ULTRASOUND GUIDED FINE NEEDLE ASPIRATION CYTOLOGY (FNAC) VERSUS FINE NEEDLE CAPILLARY SAMPLING (FNCS) OF THYROID NODULES

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Abstract

Background: Sampling of non-palpable thyroid nodule under ultrasound guidance has been widely used. However, there are relatively few studies to compare the efficacy of technique between fine needle aspiration cytology (FNAC) and fine needle capillary sampling (FNCS) under ultrasound guidance. This study aimed to determine the cytologic adequacy rates and sample quality obtained by both techniques under ultrasound guidance.

Methods: Ultrasound guided thyroid nodule samplings were performed on 88 patients, 44 of whom had FNAC and another 44 the FNCS technique. The slides obtained were scored using a predetermined scoring system comparing five parameters: background blood, amount of cellular material, appropriate architecture retention, degree of cellular degeneration, and cellular trauma. The results were analyzed using independent T-test and chi-square test.

Results: A statistically significant difference in favor of FNAC was observed for the parameter amount of cellular material. For the rest of the parameter, individual total score favored FNAC for the parameter degree of cellular degeneration and retention of appropriate architecture whereas the score favored FNCS for the parameter background blood clot and degree of cellular trauma. In overall, total score for FNAC was better than FNCS. However, these results were not statistically significant. Diagnostic adequacy rates between the two techniques were similar in both techniques and showed no significant difference.

Conclusions: Ultrasound guided FNAC and FNCS yielded comparable diagnostic adequacy rates. Our study did not prove a clear superiority of FNCS over FNAC or vice versa. Both techniques could be used in tandem to achieve better diagnostic accuracy.

Keywords: Fine Needle Aspiration Cytology (FNAC), Fine Needle Capillary Sampling (FNCS), Ultrasound Guided

Introduction

The prevalence of goitre and thyroid nodules in the Malaysian population is 9.3% and 3.6% respectively (1). Differentiating thyroid nodules as benign or malignant nodule is important, as early detection of malignant nodule with prompt surgical management reduces patient morbidity. Sonographic features can suggest a malignant nature of thyroid nodules such as taller-than-wide lesion, irregular hypoechoic lesion as well as the presence of microcalcification, but they are not confirmatory (2, 3). Cytology and histopathology of thyroid nodule are required to obtain a definitive diagnosis (4).

There are two methods available for cytology sampling of thyroid nodules. Fine needle aspiration cytology (FNAC) is the first line diagnostic method in evaluating thyroid nodules since decades and has been used extensively since 1950s in Europe (5, 6). It has several advantages of being minimally invasive and yet has a high degree of specificity and sensitivity (7, 8). However, with some unsatisfactory samples especially those mixed with blood obtained by FNAC technique (9, 10), fine needle capillary sampling (FNCS) has emerged as an alternative technique for thyroid nodule sampling. This FNCS technique, pioneered in France in the 1980s, uses the principle of capillary suction of fluid or semifluid into a fine needle, thus reducing bleeding and trauma to the thyroid tissue (11). FNCS has the advantage of easier needle manipulation especially for neck organs and lymph nodes, lesser contamination of blood as well as better appreciation of nodule consistency (12). Santos and Leiman (1988) were the first to compare FNAC versus FNCS thyroid nodule sampling using palpation (not imaging guided) directed technique (13). The use of ultrasound (image guided) directed thyroid sampling has been shown to increase the sampling adequacy rates compared to palpation directed technique and allows us to obtain cytological diagnosis of thyroid lesion which is inaccessible by palpation (14).

Most of the few prior studies evaluated the adequacy rate of palpation directed sampling technique between FNAC and FNCS. Some studies showed statistically significant difference between the performance/efficacy of FNAC and FNCS (13, 15) while other studies showed no significant difference between these two techniques (16). The relative benefit of each technique when coupled with ultrasound guidance was only conducted in one study performed on 180 thyroid nodules. The study revealed FNCS and FNAC sampling resulted in almost identical sample adequacy rates (17). The objective of this study was to determine the cytology adequacy rate and compare the quality of samples obtained by FNCS versus FNAC under ultrasound guidance.

Materials and Methods

Study design

A prospective cohort study was conducted on 88 patients (aged 18 to 80 years old) who were referred from Surgical Department Hospital Seberang Jaya for ultrasound guided fine needle cytology sampling of thyroid nodule from year 2020 to 2021. Patients who were pregnant, on anticoagulant and patients with predominantly cystic thyroid lesion determined on ultrasound were excluded from this study.

Sampling design

By means of a ballot system, the 88 patients were randomized equally into two groups (44 patients in each group). One group underwent ultrasound guided FNAC and another group underwent ultrasound guided FNCS of the thyroid nodules. The fine needle sampling was performed by a single radiologist. All slides were interpreted by a single cytopathologist without any prior knowledge of which technique was used, thus preventing observer bias.

Ethical consideration

This study was conducted in compliance with ethical principles outlined in the Declaration of Helsinki and Malaysian Good Clinical Practice Guideline. Informed written consent from all patients involved in this study was obtained. The study protocol was registered on National Medical Research Registry (NMRR-18-3840-45237).

Pre-procedures

In pre-procedures, the patient laid in the supine position with the neck extended by placing a pillow behind the neck. Using a 12 MHz linear array probe of ultrasound (GE Healthcare), the targeted thyroid nodule was localized. The overlying skin was cleaned with 10% povidone solution. The patient was told not to swallow or talk during the procedure. Local anaesthesia of 1 to 2 ml 1% lidocaine was given to all patients. 23 G needles were used for the procedure. The nodule for cytology was localized using an ultrasound transducer in a transverse plane. The short axis approach was used where the needle entrance point was in the middle of the transducer surface and the needle shaft was traced during the advancement, and the tip of the needle was seen as a bright echogenic focus. Ultrasound guided fine needle cytology has the advantages over palpation guided fine needle cytology in that it allowed for cytology sampling of smaller non-palpable lesion and sampling of deep-seated thyroid lesion.

Fine needle aspiration cytology (FNAC)

During FNAC, a 10 ml syringe was attached to a 23 G needle. Under ultrasound guidance, the needle was advanced into the thyroid nodule, suction was applied and the needle was moved quickly back and forth. Suction pressure was released once aspirated material appeared in the needle hub and the needle was withdrawn. The needle was then disconnected from the syringe. Syringe was then prefilled with air and reconnected to the needle. The aspirated material was expelled onto glass slides and smears were prepared.

Fine needle capillary sampling (FNCS)

In FNCS, a 23 G needle was inserted into the thyroid nodule under ultrasound guidance without attaching to a syringe (Figure 1). The needle was moved back and forth in different directions. The cells were detached by the cutting edge of the needle. The needle was then withdrawn and attached to an air-filled syringe to express the material onto glass slides.

Smears preparation

Four slides were prepared with the samples obtained from the thyroid lesion. Two smears were fixed in 95% ethyl alcohol for subsequent Papanicolaou staining, and another two smears were air-dried and stained by May Grunwald-Giemsa stain.

Interpretation of smears

The smears were scored according to criteria using a predetermined scoring system developed by Mair et al. (1989) (16) as explained in Table 1. The two sampling techniques (FNAC and FNCS) were compared using five objective parameters which include background blood or clot, amount of cellular material, degree of cellular degeneration, degree of cellular trauma and retention

Figure 1: Technique of FNCS sampling

Table 1: Point scoring system to classify quality of cytological aspirate

Criteria	Quantitative description	Points
Background blood or clot	Large amount; great compromise to diagnosis	0
	Moderate amount; diagnosis possible	1
	Minimal; diagnosis easy; specimen of textbook quality	2
Amount of cellular material	Minimal to absent; diagnosis not possible	0
	Sufficient for cytological diagnosis	1
	Abundant	2
Degree of cellular degeneration	Marked; diagnosis impossible	0
	Moderate; diagnosis possible	1
	Minimal; diagnosis obvious	2
Degree of cellular trauma	Marked; diagnosis impossible	0
	Moderate; diagnosis possible	1
	Minimal; diagnosis obvious	2
Retention of appropriate architecture	Minimal to absent; diagnosis not possible	0
	Moderate; some preservation of architecture	1
	Excellent; architecture display closely resembling histology, diagnosis obvious	2

of appropriate architecture. A cumulative score between 0 and 10 points was allocated to each specimen. The specimens were then divided into three categories based on cumulative scores obtained: Unsuitable for diagnosis (0-2 points); Adequate for cytological diagnosis (3-6 points); Diagnostically superior (7-10 points). Diagnostically adequate samples were those samples graded as adequate for cytological analysis and diagnostically superior samples. Cytopathologic diagnoses of the thyroid lesions were recorded.

Statistical analysis

All statistical analysis was performed using Statistical Package for Social Science (SPSS) Version 26.0 and p-value of less than 0.05 was considered to be significant. Results of the categorical variables were described with frequency and percentage (%). Results of the continuous variables were described with mean and standard deviation. All the data was normally distributed. Independent T-test was used determine the significant difference between the two fine needle cytology sampling techniques for each parameter. The significant difference in diagnostic adequacy rates between the techniques were assessed with chi-square test.

Results

Among 88 patients who participated in this study, 76 (86.4%) were female and 12 (13.6%) were male. Patient's distribution according to ethnicity showed highest frequency of Malay patients which was 48 (54.5%) followed by 23 (26.1%) from Chinese, 16 (18.2%) from Indians and 1 (1.1%) from others. The demographic characteristics are presented in Table 2. Cytological diagnosis of thyroid lesion is shown in Table 3. The mean, standard deviations and p-value obtained by FNAC and FNCS for each parameter are shown in Table 4.

Table 2: Demographic characteristic of respondents

	Variables	Frequency (%)
Sex		
	Male	12 (13.6%)
	Female	76 (86.4%)
Ethnic group		
	Malay	48 (54.5%)
	Indian	16 (18.2%)
	Chinese	23 (26.1%)
	Others	1 (1.1%)

Table 3: Cytological diagnosis of thyroid lesion

Cytological diagnosis of thyroid lesion	Frequency (%)
Nodular hyperplasia	51 (58%)
Nodular goiter	20 (22.7%)
Carcinoma	3 (3.4%)
Suspicious neoplasm	3 (3.4%)
Grave's disease	1 (1.1%)
Unsatisfactory	10 (11.4%)

Table 4: Comparison between FNAC and FNCS based on various parameters

	FNAC		FNCS		p-value
	Mean + SD	Total	Mean + SD	Total	
Background blood clot	0.95 ± 0.608	42	1.02 ± 0.590	45	0.724
Amount of cellular material	1.41 ± 0.693	62	1.11 ± 0.579	49	0.006*
Degree of cellular degeneration	1.11 ± 0.443	49	1.07 ± 0.625	46	0.087
Degree of cellular trauma	1.11 ± 0.493	49	1.16 ± 0.479	51	0.772
Retention appropriate architecture	1.16 ± 0.645	51	1.05 ± 0.569	46	0.103
Total score		253		237	0.449

SD=standard deviation
*p-value<0.05

Mean scores for parameter amount of cellular material, degree of cellular degeneration, and retention of appropriate architecture were higher for FNAC technique. Mean scores for parameter background blood and degree of cellular trauma were higher for FNCS technique. All the results showed no significant difference between the two techniques except for parameter amount of cellular material where FNAC yielded statistically significant greater amount of cellular material compared to FNCS. The total and average score per case obtained by FNAC technique was greater than FNCS technique but it was not statistically significant.

Grading of smears and diagnostic adequacy based on total score are shown in Table 5. FNAC technique yielded more diagnostically superior smears when compared to FNCS technique. Diagnostically adequate samples were those samples graded as adequate for cytological analysis and diagnostically superior samples. Five samples (11.4%) were diagnostically inadequate and 39 samples (88.6%) were diagnostically adequate from both FNAC and FNCS techniques. The diagnostic adequacy between the two techniques showed no significant difference with p-value of 1.00.

Table 5: Grading of smears and diagnostic adequacy of FNAC versus FNCS

Grading of smears	FNAC	FNCS	
Unsuitable for diagnosis	5 (11.4%)	5 (11.4%)	
Adequate for cytological diagnosis	21 (47.6%)	27 (61.4%)	
Diagnostically superior	18 (40.9%)	12 (27.3%)	
Diagnostic adequacy			**p-value**
Diagnostically inadequate	5 (11.4%)	5 (11.4%)	1.00
Diagnostically adequate	39 (88.6%)	39 (88.6%)	

Discussion

To date, there is only few data comparing the efficacy of FNAC versus FNCS technique for thyroid nodule sampling and the majority of the procedures were performed under palpation guidance instead of under ultrasound guidance. Since non-palpable nodules account for approximately 90% of all thyroid nodules, ultrasound guided cytology sampling has the advantage of allowing sampling of thyroid lesion which is inaccessible by palpation (14). Ultrasound guided technique has also been shown to increase the diagnostic adequacy rate by targeting the solid component of a solid cystic lesion (18). Compared to palpation directed biopsy, ultrasound guided sampling technique has been shown to increase the sensitivity and specificity of the procedure (19).

In this study we compared the cytological adequacy rate and quality of samples obtained by FNAC and FNCS under ultrasound guidance using the 5 parameters scoring system developed by Mair et al. (1989), namely the background blood or clot, amount of cellular material, degree of cellular degeneration, degree of cellular trauma, and retention of appropriate architecture (16).

For the parameters of background blood contamination, our results showed FNCS technique produced sample with minimal amount of background blood compared to FNAC, however the result was not statistically significant. Similarly, Pinki et al. (2015) and Ghosh et al. (2000) showed lesser background blood in FNCS technique sample, and the difference compared to FNAC was statistically significant (7, 20). However, study by Akhtar et al. (1997) did not notice a significant difference of background blood contamination between the two techniques (21).

FNCS was performed on various organs including liver, intraabdominal and intrathoracic lesions previously and the smears were shown to have lesser contamination by blood with this technique (15). Higher background blood seen in FNAC samples could be due to the suction used in fine needle aspiration technique which apply high negative pressure suction compared to FNCS technique which used the principle of spontaneous capillary action.

Our study showed FNAC yielded samples with abundant cellular material when compared to FNCS and the result was statistically significant. This was in concordance with the study by Jayaram and Gupta (1991) who observed higher cellularity of samples obtained with FNAC in most goiters (22). On the other hand, Mair et al. (1989) showed higher cellularity sample yielded by FNCS but the result was not statistically significant (16). Kamal et al. (2002) showed FNCS produced more abundant cellular material sample compared to FNAC (23).

Similar to the study of Kamal et al. (2002), our results showed FNCS produced samples with minimal cellular trauma (23). FNAC produced samples with minimal cellular degeneration. This results however were not statistically significant. Dey and Ray (1993) showed statistically significant difference in favor of FNCS with lesser degree of cellular trauma and degeneration (15). The fact that FNCS uses capillary suction technique with lesser negative pressure probably resulted in samples with less traumatized cells. