

https://dspace.org/

Performance of Thyroid FineNeedle Aspiration Biopsy in a Low and MiddleIncome Country

W Conradie; K Baatjes; Thifhelimbilu Luvhengo; J Buitendag; R Razack ...

https://hdl.handle.net/10539/43139
WOS

Downloaded from a DSpace repository. https://dspace.org/

Acta Cytologica

Fine Needle Aspiration

Acta Cytologica 2024;68:301–308
DOI: 10.1159/000539153

Received: January 3, 2024
Accepted: April 23, 2024
Published online: May 10, 2024

Performance of Thyroid Fine-Needle Aspiration Biopsy in a Low- and Middle-Income Country

Wilhelmina Conradie[a] Karin Baatjes[a] Thifhelimbilu Luvhengo[b] Johannes Buitendag[a] Rubina Razack[c] John Davies[d] Fabio Crabbia[e] Amir Afrogheh[f] Jeanne Lübbe[a]

[a]Tygerberg Hospital, Department of Surgery, University of Stellenbosch, Cape Town, South Africa; [b]Department of Surgery, University of Witwatersrand, Johannesburg, South Africa; [c]Division of Anatomical Pathology, National Health Laboratory Service, University of Stellenbosch, Cape Town, South Africa; [d]Ampath Laboratory, Cape Town, South Africa; [e]Pathcare Laboratory (Dietrich, Voigt, Mia and Partners), Cape Town, South Africa; [f]National Health Laboratory Service, Department of Oral and Maxillofacial Pathology, University of Western Cape, Cape Town, South Africa

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

Keywords
Thyroid · Fine needle aspiration · Africa · South Africa · Risk of malignancy

Abstract

Introduction: The 6 categories of the Bethesda System for Reporting Thyroid Cytology (TBSRTC) with associated risk of malignancy (ROM) provide evidence-based clinical management guidelines. This study aimed to determine the ROM and accuracy of FNAB in South Africa (SA). ***Methods:*** Thyroid specimens from 3 pathology laboratories registered between January 2015 and December 2019 were considered for inclusion. ROM was obtained per TBSRTC category by cytohistological correlation and dividing the total number of specimens with malignant histology by the total number of cases operated. Accuracy was calculated based on the Bethesda category and eventual malignant histology. ***Results:*** Seventeen thousand seven hundred and seventy-three histology and 4,791 cytology cases were identified. Of the 4,791 cytology cases, 931 (19%) underwent surgery. More than a third (333, 35.8%) of cases were confirmed as malignant following histological assessment, with the majority being benign (584, 62.7%). The ROM for the nondiagnostic and benign categories was 24.3% and 20.5%. The highest ROM was for category VI (91.5%), followed by categories V (69.5%), IV (51.9%), and III (38.8%). Thyroid FNAB had a sensitivity of 73%, specificity of 74%, and overall accuracy of 74%. ***Conclusion:*** Bethesda categories II and IV have a relatively higher ROM in SA compared to findings from other developed countries. The diagnostic accuracy of thyroid FNAB in SA and the high rate of nondiagnostic diagnoses (38%) require further investigation. A national thyroid registry could provide location-specific data to aid the implementation of appropriate local policies and national guidelines for practicing thyroid surgeons.

© 2024 S. Karger AG, Basel

Introduction

Palpable thyroid nodules are common, detected in 33–68% of the population on high-resolution ultrasound (US) [1–3]. The risk of malignancy (ROM) of thyroid

karger@karger.com
www.karger.com/acy

© 2024 S. Karger AG, Basel

Correspondence to:
Wilhelmina Conradie, ilnaconradie@sun.ac.za

Karger

Table 1. Distribution and ROM of Bethesda categories according to the 1st, 2nd, and 3rd editions

Bethesda category	Distribution of Bethesda categories meta-analysis 2012 [12] (%)	ROM % 1st edition 2009 [13]	ROM % 2nd edition 2017 [10]	ROM % 3rd edition 2023 [14]	Recommended management 2023 [14]
I Nondiagnostic	12.9	1–4	5–10	5–20	Repeat FNAB with US guidance
II Benign	59.3	0–3	0–3	2–7	Clinical and US follow-up
III AUS/FLUS	9.6	5–15	10–30	13–30	Repeat FNAB, molecular testing, diagnostic lobectomy or surveillance
IV FN/SFN	10.1	15–30	25–40	23–34	Molecular testing, diagnostic lobectomy
V Suspicious for malignancy	2.7	60–75	50–75	67–83	Molecular testing, lobectomy or total thyroidectomy
VI Malignant	5.4	97–99	97–99	97–100	Lobectomy or total thyroidectomy

