	Malignant, n (%)	Benign, n (%)	Total (n)
Malignant, excluding FN/SFN (DC V and DC VI)	118 (99.2)	1 (0.8)	119
Malignant, including FN/SFN (DC IV, DC V and DC VI)	161 (79.7)	41 (20.3)	202
Benign (DC II)	20 (15.6)	108 (84.4)	128

DC – Diagnostic category; FN/SFN – Follicular neoplasm/suspicious for follicular neoplasm; FNA – Fine-needle aspiration

**Table 5: Results of analyses with exclusion and inclusion of fine-needle aspiration follicular neoplasm/suspicious for a follicular neoplasm category**

Method	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Malignancy and suspicious for malignancy (FN/SFN excluded)	85.5	99.1	99.2	84.4	91.5
Malignancy/suspicious for malignancy (FN/SFN included)	88.9	75.6	79.7	84.4	81.5

FN/SFN – Follicular neoplasm/suspicious for a follicular neoplasm; NPV – Negative predictive value; PPV – Positive predictive value

**Table 6: Histopathological diagnoses of patients in different fine-needle aspiration categories**

Histopathology	FNA category		
	Nondiagnostic (DC I), n (%)	AUS/FLUS (DC III), n (%)	FN/SFN (DC IV), n (%)
Benign (total)	17 (65.4)	26 (50)	40 (48.2)
Multinodular goiter	15 (57.7)	19 (36.5)	15 (18.1)
Hashimoto's thyroiditis	1 (3.8)	2 (3.8)	6 (7.2)
Follicular adenoma	1 (3.8)	5 (9.6)	19 (22.9)
Malignant (total)	9 (34.6)	26 (50)	43 (51.8)
Papillary carcinoma	5 (19.2)	5 (9.6)	2 (2.4)
Follicular variant papillary carcinoma	2 (7.7)	18 (34.6)	28 (33.7)
Follicular carcinoma	2 (7.7)	1 (1.9)	6 (7.2)
Hürthle cell carcinoma	0	1 (1.9)	7 (8.4)
Poorly differentiated thyroid carcinoma	0	1 (1.9)	0
Total	26	52	83

AUS/FLUS – Atypia/follicular lesion of undetermined significance; FN/SFN – Follicular neoplasm/suspicious for follicular neoplasm; FNA – Fine-needle aspiration; DC – Diagnostic category

in a single-institution study,<sup>[7]</sup> but higher than the 16.8% reported in a meta-analysis of eight studies.<sup>[8]</sup>

Thyroid nodules classified by FNA as benign (DC II) are managed by clinical follow-up, unless surgery is indicated for other reasons, such as for pressure symptoms or cosmetic concerns. Among the 128 FNAs that were reported as benign, 20 were found to be malignant on excision, giving a 15.6% risk of malignancy. This rate was considerably higher than the 3.7%, 5.6% and 8% previously reported.<sup>[7-9]</sup> The risk reported for this category in the

initial BSRTC definition was even lower at 0%–3%.<sup>[4]</sup> This discrepancy led the authors to review the specimens, resulting in 12 of the 20 “malignant” DC I samples being identified as occult papillary thyroid carcinoma. When these were excluded, the calculated risk was reduced to 6%, which is comparable with the risk of malignancy reported in previous studies.<sup>[7-9]</sup>

In DC III, the BSRTC recommendation is to repeat the FNA. In the current study, of the 52 aspirates with a DC III diagnosis, 26 nodules (50%) were found to be malignant

on subsequent histology. This high rate of malignancy could be explained by a low threshold of the treating physicians in deciding to refer patients directly to surgery without repeating the FNA. This finding is also possibly the result of a high threshold in some cytopathologists to make a diagnosis of malignancy. Reported malignancy rates for this category vary widely, from a similar rate of 50%<sup>[6]</sup> to higher rates of 69%<sup>[7]</sup> and 79%<sup>[10]</sup> as well as much lower rates of 5%–15% in the BSRTC definition<sup>[4]</sup> and 15.9% in a meta-analysis.<sup>[8]</sup> These lower rates could relate to the larger number of patients included in these studies. Among the patients in the current study who were diagnosed in DC III, multinodular goiter constituted 73% of the benign group, while the follicular variant of papillary thyroid carcinoma constituted 69% of the malignant group.

