ORIGINAL RESEARCH

Evaluating Solid Thyroid Nodules: A Comparison of Ultrasound-Guided Fine Needle Aspiration and Non-Aspiration Techniques

[1]Dr. Khyati Jayantkumar Patel, [2]Dr. Jigar Patel, [3]Dr. Bhargavi Vasudev Patel, [4]Dr. Sanket A. Shah

[1]Senior Resident (M.S E.N.T), GMERS Medical College & Hospital, Valsad, Gujarat, India
[2,3]Assistant Professor (M.S Surgery), GMERS Medical College & Hospital, Valsad, Gujarat, India
[4]Assistant Professor (M.S E.N.T), GMERS Medical College & Hospital, Dharpur, Patan, Gujarat, India

Corresponding author
Dr. Sanket A. Shah
Assistant Professor (M.S E.N.T), GMERS Medical College & Hospital, Dharpur, Patan, Gujarat, India
Email: sanketshah1211@gmail.com

Received: 19 March, 2024 Accepted: 23 April, 2024

ABSTRACT
Background: Comparison between the Fine Needle Non-Aspiration Cytology (FNNAC) and Fine Needle Aspiration Cytology (FNAC) in acquiring ultrasound-guided fine needle cytology (FNC) samples from solid thyroid nodules to determine the better technique, hence improving the sample quality aiming to decrease the number of unnecessary thyroidectomy operations. **Result:** Prospective study showed statistically significant increase in cellular yield, preservation of cellular architecture and decrease in cellular trauma along with statistically significant increase in total sample quality with FNNAC (P value = 0.32, 0.004, 0.011, 0.21 respectively), and statistically insignificant difference in background blood in the sample (P value = 0.8).Regarding sample convenience, FNNAC demonstrated higher cellular yield, less cellular trauma, and better preservation of cellular architecture compared to FNAC. The total sample quality score was significantly higher with FNNAC. Diagnostically superior samples were obtained more frequently with FNNAC, while FNAC acquired more diagnostically adequate samples. Non-diagnostic samples were less common with FNNAC. **Conclusion:** FNC is an approved sensitive and cost-effective method to evaluate thyroid nodules, FNNAC technique was found to be more convenient for both the patient and the operator with statistically significant improvement in total sample quality compared to FNAC.

Keywords: FNAC, FNNAC, Thyroid, Nodules, Ultrasound

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution- Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

INTRODUCTION

Thyroid nodules are prevalent in the endocrine system, affecting approximately thirty four percentage of randomly selected individuals, with a higher incidence among females [1]. Among detected nodules, the risk of malignancy ranges from 5% to 15% [2]. Fine-needle aspiration cytology (FNAC) was first introduced by Martin and Ellis in 1930 in the United States [3].Ultrasound-guided fine needle cytology biopsy has proven to be an accurate method for evaluating thyroid nodules, even those larger than 3 cm, with a false-negative rate of approximately 2% [4, 5]. Fine needle cytology (FNC) is commonly used for evaluating indeterminate thyroid nodules due to its safety, accuracy, and cost-effectiveness, aided by ultrasound guidance [6].Unsatisfactory specimens, particularly those mixed with blood, pose challenges to cytological interpretation. To address this, the fine needle non-aspiration cytology (FNNAC) technique was developed, relying solely on capillary pressure to draw cells into the needle bore [7]. Originally developed in France in 1982 by Briford et al., FNNAC, also known as cytopuncture, was initially designed for vascular organs to minimize hemorrhage and obtain less hemorrhagic cytology samples from breast lesions [7].FNNAC, devoid of syringe attachment, operates on the capillary principle, which dictates that fluid or semi-fluid material will ascend spontaneously in a tube, reducing trauma to samples [8]. Despite advancements in aspiration and evaluation techniques, onsite cytopathology analysis, and ultrasound guidance, up to 20% of initial aspirations may yield nondiagnostic results [9].

Numerous non-invasive tools have been utilized to evaluate thyroid nodules, with the American Thyroid Association revised guidelines being one of the most practical and convenient. These guidelines, initially described in 1996 and revised in 2009 and 2015, have led to more objective evaluation of thyroid nodules, decreased unnecessary fine needle cytology, and a reduction in unnecessary thyroidectomy operations [3].

Our study aims to compare the efficacy of FNAC and FNNAC techniques in acquiring FNC from thyroid nodules, with implications for optimizing diagnostic accuracy and reducing unnecessary procedures.