ROM, risk of malignancy; AUS, atypia of undetermined significance; FLUS, follicular lesion of undetermined significance; FN, follicular neoplasm; SFN, suspicious for follicular neoplasm.

nodules is determined by clinical, US, and cytology assessment and ranges between 5% and 10% [4–7]. The Bethesda System for Reporting Thyroid Cytopathology (TBSRTC) was introduced in 2007, resulting in less ambiguous diagnoses and lower rates of unnecessary surgery while maintaining the accuracy of fine-needle aspiration biopsy (FNAB) results [8, 9]. The 6-tiered TBSRTC system provides evidence-based clinical management recommendations [7, 10, 11]. The distribution of Bethesda categories is reported in a meta-analysis conducted by Bongiovanni (n = 25,445) and presented in Table 1 [12], with ROM for each diagnostic category varying as diagnostic criteria evolved over time.

Surgery is indicated for Bethesda VI (malignant) and follow-up for Bethesda II (benign) nodules, with the management of indeterminate nodules being less precise. Management recommendations for indeterminate categories (Bethesda III, IV, and V) include, amongst others, molecular testing [7], which further defines the ROM, limiting unnecessary surgery, and tailoring surgical approaches [15, 16]. Molecular tests are costly and currently not available in South Africa (SA). Reported thyroid FNAB surgical rates in low- and middle-income countries (LMICs) are similar to those determined in high-income countries (HICs) (13.5–41.8% and 18.5–61%, respectively) [17–21].

The diagnostic accuracy of thyroid FNAB ranges between 69% and 78% [12, 22]. Substantial interobserver variability between cytopathologists exists and can be minimized by standardizing FNAB procedures, reducing unnecessary biopsies in benign nodules, and implementing rapid onsite cytology evaluation (ROSE) to ensure the adequacy of specimens [23–25]. Reporting improves when cytopathologists are onsite, as clinical and US parameters are also considered [23].

There is limited evidence about the ROM and diagnostic accuracy of thyroid FNAB in Sub-Saharan Africa [24, 26]. In 2013, researchers from Groote Schuur Hospital (GSH) in Cape Town, SA, determined a thyroid FNAB sensitivity of 44.7% in 109 patients [26]. In 2022, researchers at Tygerberg Hospital (TBH) in Cape Town, SA, determined the ROM for the Bethesda categories, with findings showing improved inadequacy rates (34.3–16.2%) after establishing a multidisciplinary thyroid clinic [24].

This knowledge gap is echoed by Ogbera et al. [27] in their review of thyroid disease epidemiology in Africa, emphasizing the need for thyroid registries in Africa. In 2022, Sajisevi et al. analyzed the mode of detection of thyroid cancer in 16 centers (USA, Canada, Denmark, and SA) across 4 countries. Extensive variation in practice was noted between the countries, with patients presenting more commonly with symptoms in SA and Denmark, compared to incidental detection with no thyroid symptoms in the USA and Canada [28]. The findings emphasize the need for national data collection, not only extrapolating evidence from developed countries. This study aimed to determine the ROM and diagnostic accuracy of thyroid FNAB in a large SA population.