Patients with a diagnosis of follicular neoplasm (DC IV) from FNA are recommended for surgical lobectomy. Of the 83 DC IV diagnoses, 43 (52%) were confirmed by histopathology as being malignant. Reported malignancy rates associated with DC IV diagnoses vary from 50%<sup>[7]</sup> to 79%<sup>[10]</sup> with lower rates of 15%–30% given in the BSRTC definition and 26.1% reported in a meta-analysis.<sup>[8]</sup> In the present study, for patients with FNA diagnoses of DC IV, the most common benign diagnosis by histopathology was follicular adenoma in 19 patients (47.5%), while the most common malignancy was the follicular variant of papillary carcinoma in 28 patients (65%).

An FNA diagnosis of DC V (suspicious for malignancy) was made in 23 (5.6%) aspirates, with a subsequent histological diagnosis of malignancy in 22 of the 23 (95.6%) aspirates; this corresponds to a higher level of risk than the 60%–75% given in the BSRTC definition<sup>[4]</sup> or the 75.2% reported in a meta-analysis.<sup>[8]</sup> The higher rate observed in this study could relate to sampling issues and variable experience with techniques of aspiration between pathologists along with differences in interpretation of findings. However, these differences should have no clinical consequences because the BSRTC recommendation for management of patients in DC V and DC VI is total thyroidectomy. In the current study, a 100% risk of malignancy was found in the 96 patients with malignant diagnoses by FNA, a result comparable with the risk of malignancy in the BSRTC definition (97%–99%)<sup>[4]</sup> as well as with that reported in a meta-analysis (98.6%).<sup>[8]</sup> A significant association was observed between gender and diagnosis ( $P = 0.016$ ): 52 of 73 (71.2%) males had a malignant diagnosis compared with 164 of 300 (55%) females.

Several studies have evaluated the diagnostic accuracy of FNA compared with the gold standard of histopathology.<sup>[11–15]</sup> However, the authors believe that directly comparing the results of these studies may not be appropriate, as the methodology used to evaluate FNA accuracy varies.

In the current study, a true negative was confirmed if the FNA classification was benign (DC II) and the histopathology diagnosis was also benign. In the first analysis, a true positive was confirmed if the FNA classification was DC V or DC VI and the histopathology diagnosis was also malignant. In the second analysis, the DC IV category was also considered as a diagnosis of malignancy, as patients with this diagnosis are subjected to lobectomy. The sensitivity of 88.9% in this study was comparable with the 97% in a meta-analysis of 6362 patients,<sup>[8]</sup> in which DC IV, DC V and DC VI were included. However, comparing the observed values for specificity, PPV, NPV and accuracy of the present study (75.6%, 79.7%, 84.4% and 81.6%, respectively) with that of the meta-analysis (50.7%, 55.9%, 96.3% and 68.8%, respectively) indicates higher specificity and accuracy in the present study.

## CONCLUSION

This study found higher risks of malignancy among FNA categories DC I, DC II, DC III and DC IV than that stated in the BSRTC definition. Physicians and surgeons should be made aware of the 50% risk of malignancy associated with the DC III category (follicular lesion of undetermined significance). Although a repeat FNA for re-evaluation, as also stated in the BSRTC recommendation, is important to avoid unnecessary surgery in these patients, factors such as the patients' choice and other risk factors should be considered before proceeding to surgery. Furthermore, the results of the current study showed higher specificity and PPV for the diagnosis of malignancy, while the sensitivity and NPV were lower than that of previous studies. Thyroid FNA remains a strong screening modality for thyroid nodules in a multidisciplinary setup of endocrinologists, surgeons and pathologists, and its results can guide clinical management.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Hussain F, Iqbal S, Mehmood A, Bazarbashi S, ElHassan T, Chaudhri N, *et al.* Incidence of thyroid cancer in the Kingdom of Saudi Arabia, 2000-2010. *Hematol Oncol Stem Cell Ther* 2013;6:58-64.
2. Cancer Incidence Report, Saudi Arabia; 2014. Saudi Cancer Registry. Available from: <https://www.nhic.gov.sa/eServices/Documents/2014.pdf>. [Last accessed on 2018 Jul 02].
3. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, *et al.* 2015 American thyroid association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: The American thyroid association guidelines task force on thyroid nodules and differentiated thyroid cancer. *Thyroid* 2016;26:1-33.
4. Cibas ES, Ali SZ; NCI Thyroid FNA State of the Science Conference. The Bethesda system for reporting thyroid cytopathology. *Am J Clin Pathol* 2009;132:658-65.
5. Al-Shraim MM, Kaood OM, Hussein MR, Al-Ahmary AM, Al Shehri GY, Jastania RA, *et al.* Assessment of malignancy rate in thyroid nodules according to the Bethesda system of fine-needle aspiration. Report from a tertiary center in the Southwestern region of Saudi Arabia. *Saudi Med J* 2012;33:167-71.
6. Mufti ST, Molah R. The Bethesda system for reporting thyroid cytopathology: A five-year retrospective review of one center experience. *Int J Health Sci (Qassim)* 2012;6:159-73.
7. Park JH, Yoon SO, Son EJ, Kim HM, Nahm JH, Hong S, *et al.* Incidence and malignancy rates of diagnoses in the Bethesda system for reporting thyroid aspiration cytology: An institutional experience. *Korean J Pathol* 2014;48:133-9.
8. Bongiovanni M, Spitale A, Faquin WC, Mazzucchelli L, Baloch ZW. The Bethesda system for reporting thyroid cytopathology: A meta-analysis. *Acta Cytol* 2012;56:333-9.
9. Wu HH, Rose C, Elsheikh TM. The Bethesda system for reporting thyroid cytopathology: An experience of 1,382 cases in a community practice setting with the implication for risk of neoplasm and risk of malignancy. *Diagn Cytopathol* 2012;40:399-403.
10. Lee K, Jung CK, Lee KY, Bae JS, Lim DJ, Jung SL. Application of Bethesda system for reporting thyroid aspiration cytology. *Korean J Pathol* 2010;44:521-7.
11. Wang CC, Friedman L, Kennedy GC, Wang H, Kebebew E, Steward DL, *et al.* A large multicenter correlation study of thyroid nodule cytopathology and histopathology. *Thyroid* 2011;21:243-51.
12. Gupta M, Gupta S, Gupta VB. Correlation of fine needle aspiration cytology with histopathology in the diagnosis of solitary thyroid nodule. *J Thyroid Res* 2010;2010:379051.
13. Roldan P, Lopez-Tinoco C, Mateo I, Larran L, Ojeda B, Gavilan I, Vallejo E, *et al.* A correlation study of thyroid nodule cytopathology and histopathology. *Endocrine Abstracts*; 2012; 29:1694.
14. Melo-Urbe MA, Sanabria Á, Romero-Rojas A, Pérez G, Vargas EJ, Abaúnza MC, *et al.* The Bethesda system for reporting thyroid cytopathology in Colombia: Correlation with histopathological diagnoses in oncology and non-oncology institutions. *J Cytol* 2015;32:12-6.
15. Reddy P, Prakash A, Giriyan SS. Evaluation of Bethesda system for reporting thyroid cytology with histopathological correlation. *Int J Res Med Sci* 2017;6:247-52.