METHODS

Study Design and Participants

A prospective study enrolled 48 subjects from August 2020 to December 2023, all presenting with solid thyroid nodules and referred for ultrasound-guided fine needle cytology (FNC). Inclusion criteria encompassed patients with multiple or solitary solid thyroid nodules, regardless of age, sex, or thyroid profile. Exclusion criteria included a bleeding tendency defined by INR>1.7 or other coagulopathies. Comprehensive clinical histories, including anticoagulant usage, were obtained. FNC procedures were conducted with strict infection control measures, prioritizing patient safety, convenience, and confidentiality.

Sampling Procedure

A 23 G conventional needle was uniformly employed for all sampling by a single operator to mitigate bias. Sterilization and proper antiseptic measures preceded ultrasound-guided targeting of the most suspicious nodule based on ACR-TIRADS scoring. Local anesthesia was optional, with cold packs used for pain relief if requested. Sampling involved two passes for both non-aspiration (FNNAC) and aspiration (FNAC) techniques. Each pass comprised specific movements within the nodule under complete ultrasound guidance. Following sampling, material smearing and fixation were promptly performed, and slides were processed and stained using Papanicolaou stains.

Sample Quality Assessment

An expert pathologist assessed cytology results from FNNAC and FNAC based on criteria including background blood, cellular yield, preservation of cellular architecture, and degree of cellular trauma. The total sample quality score was determined by summing scores for each criterion. Data entry, processing, and statistical analysis were conducted utilizing MedCalc ver. 20 (MedCalc, Ostend, Belgium). Various tests of significance including paired t-test, Wilcoxon's, McNemar's, logistic regression analysis, ROC curve analysis, and Kappa statistics were employed. The presentation of data and subsequent analysis was tailored to the type of data obtained for each variable, distinguishing between parametric and non-parametric data. Statistical significance was determined by P values less than 0.05 (5%).

RESULTS

Forty-eight patients, consisting of 41 females and 7 males, participated in the study, with mean ages of 47.1 years for females and 50.6 years for males, ranging from 18 to 70 years. The mean INR was 1.1, and the mean nodule size was 2.57 cm. Ultrasound characteristics of the nodules are outlined in Table 2. Each of the 48 patients underwent fine needle cytology using both aspiration (FNAC) and non-aspiration (FNNAC) techniques. The results were evaluated by an expert pathologist blinded to the technique used, scoring each sample based on four criteria and calculating the total sample quality score. Statistical analysis revealed a significant difference between the non-aspiration and aspiration techniques, with FNNAC demonstrating higher cellular yield, less cellular trauma, and better preservation of cellular architecture, resulting in a superior total sample quality score. Although there was a statistically insignificant decrease in background blood with the aspiration technique, Table 3 provides a summary of the means and standard deviations for each criterion along with their respective p-values. The average total (sample quality) score was 7.708 ± 2.24 for FNAC and 8.792 ± 1.74 for FNNAC, with a significant P value of 0.011.

Table 4 presents the diagnostic categories reflecting the quality of the samples. FNNAC obtained more diagnostically superior samples compared to FNAC (60.4% vs. 37.5%, respectively), while FNAC acquired more diagnostically adequate samples than FNNAC (50% vs. 39.6%, respectively). Non-diagnostic samples were observed in only 12.5% of FNAC cases and 0% of FNNAC cases, with a significant P value of 0.024.

Table 1 Sample quality score

Background blood	**Large**	**Moderate**	**Minimal**
	1	**2**	**3**
Cellular Yield	Minimal	Sufficient	Abundant
	1	2	3
Cellular architecture	Lost	Moderately preserved	Preserved
	1	2	3
Cellular trauma	Marked	Moderate	Minimal
	1	2	3

©2024Int. J. LifeSci.Biotechnol.Pharma.Res.

Quality of sample	Non-diagnostic	Adequate	Superior
	1–4	5–8	9–12

Table 2 Ultrasound appearance of the nodules

	Category	Number	Percentage
Echo-pattern	**Hyperechoic**	**17**	**35.42%**
	Isoechoic	**11**	**22.92%**
	Hypoechoic	**20**	**41.67%**
Vascularity	**Unnoticeable**	**9**	**18.75%**
	Mild	**23**	**47.92%**
	Moderate	**13**	**27.08%**
	Marked	**3**	**6.25%**
Calcification	**Absent/Comet tail**	**32**	**66.67%**
	Punctuate	**7**	**14.58%**
	Macrocalcifications	**6**	**12.50%**
	Peripheral/eggshell	**3**	**6.25%**

Table 3 Mean scores for sample quality criteria

	FNAC		**FNNAC**		**P-value**
	Mean	**± S.D.**	**Mean**	**± S.D.**	
Background blood	1.979	0.79	1.938	0.78	0.755
Cellular yield	1.604	0.76	1.9375	0.70	0.012
Cellular trauma	2.271	0.84	2.58	0.61	0.038
Cellular architecture	1.85	0.82	2.33	0.72	0.003
Total score	7.708	2.24	8.792	1.74	0.011

Table 4 diagnostic quality categories percentage with each technique

Technique used / Diagnostic quality	FNAC		FNNAC	
	Number	Percentage	Number	Percentage
Non-diagnostic	6	12.5	0	0.0
Diagnostically adequate	24	50.0	19	39.6
Diagnostically superior	18	37.5	29	60.4

Table 5 Sample quality [17]

Category	FNAC	FNNAC
Diagnostically superior	40% ($n = 20$)	46% ($n = 23$)
Diagnostically adequate	24% ($n = 12$)	18% ($n = 18$)
Unsuitable for diagnosis	34% ($n = 17$)	38% ($n = 38$)

Table 6 Samples scores [17]

Criteria	FNAC	FNNAC	*P* value
Background blood	1.16	1.24	> 0.05
Amount of cellular material	1.35	1.42	> 0.05
Degree of cellular degeneration	1.18	1.32	> 0.05
Degree of cellular trauma	1.27	1.29	> 0.05
Retention of appropriate architecture	1.13	1.28	> 0.05

Table 7 Samples scores [5]

Criteria	FNAC	FNNAC	*P* value
Background blood	1.82 ± 0.42	1.87 ± 0.36	0.01
Amount of cellular material	1.28 ± 0.65	1.19 ± 0.65	0.04
Degree of cellular degeneration	0.99 ± 0.57	0.93 ± 0.62	0.1
Degree of cellular trauma	0.98 ± 0.58	0.93 ± 0.62	0.1
Retention of appropriate architecture	0.97 ± 1.03	0.83 ± 0.61	0.02
Total score	6.00 ± 2.17	5.76 ± 2.3	0.08

©2024Int. J. LifeSci.Biotechnol.Pharma.Res.

Table 8 Comparison between different studies regarding background blood using FNAC vs. FNNAC [11]

Background blood	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
Pinki et al., [12]	0.56	0.499	1.74	0.485
Ghosh et al., [16]	0.714	0.468	1.28	0.468
Mahajan et al., [15]	1.04	0.7348	1.32	0.8021
Kashi et al., [5]	1.82	0.42	1.87	0.36
de Carvalho et al., [13]	1.39	0.71	1.39	0.72

Table 9 Comparison between different studies regarding degree of cellular trauma using FNAC vs FNNAC [11]

Degree of cellular trauma	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
de Carvalho et al., [11]	1.7	0.61	1.74	0.55
Ghosh et al., [16]	1.07	0.474	1.357	0.497
Kashi et al., [5]	0.98	0.58	0.93	0.62
Mahajan et al., [15]	1.48	0.7141	1.52	0.7703
Pinki et al., [12]	1.32	0.584	0.85	0.479

Table 10 comparison between different studies regarding amount of cellular yield using FNAC vs FNNAC [11]

Amount of cellular yield	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
de Carvalho et al., [13]	1.54	0.68	1.51	0.69
Ghosh et al., [16]	1.28	0.611	1.375	0.497
Kashi et al., [5]	1.28	0.65	1.19	0.65
Mahajan et al., [15]	1.28	0.7371	1.36	0.8103
Pinki et al., [12]	1.25	0.557	1.76	0.474

Table 11 Comparison between different studies regarding degree of cellular degeneration using FNAC vs FNNAC [11]

Degree of cellular degeneration	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
de Carvalho et al., [13]	1.71	0.58	1.72	0.58
Ghosh et al., [16]	1.07	0.474	1.42	0.513
Kashi et al., [5]	0.99	0.57	0.93	0.62
Mahajan et al., [15]	1.48	0.7141	1.52	0.7703
Pinki et al., [12]	1.33	0.711	0.92	0.662

