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original article

Comparison of the Efficacy and the Safety between Suction and Non-Suction Techniques of Fine Needle Cellular Biopsy of the Thyroid Nodules

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Abstract

Background: Fine needle aspiration with adequate cytological evaluation has contributed to reduction of unnecessary thyroid surgeries for benign nodules of up to 50 %. **This study aimed to** compare the diagnostic efficacy and accuracy between suction and non-suction technique of fine needle cellular biopsy of the thyroid nodules. **Methods:** This prospective study included patients with thyroid nodules warranting FNAC based on TIRADS classification. The selected nodules were aspirated under ultrasound guidance at least twice, using both FNA+P and FNA-P techniques. The adequacy and diagnostic value of the cytological samples were assessed by two blinded cytologists. Complications were recorded, and immediate complications were linked to specific needle passes. **Results**: The mean age was 32.08 ± 7.83 years. 47% of the subjects were younger than 30 years, 35% were between 31 and 40 years, and 18% were older than 40 years. There was a significant higher number of cases under the age of 30 years (p=0.002). 92% of the subjects were female and 8% were male. There was a significant difference in gender distribution, with more females than males included in the study (p<0.001). Fine needle aspiration with suction showed higher sensitivity (97.53%), accuracy (97%), PPV (94.88) and NPV (97.46%) compared to non-suction technique. Both techniques had high AUC for predicting adequate diagnosis (p <0.001). **Conclusion:** FNA with suction demonstrated significantly higher adequacy in diagnosis prediction compared to non-suction technique. Moreover, fine needle aspiration with suction showed higher sensitivity, accuracy, PPV, and NPV compared to the non-suction technique.

Keywords: Suction; Non-Suction; Fine Needle; Cellular Biopsy; Thyroid Nodules.

Introduction

Ultrasound (US) is the modality of choice in characterization of thyroid nodules, which prevalence is high reaching up to 70 %. Although only 10% of thyroid nodules are malignant, fine needle aspiration (FNA) is an essential part for their evaluation. Since 1980s, thyroid fine needle aspiration has been considered the most accurate and effective method in differentiation between benign and malignant nodules. More recently, it become usually indicated regarding to "Thyroid imaging reporting and data system" (TI-RADS) (1).

Fine needle aspiration with adequate cytological evaluation has contributed to reduction of unnecessary thyroid surgeries for benign nodules of up to 50 % (2). Although, it is safe and effective, but now there is increasing rate of non-diagnostic cytology reaching up to 34% (3).

There are two techniques of FNA: 'without negative pressure' which reduces blood contamination of the sample, and 'with negative pressure' which increases the sensitivity of the result (4).

The purpose of this study was to compare the diagnostic efficacy and accuracy between suction and non-suction technique of fine needle cellular biopsy of the thyroid nodules.

Patients and methods

This prospective diagnostic accuracy study was carried out on 100 patients presented to the Radiology Department in Benha University Hospital and were candidates for thyroid FNAC, during the period from January 2022 to December 2022.

An informed written consent was obtained from the patients. Every patient received an explanation of the purpose of the study and had a secret code number. The study was done after being approved by the Research Ethics Committee (Ms 26.3.2022), Faculty of Medicine, Benha University.

Inclusion criteria were all patients with thyroid nodules warranting fine needle aspiration and cytology according to Thyroid Imaging Reporting and Data System (TIRADS).

Exclusion criteria were patients with major coagulopathy, that hinders performance of any invasive procedure and patients whose cytological results are not available.

All the study patients underwent superficial ultrasound examination of the thyroid gland using GE Logic P6 ultrasound machine, linear probe 12L-RS (5-12MHz).

The patients who showed thyroid nodules were selected and TIRADS classification for each nodule was calculated.

The patients whom nodules were candidates for FNAC according to TIRADS classification -with no

contraindications- were enrolled in the study sample.

Each thyroid nodule in the study was aspirated under ultrasound guidance -at least- twice: 1. At least one time, fine-needle aspiration with suction (FNA+P). 2. At least one time, fine-needle aspiration without suction (FNA-P).

A 5-mL syringe and a 23-G needles were used in the FNA+P approach. The needle attached to the syringe with an approximately 3-mL vacuum suction applied after the needle is inserted to the center of the nodule under ultrasonographic guidance. Several passes through the nodule were performed with back-and-forth maneuver from different orientations and then released when the sample became visible in the hub of needle. The negative pressure is released before the needle is withdrawn.

The FNA-P approach was performed by simply inserting 23G needle to the center of the mass under ultrasonographic guidance. The recurrent rocking and rotation of the needle into the nodule is performed till sample is collected in the hub of needle via capillary action.