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

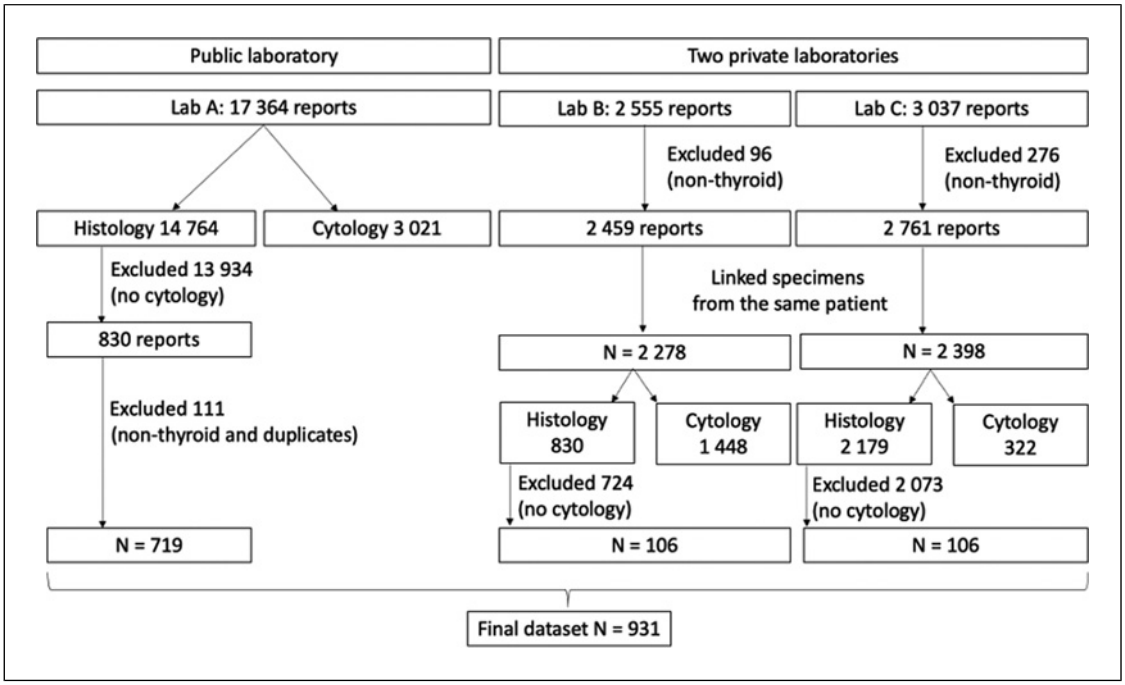


Fig. 1. Flow diagram indicating inclusion and exclusion.

Methods

Thyroid specimens from 3 SA laboratories (1 public, 2 private), registered between January 2015 and December 2019, were included. Histology results were categorized into benign or malignant according to the 2022 World Health Organization classification of thyroid tumors [29]. Cytology and histology reports from the same patient were matched, and only cases with both cytology and histology reports were included in the final dataset. Bethesda I and III were excluded in the calculation of diagnostic accuracy as these categories commonly require re-biopsy and not surgery [12, 19].

The 2009 TBSRTC was used as a model to create the statistical analysis plan [10]. The distribution of cases in the TBSRTC was determined by dividing the number of FNABs in each category by the total number of FNABs [19]. Cytohistological correlation assessing the ROM was obtained per category by dividing the total number of malignant histology results by the total number of cases operated. The diagnostic accuracy of FNAB was calculated based on all patients who had surgery and not on all cytology specimens [18, 21, 22, 30–32]. The sensitivity, specificity, positive predictive value, and negative predictive value were calculated based on the two groups: TBSRTC category and malignancy (histology) [32].

Results

After removing duplicates, 17,773 histology cases and 4,791 cytology cases were identified (Fig. 1). Overall cytology results were reported as Bethesda I (non-diagnostic) in 38% (n = 1,810) and Bethesda II (benign) in 43% (n = 2,027) (Table 2). Of the 931 operated patients where correlating cytology was performed, 778 (83.6%) were female, and the median age was 50 (IQR 41–61).

Only 931 (0.5%) of 17,773 histology cases had correlating cytology, indicating a 19% surgery rate in all FNAB cases (Table 3). The final histological diagnosis for each TBSRTC category is presented in Table 4. Overall, 333 (35.8%) cases were malignant, and 14 were low-risk neoplasms (including NIFTP, follicular thyroid tumor of uncertain malignant potential, and hyalinizing trabecular tumor) [29]. Benign histology (Table 4) was reported in 589 (63%) cases, with thyroid follicular nodular disease being the most common. There were 216 papillary thyroid cancers compared to 44 follicular thyroid cancers. Of the 216 papillary thyroid cancers, 33 (15%) were smaller than 1 cm.

The ROM in nondiagnostic samples and benign FNAB was 24.3% and 20.5%, respectively (Fig. 2). The highest ROM was in category VI (91.5%), followed by categories V (69.5%), IV (51.9%), and III (38.8%). Nine low-risk neoplasms were excluded when calculating the ROM.

The diagnostic accuracy of FNAB was 74%, with a sensitivity of 73% and specificity of 74%. The positive predictive value was 67%, and the negative predictive value was 79%.

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

Table 2. Distribution of Bethesda categories and cytohistological correlation for operated patients

Bethesda category	All cytology, *n* = 4,791 (% of total)	Cytology cases with correlating histology, *n* = 931 (% operated)	Benign histology, *n* = 589 (% operated)	Malignant histology, *n* = 333 (% operated)	Low-risk neoplasms, *n* = 9 (% operated)
I	1,810 (38)	288 (16)	216 (75)	70 (24)	2 (0.7)
II	2,072 (43)	292 (14)	232 (79)	60 (21)	0 (0)
III	303 (6)	98 (32)	59 (60)	38 (39)	1 (0.1)
IV	314 (7)	135 (43)	60 (44)	70 (52)	5 (0.04)
V	125 (3)	59 (47)	17 (29)	41 (69)	1 (0.02)
VI	167 (3)	59 (35)	5 (8)	54 (92)	0 (0)
Total	4,791 (100)	931 (19)	589 (63)	333 (36)	9 (0.01)

Table 3. Surgical rate in the current study and other low- and middle-income countries

	Tepeoglu, Turkey (2014) [17]	Mahajan, India (2017) [18]	Reuters, Brazil (2018) [19]	Zhu, China (2020) [20]	Kamboj, India (2022) [21]	Current study, SA (2023)
Cytology number	1,021	4,532	585	2,781	431	4,791
Surgery number	220	335	245	1,122	142	931
Surgery rate (%)	21.5	13.5	41.8	40.3	33	19.0

Table 4. Final histopathology report for each Bethesda category [29]

Bethesda category	Follicular-derived neoplasms									Thyroid C-cell-derived carcinoma	Other		Total
	Benign lesions			Low-risk neoplasms, e.g., NIFTP	Malignant thyroid neoplasms						Benign[a]	Malignant[b]	
	T-FND	FA	OA		PTC	FTC	OCA	PDTC	ACA	MTC			
I	150	39	6	8	38	16	5	8	0	2	15	1	288
II	157	40	9	5	50	6	1	3	0	1	20	1	292
III	34	9	5	4	24	5	4	3	2	0	9	0	98
IV	36	12	8	5	29	15	9	10	0	5	4	2	135
V	9	4	1	2	35	0	0	0	0	2	3	4	59
VI	1	0	0	1	41	1	0	1	4	3	4	4	59
Total	381	104	4	25	217	43	19	25	6	13	55	12	931

T-FND, thyroid follicular nodular disease; FA, follicular adenoma; OA, oncocytic adenoma; NIFTP, noninvasive follicular thyroid neoplasm with papillary-like nuclear features; PTC, papillary thyroid carcinoma; FTC, follicular thyroid carcinoma; OCA, oncocytic carcinoma of thyroid; PDTC, poorly differentiated thyroid carcinoma; ACA, anaplastic thyroid carcinoma; MTC, medullary thyroid carcinoma. [a]Other benign (thyroiditis 27, normal thyroid 14, thyroglossal duct cyst 2, other 12). [b]Other malignant (lymphoma 4, squamous cell carcinoma 5, metastases 2, non-medullary neuroendocrine tumor 1).

Discussion

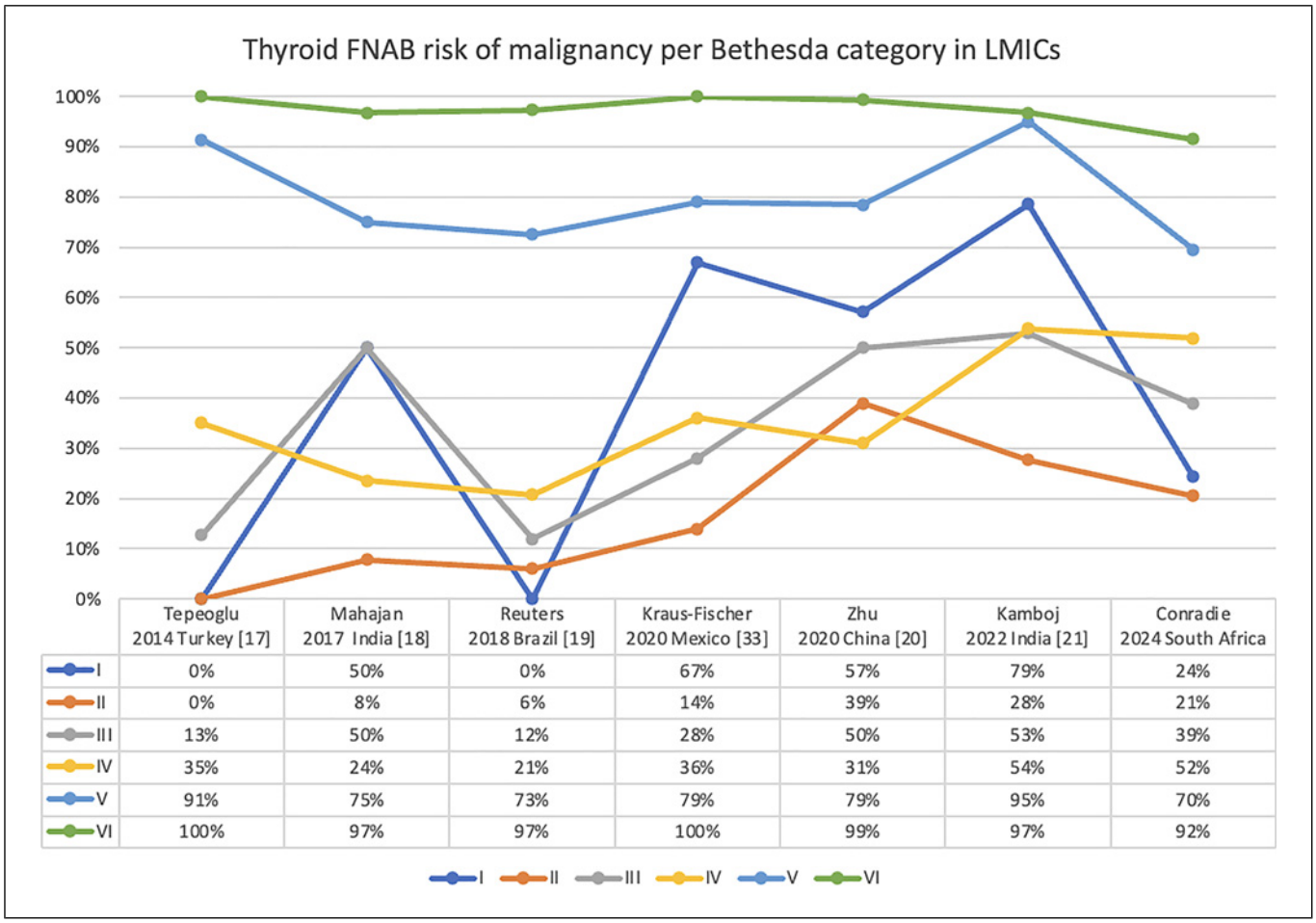
This study calculated the ROM and diagnostic accuracy of FNAB in SA, with 77% of the data representing the single public health system laboratory utilized by 84% of the country's population [34]. The SA health system is divided into public and private healthcare sectors. The public health care system serves 84% of the population, with a maldistribution of doctors – only 30% of doctors working in the public sector. The public sector is in a chronic state of distress,

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

Table 5. Diagnostic accuracy of thyroid FNAB for the current study and other low- and middle-income countries

	Mahajan, India [18]	Reuters, Brazil [19] (%)	Kraus Fischer, Mexico [33] (%)	Zhu, China [20] (%)	Kamboj, India [21] (%)	Current study, SA
Sensitivity	80.5	92.1	92.5	98.1	94.4	73
Specificity	85.9	67.8	63.1	81.5	61.9	74
PPV	80.7	61.4	78.7	99.3	90.3	67
NPV	85.7	93.9	–	61.1	72.2	79
Accuracy	82.4	–	80.8	97.5	–	74

PPV, positive predictive value; NPV, negative predictive value.



	Tepeoglu 2014 Turkey [17]	Mahajan 2017 India [18]	Reuters 2018 Brazil [19]	Kraus-Fischer 2020 Mexico [33]	Zhu 2020 China [20]	Kamboj 2022 India [21]	Conradie 2024 South Africa
I	0%	50%	0%	67%	57%	79%	24%
II	0%	8%	6%	14%	39%	28%	21%
III	13%	50%	12%	28%	50%	53%	39%
IV	35%	24%	21%	36%	31%	54%	52%
V	91%	75%	73%	79%	79%	95%	70%
VI	100%	97%	97%	100%	99%	97%	92%

Fig. 2. ROM per Bethesda category compared to findings from other low- and middle-income countries [17–19, 21, 33].

with a high burden of traumatic injuries, violence, and chronic diseases, limited resources and access to care [34].

The current study's 38% nondiagnostic rate is higher than the previously reported 15% [35]. This high rate may, in part, be due to staff shortages, lack of seniority at healthcare facilities, limited FNAB technique training, limitations in availability of senior staff, and access to US and ROSE. Implementing a multidisciplinary biopsy team may decrease the nondiagnostic rate to 16.2%, as in the previous study [24].

Similarly, the thyroid surgery rate of 19% determined in the current study may be due to various factors,

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

including limited access to surgery, loss to follow-up, patient preference, a difference in surgical threshold, or incomplete laboratory data. The data revealed mostly histology cases, with limited correlating thyroid cytology (0.5%), suggesting that many thyroid surgeries are being performed without FNAB, contrary to recommendations by the American Thyroid Association [7]. The limited number of cytological reports may be explained by clinical/sonographic concerns or cytology at a different laboratory. The low surgical rate (35%) for Bethesda VI nodules may be explained by unresectable disease, patients declining surgery, histology reported at a different laboratory, or poor follow-up of results.

Over the last 2 decades, the ROM diagnostic criteria have evolved. In the current study, ROM in most categories is higher than in other countries, particularly for follicular neoplasms (51.9%). This increased ROM raises questions about differences in thyroid disease management in SA. We hypothesize that the thyroid surgery threshold in SA is much higher, and therefore, only patients with highly suspicious nodules are offered surgery. As highlighted in the Sajisevi study, this may be explained by a rural population with limited access to specialized care [28].

Studies examining the accuracy of thyroid FNABs reveal a wide range of sensitivities (80.5–98.1%) [26, 36]. The sensitivity and specificity determined in this study is lower compared to some LMICs, suggesting more false positives. An FNAB reported as suspicious for malignancy will result in unnecessary interventions or surgeries, and overtreatment of thyroid nodules.

The accuracy rate of thyroid FNAB (74%) can be addressed by improving specimen retrieval and interpretation errors. To help increase the accuracy of FNABs, multiple passes of various parts of a large nodule can be performed to reduce the false-negative rate. To prevent interpretation errors, cytopathologists can revisit the criteria for identifying cystic lesions, thyroiditis, and adenomatous hyperplasia to minimize false-positive diagnoses. Careful patient selection for FNAB, skill and expertise development in FNAB, and the utilization of molecular testing may improve diagnostic accuracy in SA [37–39].

This study highlights several challenges encountered in investigating thyroid disease management in SA. Difficulties in terms of recruitment, participation, and time were encountered. Data capturing was labor and time-intensive as reports were received as single text files, PDFs, and Excel sheets containing thousands of text reports requiring extraction from every individual report. Selection bias for surgery served as a limitation. The ROM and diagnostic accuracy were calculated based on surgical cases with benign thyroid nodules not undergoing surgery. This may have skewed results, similar to other referenced studies [18, 21, 22, 30–32].

The challenges encountered with data acquisition and the variation in diagnostic accuracy and ROM compared to other publications support the implementation of a prospectively collected national thyroid registry that will inform decision-making and local guidelines, promote collaboration, and improve thyroid nodule management in SA.

Conclusion

In SA, thyroid FNAB reflects a higher ROM with a lower surgical rate compared to other international publications. The diagnostic accuracy of thyroid FNAB in SA and the high rate of nondiagnostic diagnoses (38%) is concerning and requires further investigation. Country and institution-based rates should be tracked by locally driven research, and a uniform national registry could allow for centralized data collection and contextual analysis, informing more appropriate interventions.

Statement of Ethics

This study was approved by the Health Research Ethics Committee of the University of Stellenbosch (S23/05/115). A waiver of written informed consent was granted by the Health Research Ethics Committee of the University of Stellenbosch (S23/05/115).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

This study was not supported by any sponsor or funder.

Author Contributions

W.C. and K.B. contributed to the design and implementation of the study. W.C., K.B., T.L., J.B., J.D., F.C., A.A., J.L., and R.R. contributed to the analysis, interpretation, and writing of the manuscript. All authors approved the final paper.

Data Availability Statement

Data will not be publicly accessible due to ethical reasons. The corresponding author may be contacted directly in this regard.

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

References

1 Guth S, Theune U, Aberle J, Galach A, Bamberger CM. Very high prevalence of thyroid nodules detected by high frequency (13 MHz) ultrasound examination. Eur J Clin Invest. 2009;39(8):699–706. https://doi.org/10.1111/j.1365-2362.2009.02162.x

2 Van der JB, Gaston EA, Dawber TR. The significance of nontoxic thyroid nodules. Final report of a 15-year study of the incidence of thyroid malignancy. Ann Intern Med. 1968;69(3):537–40. https://doi.org/10.7326/0003-4819-69-3-537

3 Tunbridge WMG, Evered DC, Hall R, Appleton D, Brewis M, Clark F, et al. The spectrum of thyroid disease in a community: the Whickham survey. Clin Endocrinol. 1977;7(6):481–93. https://doi.org/10.1111/j.1365-2265.1977.tb01340.x

4 Liu Y, Su L, Xiao H. Review of factors related to the thyroid cancer epidemic. Int J Endocrinol. 2017;2017:1–9. https://doi.org/10.1155/2017/5308635

5 Alkhatib AA, Mahayni AA, Chawki GR, Yoder L, Elkhatib FA, Al-Haddad M. Endosonographic examination of thyroid gland among patients with nonthyroid cancers. Endosc Ultrasound. 2016;5(5):328–34. https://doi.org/10.4103/2303-9027.191664

6 Albair Ashamallah G, El-Adalany MA. Risk for malignancy of thyroid nodules: comparative study between TIRADS and US based classification system. Egypt J Radiol Nucl Med. 2016;47(4):1373–84. https://doi.org/10.1016/j.ejrnm.2016.08.021

7 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):1–133. https://doi.org/10.1089/thy.2015.0020

8 Baloch ZW, LiVolsi VA, Asa SL, Rosai J, Merino MJ, Randolph G, et al. Diagnostic terminology and morphologic criteria for cytologic diagnosis of thyroid lesions: a synopsis of the national cancer institute thyroid fine-needle aspiration state of the science conference. Diagn Cytopathol. 2008;36(6):425–37. https://doi.org/10.1002/dc.20830

9 Patel KN, Yip L, Lubitz CC, Grubbs EG, Miller BS, Shen W, et al. The American association of endocrine surgeons guidelines for the definitive surgical management of thyroid disease in adults. Ann Surg. 2020;271(3):21–93. https://doi.org/10.1097/sla.0000000000003580

10 Cibas ES, Ali SZ. The 2017 Bethesda system for reporting thyroid cytopathology. J Am Soc Cytopathol. 2017;6(6):217–22. https://doi.org/10.1016/j.jasc.2017.09.002

11 Baloch Z, LiVolsi VA. The Bethesda system for reporting thyroid cytology (TBSRTC): from look-backs to look-ahead. Diagn Cytopathol. 2020;48(10):862–6. https://doi.org/10.1002/dc.24385

12 Bongiovanni M, Spitale A, Faquin WC, Mazzucchelli L, Baloch ZW. The Bethesda system for reporting thyroid cytopathology: a meta-analysis. Acta Cytol. 2012;56(4):333–9. https://doi.org/10.1159/000339959

13 Cibas ES, Ali SZ. The Bethesda system for reporting thyroid cytopathology. Thyroid. 2009;19(11):1159–65. https://doi.org/10.1089/thy.2009.0274

14 Ali SZ, Baloch ZW, Cochand-Priollet B, Schmitt FC, Vielh P, VanderLaan PA. The 2023 Bethesda System for reporting thyroid cytopathology. J Am Soc Cytopathol. 2023;12(5):319–25. https://doi.org/10.1016/j.jasc.2023.05.005

15 Rossi ED, Vielh P. Thyroid and molecular testing. Advances in thyroid molecular cytopathology. J Mol Pathol. 2021;2(2):77–92. https://doi.org/10.3390/jmp2020008

16 Khan TM, Zeiger MA. Thyroid nodule molecular testing: is it ready for prime time? Front Endocrinol. 2020;11:590128–9. https://doi.org/10.3389/fendo.2020.590128

17 Tepeoğlu M, Bilezikçi B, Bayraktar SG. A histological assessment of the Bethesda system for reporting thyroid cytopathology (2010) abnormal categories: a series of 219 consecutive cases. Cytopathology. 2014;25(1):39–44. https://doi.org/10.1111/cyt.12051

18 Mahajan S, Srinivasan R, Rajwanshi A, Radotra B, Panda N, Dey P, et al. Risk of malignancy and risk of neoplasia in the Bethesda indeterminate categories: study on 4,532 thyroid fine-needle aspirations from a single institution in India. ACY. 2017;61(2):103–10. https://doi.org/10.1159/000470825

19 Reuters KB, Mamone MCOC, Ikejiri ES, Camacho CP, Nakabashi CCD, Janovsky CCPS, et al. Bethesda classification and cytohistological correlation of thyroid nodules in a Brazilian thyroid disease center. ETJ. 2018;7(3):133–8. https://doi.org/10.1159/000488104

20 Zhu Y, Song Y, Xu G, Fan Z, Ren W. The Bethesda system for reporting thyroid cytopathology (TBSRTC): a report of 2,781 cases in a Chinese population. Chin J Cancer Res. 2020;32(2):140–8. https://doi.org/10.21147/j.issn.1000-9604.2020.02.02

21 Kamboj M, Mehta A, Pasricha S, Gupta G, Sharma A, Durga G. Cytomorphological categorization of thyroid lesions according to the Bethesda system for reporting thyroid cytology and correlation with their histological outcome: an Indian oncology centre experience. J Cytol. 2022;39(1):44–50. https://doi.org/10.4103/JOC.JOC_79_20

22 Pasha HA, Mughal A, Wasif M, Dhanani R, Haider SA, Abbas SA. The efficacy of Bethesda system for prediction of thyroid malignancies- A 9 Year experience from a tertiary center. Iran J Otorhinolaryngol. 2021;33(117):209–15. https://doi.org/10.22038/ijorl.2021.50538.2687

23 Poller DN, Johnson SJ, Bongiovanni M. Measures to reduce diagnostic error and improve clinical decision making in thyroid FNA aspiration cytology: a proposed framework. Cancer Cytopathol. 2020;128(12):917–27. https://doi.org/10.1002/cncy.22309

24 Conradie W, Du Plessis A, Edge J, Baatjes K, Ruiters A, Razack R. Impact of a multidisciplinary approach to ultrasound-guided thyroid fine-needle aspiration biopsy at Tygerberg Hospital, Cape Town, South Africa: a retrospective audit. S Afr Med J. 2022;112(1):13521–52.

25 Cibas ES, Baloch ZW, Fellegara G, LiVolsi VA, Raab SS, Rosai J, et al. A prospective assessment defining the limitations of thyroid nodule pathologic evaluation. Ann Intern Med. 2013;159(5):325–32. https://doi.org/10.7326/0003-4819-159-5-201309030-00006

26 Cairncross L, Panieri E. Pre-operative diagnosis of thyroid cancer: clinical, radiological and pathological correlation. S Afr J Surg. 2013;51(2):46–9. https://doi.org/10.7196/sajs.1261

27 Ogbera A, Kuku S. Epidemiology of thyroid diseases in Africa. Indian J Endocrinol Metab. 2011;15(Suppl 2):82–S88. https://doi.org/10.4103/2230-8210.83331

28 Sajisevi M, Caulley L, Eskander A, Du Y, Auh E, Karabachev A, et al. Evaluating the rising incidence of thyroid cancer and thyroid nodule detection modes: a multinational, multi-institutional analysis. JAMA Otolaryngol Head Neck Surg. 2022;148(9):811–8. https://doi.org/10.1001/jamaoto.2022.1743

29 Christofer Juhlin C, Mete O, Baloch ZW. The 2022 WHO classification of thyroid tumors: novel concepts in nomenclature and grading. Endocr Relat Cancer. 2023;30(2):e220293. https://doi.org/10.1530/ERC-22-0293

30 Yang J, Schnadig V, Logrono R, Wasserman PG. Fine-needle aspiration of thyroid nodules: a study of 4,703 patients with histologic and clinical correlations. Cancer Cytopathology. 2007;111(5):306–15. https://doi.org/10.1002/cncr.22955

31 Anand B, Ramdas A, Ambroise MM, Kumar NP. The Bethesda system for reporting thyroid cytopathology: a cytohistological study. J Thyroid Res. 2020;2020:e8095378. https://doi.org/10.1155/2020/8095378

32 Inabnet WB, Palazzo F, Sosa JA, Kriger J, Aspinall S, Barczynski M, et al. Correlating the Bethesda system for reporting thyroid cytopathology with histology and extent of surgery: a review of 21,746 patients from four endocrine surgery registries across two continents. World J Surg. 2020;44(2):426–35. https://doi.org/10.1007/s00268-019-05258-7

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024

33 Kraus-Fischer G, Alvarado-Bachmann R, Rienzo-Madero BDE, Núñez-García E, Peña M, Zerrweck-López C, et al. Correlation between the Bethesda system for thyroid nodules and post-thyroidectomy histopathological diagnosis. Rev Med Inst Mex Seguro Soc. 2020;58(2):114–21. https://doi.org/10.24875/RMIMSS.M20000008
34 Africa SS. Statistics South Africa: improving lives through data ecosystems. [Internet]. [cited 2023 May 28]. Available from: https://www.statssa.gov.za/
35 Jack GA, Sternberg SB, Aronson MD, Mukamal KJ, Oshin A, Hennessey JV. Nondiagnostic fine-needle aspiration biopsy of thyroid nodules: outcomes and determinants. Thyroid. 2020;30(7):992–8. https://doi.org/10.1089/thy.2019.0140
36 Aliyev A, Aliyeva I, Giammarile F, Talibova N, Aliyeva G, Novruzov F. Diagnostic accuracy of fine needle aspiration biopsy versus postoperative histopathology for diagnosing thyroid malignancy. Endocrinol Diabetes Metab. 2022;5(6):e373. https://doi.org/10.1002/edm2.373
37 Zhu Y, Song Y, Xu G, Fan Z, Ren W. Causes of misdiagnoses by thyroid fine-needle aspiration cytology (FNAC): our experience and a systematic review. Diagn Pathol. 2020;15(1):1. https://doi.org/10.1186/s13000-019-0924-z
38 Hsiao V, Massoud E, Jensen C, Zhang Y, Hanlon BM, Hitchcock M, et al. Diagnostic accuracy of fine-needle biopsy in the detection of thyroid malignancy: a systematic review and meta-analysis. JAMA Surg. 2022;157(12):1105–13. https://doi.org/10.1001/jamasurg.2022.4989
39 Carpi A, Di Coscio G, Iervasi G, Antonelli A, Mechanick J, Sciacchitano S, et al. Thyroid fine needle aspiration: how to improve clinicians' confidence and performance with the technique. Cancer Lett. 2008;264(2):163–71. https://doi.org/10.1016/j.canlet.2008.02.056

Downloaded from http://karger.com/acy/article-pdf/68/4/301/4282297/000539153.pdf by Witwatersrand Health Sciences user on 08 October 2024