Table 12 Comparison between different studies regarding the retention of the appropriate cellular architecture using FNAC vs FNNAC [11]

Retention of appropriate cellular architecture	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
de Carvalho et al., [13]	1.63	0.67	1.58	0.69
Ghosh et al., [16]	0.92	0.257	1.357	0.497
Kashi et al., [5]	0.97	1.03	0.83	0.61
Mahajan et al., [15]	0.88	0.7257	1.12	0.7257
Pinki et al., [12]	0.96	0.53	1.83	0.428

©2024Int. J. LifeSci.Biotechnol.Pharma.Res.

Table 13 Comparison between different studies regarding the total sample quality score using FNAC vs FNNAC [11]

Total sample quality score	Technique			
	FNAC		FNNAC	
	Mean	± S.D	Mean	± S.D
de Carvalho et al., [13]	7.94	2.84	7.96	2.81
Kashi et al., [5]	6	2.17	5.76	2.3
Mahajan et al., [5]	6.16	2.8531	6.84	3.3749
Pinki et al., [12]	5.42	2.113	7.1	1.761
Torabizadeh et al., 2008	5.82	2.3	5.7	2.4

Table 14 Comparison between FNAC and FNNAC regarding diagnostic quality [10]

	FNAC		FNNAC	
	No	%	No	%
Diagnostically superior	18	19.7	42	46.1
Diagnostically adequate	62	68.2	44	48.6
Unsuitable	11	12.08	5	5.49

DISCUSSION

Fine needle cytology (FNC) stands as a cornerstone in the evaluation of thyroid nodules due to its safety and high sensitivity. However, suboptimal sample quality remains a significant challenge, often necessitating repeat procedures to obtain satisfactory samples. Our study aimed to address this issue by investigating whether the non-aspiration technique could yield superior sample quality compared to the conventional aspiration technique.

The non-aspiration technique, introduced as cytopuncture in 1982 by Brifford et al., was developed to minimize sample contamination and improve sample quality. Despite its potential advantages, this technique has not been widely adopted in FNC procedures, and only a few studies have compared its effectiveness in acquiring quality samples to the conventional aspiration technique.The non-aspiration technique involves inserting the fine needle directly into the nodule without attaching a syringe for aspiration. Instead, it relies on capillary action within the narrow needle channel, where fluid ascends spontaneously. Our prospective study aimed to assess the diagnostic quality of FNC samples obtained using aspiration versus non-aspiration techniques, with the goal of enhancing overall sample quality and improving the evaluation of thyroid nodules to avoid unnecessary repeat procedures and thyroidectomies.

Our results, based on 48 patients with solid thyroid nodules, demonstrated a statistically significant improvement in sample quality with the non-aspiration (FNNAC) technique. This improvement was characterized by less cellular trauma, higher cellular yield, and better preservation of cellular architecture. Although there was no significant decrease in background blood, the overall sample quality score favored FNNAC.Additionally, the non-aspiration technique offered patient convenience, as the absence of a visible syringe during sampling reduced anxiety. Moreover, it facilitated operator comfort and control, as handling only the needle allowed for better maneuverability and reduced trauma in cases of patient swallowing.Comparing our findings with previous studies, Maurya et al. (2010) and a larger study conducted from 2006 to 2008 both observed trends similar to ours, with non-aspiration techniques yielding more diagnostically superior samples but also more inadequate samples compared to aspiration techniques. However, the latter study reported slight differences in background blood, cellular material, cellular degeneration, and retention of cellular architecture between the two techniques.

A meta-analysis by Song et al. (2015) reinforced these observations, with varied results across different studies regarding background blood, cellular trauma, cellular yield, cellular degeneration, and retention of cellular architecture. Our study adds to this body of evidence by providing consistent support for the superiority of the non-aspiration technique in sample quality.Although our study had limitations, including a small sample size and the lack of tissue histopathology for patients with negative malignancy by FNC, the results underscore the potential of the non-aspiration technique to enhance FNC sample quality.

In conclusion, both aspiration and non-aspiration techniques have their merits in acquiring cytology samples. However, our findings suggest that the non-aspiration technique offers superior sample quality, with implications for both patients and operators. Combining both techniques may further optimize sample acquisition, particularly in challenging cases.

REFERENCES

1. Moon JH, Hyun MK, Lee JY et al (2018) Prevalence of thyroid nodules and their associated clinical parameters: a large-scale, multicenter-based health checkup study. Korean J Intern Med 33(4):753–762. https://doi.org/10.3904/kjim.2015.273
2. Jiang H, Tian Y, Yan W et al (2016) The prevalence of thyroid nodules and an analysis of related lifestyle factors in Beijing communities. Int J Environ Res Public Health 13(4):1–11.

©2024Int. J. LifeSci.Biotechnol.Pharma.Res.

3. Kaur DS, Garg DU, Kaur DS, Singh DK, Kamra D, Verma DS (2014) Comparison of aspiration VS non-aspiration techniques in fine needle cytology of thyroid lesions. IOSR J Dent Med Sci. 13(5):97–101. https://doi.org/10.9790/0853-135497101
4. Yoon JH, Kwak JY, Moon HJ, Kim MJ, Kim EK. The diagnostic accuracy of ultrasound-guided fine-needle aspiration biopsy and the sonographic differences between benign and malignant thyroid nodules 3 cm or larger. Thyroid. 2011 Sep;21(9):993-1000. doi: 10.1089/thy.2010.0458. Epub 2011 Aug 11. PMID: 21834673.
5. Kashi Z, Torabizadeh Z, Akha O, Yaseri A, Shahidi MH, Mokhtare M (2011) Combination of aspiration and non-aspiration fine needle biopsy for cytological diagnosis of thyroid nodules. Caspian J Intern Med 2(4):299
6. Parsa AA, Gharib H. Update on thyroid nodule management US Endocrinology. 2019; 15 (1):32-8
7. Briffod M, Gentile A, Hebert H (1982) Cytopuncture in the follow-up of breast carcinoma. Acta Cytol 26(2):195–200
8. Aysan E, Ersoy Y, Gucin Z, Cengiz M, Akbulut H, Arici S, Muslumanoglu M (2014) New thyroid fine needle aspiration biopsy needle. Prospective, randomized, clinical study. Clin Endocrinol
9. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, Pacini F, Randolph GW, Sawka AM, Schlumberger M, Schuff KG (2016) 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 26(1):1–33
10. Sasikumar MN, Mammen SC, Thomas JP (2018) A comparative study of fine needle aspiration cytology versus non aspiration technique in thyroid lesions. Int Surg J 5(2):483–486
11. Song H, Wei C, Li D, Hua K, Song J, Maskey N, Fang L (2015) Comparison of fine needle aspiration and fine needle nonaspiration cytology of thyroid nodules: a meta-analysis. BioMed Res Int 2015.
12. Pinki P, Alok D, Ranjan A, Chand MN. Fine needle aspiration cytology versus fine needle capillary sampling in cytological diagnosis of thyroid lesions. Iran J Pathol. 2015;10(1):47.
13. de Carvalho GA, Paz-Filho G, Cavalcanti TC, Graf H. Adequacy and diagnostic accuracy of aspiration vs. capillary fine needle thyroid biopsies. Endocrine Pathology. 2009;20(4):204–208. https://doi.org/10.1007/s12022-009-9092-0.
14. Tessler FN, Middleton WD, Grant EG, Hoang JK, Berland LL, Teefey SA, Cronan JJ, Beland MD, Desser TS, Frates MC, Hammers LW, Hamper UM, Langer JE, Reading CC, Scoutt LM, Stavros AT. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White Paper of the ACR TI-RADS Committee. J Am Coll Radiol. 2017;14(5):587–595. https://doi.org/10.1016/j.jacr.2017.01.046.
15. Mahajan P, Sharma PR. Fine-needle aspiration versus non aspiration technique of cytodiagnosis in thyroid lesions. JK Sci. 2010;12(3):120–122.
16. Ghosh A, Misra RK, Sharma SP, Singh HN, Chaturvedi AK. Aspiration vs nonapiration technique of cytodiagnosis—a critical evaluation in 160 cases. Ind J PatholMicrobiol. 2000;43(2):107–112.
17. Maurya AK, Mehta A, Mani NS, Nijhawan VS, Batra R (2010) Comparison of aspiration vs non-aspiration techniques in fine-needle cytology of thyroid lesions. J Cytol/Indian AcadCytolog 27(2):51

©2024Int. J. LifeSci.Biotechnol.Pharma.Res.