The samples are then spread on slides and fixed using 95% alcohol. The slides obtained by suction technique and those obtained by non-suction technique will be prepared and marked separately.

Any complications occurred would be recorded, and if it is immediate after procedure its will be recorded; it occurs after which needle pass. The slides are examined by two cytologist (in a blind manner) and are assessed whether it is cytologically adequate and diagnostic or non-diagnostic.

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test and ANOVA (F) test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. McNemer test was used to check marginal homogeneity of two dichotomous variables. The ROC Curve (receiver operating characteristic) provides a useful way to evaluate the sensitivity and specificity for quantitative diagnostic measures that categorize cases into one of two groups. The optimum cut off point was defined as that which maximized the AUC value. AUC is that a test with an area greater than 0.9 has high accuracy, while 0.7–0.9 indicates moderate accuracy, 0.5–0.7, low accuracy and 0.5 a chance result. A two tailed p value < 0.05 was considered statistically significant.

Results

The current study was carried out on 100 subjects with 100 thyroid nodules and underwent fine needle aspiration with and without suction. The mean age was 32.08 ± 7.83 years. In terms of age groups, 47%

of the subjects were younger than 30 years, 35% were between 31 and 40 years, and 18% were older than 40 years. There was a significantly higher number of cases under the age of 30 years (p=0.002). In terms of gender, 92% of the subjects were female and 8% were male. There was a significant difference in gender distribution, with more females than males in the current study (p<0.001) (**Table, 1).**

The mean lesions diameter was 2.58 ± 0.60 cm. In terms of TI-RADS classification, 86% of the nodules were classified as TI-RAD 3, 10% as TI-RAD 4, and 4% as TI-RAD 5. There was a significant high number of patients with TI-RAD 3 classification (p<0.001).

The mean lesion diameter in patients with TI RAD 3 classification was significantly the highest compared to TI RAD4 and TI RAD 5 patients (p<0.001*) (**Table, 2).**

Based on the pathological nature of thyroid nodules in the studied subjects: 66% of the nodules were diagnosed as benign, 17% were diagnosed as malignant, and 17% were inadequate for diagnosis. There was a significant high distribution of benign nodules among the studied subjects (p<0.001) (**Table, 3).**

According to association of lesion types with TI RAD classification, among nodules classified as TI RAD 3, 72.1% were diagnosed as benign, 10.5% as malignant, and 17.4% were inadequate for diagnosis. Among nodules classified as TI RAD 4, 40% were diagnosed as benign, 40% as malignant, and 20% were inadequate for diagnosis. Among nodules classified as TI RAD 5, 100% were diagnosed as malignant. A significantly high distribution of lesions was benign and classified as TI RAD 3 (p<0.001).

According to the adequacy of fine needle aspiration (FNA) with suction versus FNA without suction (non-suction technique), FNA with suction is significantly more adequate in diagnosis prediction compared to FNA without suction (CI: 0.401-0.738, p-value <0.001).

Fine needle aspiration with suction showed higher sensitivity (97.53%), accuracy (97%), PPV (94.88) and NPV (97.46%) compared to non-suction technique. Both techniques had high AUC for predicting adequate diagnosis (p<0.001) (**Table, 4).**

Table 1. Demographic data in the studied subjects

Variable		Total subjects n=100	test	*p*
Age (years)	Mean ±SD	32.08 ± 7.83	-	-
Age groups, n (%)	<30 years	47 (47%)	X^2=1.274	0.002*
	31.00 - 40.00 years	35 (35%)		
	>40 years	18 (18%)		
Gender, n (%)	Male	8 (8%)	X^2=7.056	<0.001*
	Female	92 (92%)		

X^2=Chi square test; *: Significant ≤0.05

Table 2. Association between lesion diameter and TI RAD classification

Variable	Total subjects n=100	*test*	*p*
TI RAD 3 lesion diameter, cm	2.71 ± 0.53	K= 3.111	<0.001*
TI RAD 4 lesion diameter, cm	1.72 ± 0.09		
TI RAD 5 lesion diameter, cm	1.88 ± 0.02		

K=Kruskal Wallis test; *: Significant ≤0.05

Table 3. Pathological nature of thyroid nodules in the studied subjects

Variable		Total subjects n=100	test	*p*
Diagnosis, n (%)	Benign	66 (66%)	X2=4.802	<0.001*
	Malignant	17 (17%)		
	Unsatisfactory	17 (17%)		

X^2=Chi square test; *: Significant ≤0.05

Table 4. Validity of fine needle aspiration with and without suction techniques in predicting adequate diagnosis

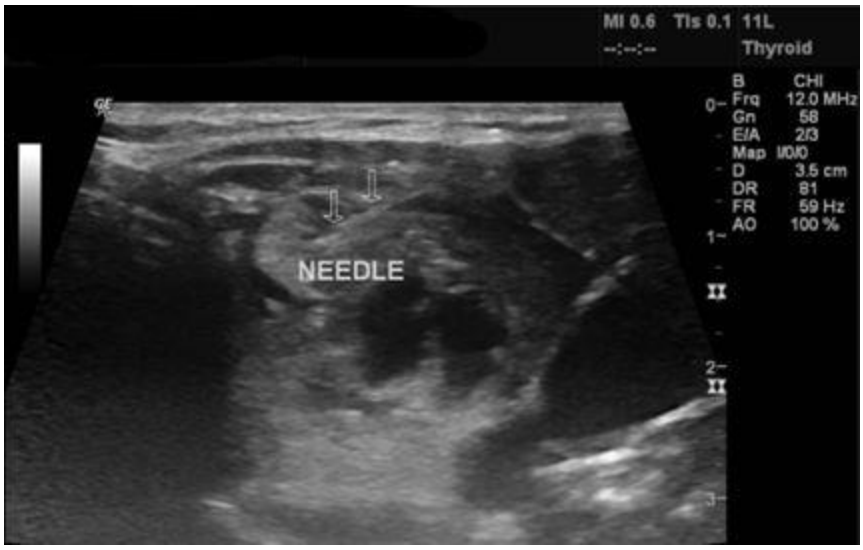
Validity	FNA +P	FNA -P
	(%)	(%)
Sensitivity rate	97.53	75.31
Specificity rate	94.74	94.74
Accuracy rate	97	79
PPV	94.88	93.47
NPV	97.46	79.99
AUC	0.961	0.850
p	<0.001*	<0.001*

AUC, Area under curve; PPV: Positive predictive value; NPV: Negative predictive value; *: Significant ≤0.05.

Cases:

Case (1): A 32 years olds female patient with left thyroid nodule (TR 3) measuring about 3 cm, underwent FNAC by both suction and non-suction techniques and pathologically proven to be equally diagnostic (benign) (Fig.,1).

Case (2): A 20 years olds female patient with left thyroid nodule (TR 3) measuring about 3.5 cm, underwent FNAC by both suction and non-suction techniques and pathologically proven that suction is better in diagnosis (benign follicular lesion) (Fig., 2).



Fiugre 1: Female patient 32 y with left thyroid nodule (TR 3) measuring about 3 cm, underwent FNAC by both suction and non-suction techniques and pathologically proven to be equally diagnostic (benign).

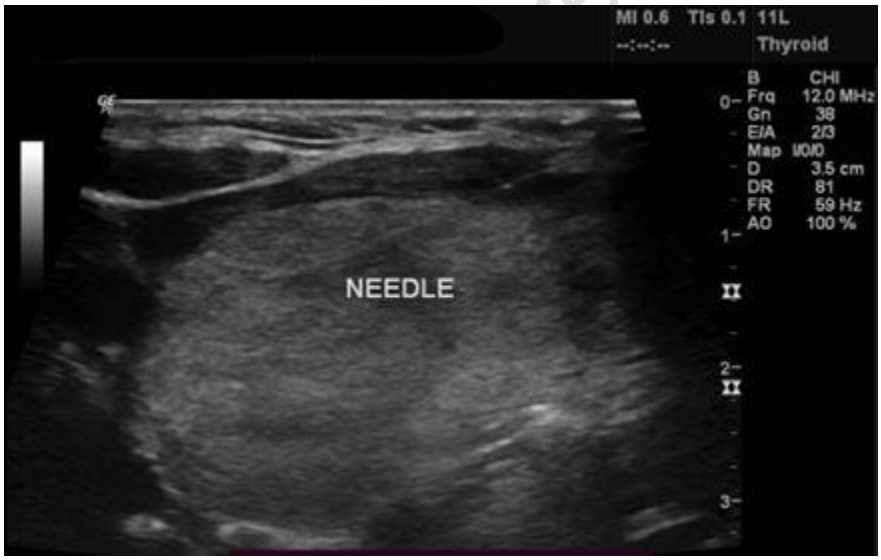


Figure 2: Female patient 20 y with left thyroid nodule (TR 3) measuring about 3.5 cm, underwent FNAC by both suction and non-suction techniques and pathologically proven that suction is better in diagnosis (benign follicular lesion).

Discussion

Regarding the demographic data of the studied patients: The patients' mean age was 32.08 ± 7.83 years. In terms of age groups, 47% of the subjects were younger than 30 years, 35% were between 31 and 40 years, and 18% were older than 40 years. There was a significantly higher number of cases under the age of 30 years (p=0.002). In terms of gender, 92% of the subjects were female and 8% were male. There was a significant difference in

gender distribution, with more females than males included in the study (p<0.001).

It is worth noting that most patients with benign thyroid nodules are commonly observed in individuals under the age of 40, with a higher prevalence among females. Epidemiological studies have consistently reported a higher incidence of thyroid nodules in women, with a female-to-male ratio ranging from 3:1 to 5:1 (5, 6).

Although the exact reasons for this gender disparity remain unclear, hormonal factors and genetic predisposition have been postulated as contributing factors (7). Understanding the demographic characteristics of patients with thyroid nodules, particularly the predominance of females and younger age groups, is crucial for optimizing diagnostic approaches and tailoring management strategies.

The epidemiological results of the current study were in line with another study which questioned better technique for acquiring FNAC from thyroid nodules; whether aspiration (FNAC) or non-aspiration technique (FNAC). Forty-eight subjects were enrolled in their prospective study. A single operator performed all the sampling procedures using a 23 G conventional needle. The needle was inserted directly into the target nodule using a uni-directional pathway. Two passes were performed for both the non-aspiration (FNNAC) and aspiration (FNAC) techniques. Forty-eight patients (41 (85%)females, 7(15%) males, median age in women were 47.1, median age in males was 50.6, age range 18–70, age range in females 18–70, age range in males 33–62) with solid thyroid nodules (8).

Furthermore, a previous study investigated the diagnostic reliability of the daily use of TIRADS classification system, in differentiating between a benign and a malignant lesion. Thirty patients with thyroid nodules underwent ultrasound examination and fine needle aspiration. The ultrasound studies were evaluated according to the TIRADS characteristics of composition, echogenicity, margins, shape, and echogenic foci. Their gender distribution is in line with our current study. But the average age of their study patients was higher (median age was 47 years “range, 21 – 71”) than the current study (9).

Supporting our results, a study determined the diagnostic accuracy rates of thyroid FNAC results reported a total 273 patients with thyroid swelling which includes 243 females and 30 males with F: M ratio of 12.3:1. Age of the patients ranged from 15 to 60 years (10).

Compatibly, a descriptive - analytical study evaluated the adequacy of prepared samples by the combination of aspiration and non- aspiration fine needle biopsy. The authors studied three hundred two cases (289 were females, 13 were males) with a mean age of 43.83±12.9 years (11).

The mean lesions diameter was 2.58 ± 0.60 cm. In terms of TI-RADS classification, 86% of the nodules were classified as TI-RAD 3, 10% as TI-RAD 4, and 4% as TI-RAD 5. There was a significant higher number of patients with TI-RAD 3 classification (p<0.001). The mean lesion diameter in patients with TI RAD 3 classification was significantly the highest among TI RAD4 and TI RAD 5 patients (p<0.001).

In harmony with our findings, a study reported that the mean lesion diameter was 2.57 cm (8).

Based on the pathological nature of the thyroid nodules in the studied subjects: 66% of the nodules were diagnosed as benign, 17% were diagnosed as malignant, and in 17% the samples were inadequate for diagnosis. There was a significant higher distribution of benign nodules among the studied subjects (p<0.001).

Consistently, a study reported that out of the 30 nodules included in the study, 23 were found to be benign and 7 were found to be malignant with statistically significant difference (p-value <0.05) (9).

In addition, a study compared the efficacy and complications of core-needle biopsy (CNB) with those of fine-needle aspiration (FNA) in a large population of patients with initially detected thyroid nodules via a propensity score analysis. The study included 4,822 thyroid nodules from 4,553 consecutive patients. They found in the FNA group that the mean size of the 2,708 nodules was 1.24 ± 0.82 cm, with 1,474 nodules (54.5%) being ≥ 1.0 cm (12).

According to the association of lesion types with TI RAD classification, among nodules classified as TI RAD 3, 72.1% were diagnosed as benign, 10.5% as malignant, and in 17.4% the samples were inadequate for diagnosis. Among nodules classified as TI RAD 4, 40% were diagnosed as benign, 40% as malignant, and in 20% the samples were inadequate for diagnosis. Among nodules classified as TI RAD 5, 100% were diagnosed as malignant. A significant high distribution of lesions was benign and classified as TI RAD 3 (p<0.001).

A study reported the risk of malignancy for all ultrasound features, an increasing trend with higher scored feature. All nodules in TIRADS 1,2 and 3 scores were benign, 1 out of 7 nodules in TIRADS 4 was malignant, all nodules in TIRADS 5 revealed malignancy. They reported that there was statistically significant difference between benign and malignant lesion regarding TIRADS classification, with benign lesion was detected from TIRADS 1 to 4 (34.8% were TIRADS 2&3, 26.1% was TIRADS 4 and 0.3 % were TIRADS 1). Malignant lesions were distributed among TIRADS 4&5 (85.7% were TIRADS 5 and 14.3% ere TIRADS 4) (9).

Similar results to ours, were reported by a study where there was a significant difference between benign and malignant cases regarding TIRADS findings (p =

0.003). There was a positive correlation between TI-RADS score and risk of malignancy (13).

A retrospective study was done to correlate the Thyroid Imaging Reporting and Data System (TI-RADS) with the reporting of cytopathology in 1,000 thyroid nodules. They evaluated 1,000 thyroid nodules of 906 patients who underwent ultrasound exam and fine needle aspiration. The proportion of malignancies among TI-RADS 2 was 0.8%, and TI-RADS 3 was 1.7%. Among those classified as TI-RADS 4A, the proportion of malignancies was 16.0%, 43.2% in 4B, 72.7% in 4C, and 91.3% among TI-RADS 5 ($p<0.001$), demonstrating a clear association between TI-RADS and biopsy results (14).

In the present work, according to the adequacy of fine needle aspiration (FNA) with suction versus FNA without suction (non-suction technique), FNA with suction gave significantly more adequate smear for diagnosis compared to FNA without suction ($p<0.001$). Fine needle aspiration with suction showed higher sensitivity (97.53%), accuracy (97%), PPV (94.88%) and NPV (97.46%) compared to non-suction technique.

Also another study showed that the diagnostic accuracy of FNAC was 95.7%. Fine needle aspiration cytology showed a sensitivity of 96.4% (10). Our results were comparable to Erkinuresin and Demirci results, however they were higher than other studies that reported that the sensitivity of thyroid FNAC ranges from 52% to 93.5%, and accuracy from 79.1% to 87% (15-17).

Few studies were conducted to evaluate the difference between sample quality acquired by aspiration and non-aspiration techniques. In 2010, over 50 thyroid lesions were studied to compare the samples obtained by both techniques. They found that samples acquired by non-aspiration technique were more diagnostically superior with better overall sample quality but the difference was not statistically significant. On the other hand, the non-aspiration technique yielded more inadequate sample than those yielded by the aspiration technique (18).

Another larger study was conducted over 289 patients with thyroid nodules, showed that aspiration technique yielded more number of diagnostically superior samples 122 (42.2%) than non-aspiration technique 98 (33.9%), moreover non-aspiration technique lead to more unsatisfactory samples 40 (13.8%) versus only 31 (10.7%) in aspiration technique, however, there was slight difference between the two techniques regarding the background blood, amount of cellular material, degree of cellular degeneration, and retention of cellular architecture (11).

In contrast to our findings, a study reported that FNNAC (fine needle non-aspiration cytology) showed higher number of overall diagnostically sufficient samples, with higher percentage of diagnostically superior samples compared to FNAC. The

percentage of non-diagnostic samples was higher with FNAC (12.5%) compared to FNNAC (0%). The reported *p*-value of 0.024 suggests that there was a statistically significant difference between the two techniques (8).

In contrast to fore-mentioned three studies, a study reviewed sixteen studies comprising 1,842 patients and 2,221 samples study, they found that no statistically significant difference between FNAC and FNNAC groups with respect to diagnostically inadequate smears, diagnostically superior smears, diagnostic performance (accuracy, sensitivity, specificity, negative predictive value, and positive predictive value) (19).

Conclusion

Our study found that on comparing the two techniques of FNAC, fine needle aspiration with suction demonstrated significantly higher adequacy in diagnosis prediction compared to non-suction technique. Moreover, fine needle aspiration with suction showed higher sensitivity, accuracy, PPV, and NPV compared to the non-suction technique. These findings reveal that the use of suction during fine needle aspiration of thyroid nodules improves diagnostic efficacy and accuracy, leading to better prediction of the pathological nature of the nodules. Fine needle aspiration with suction can be considered a preferred technique for obtaining adequate and reliable diagnostic samples in the evaluation of thyroid nodules.

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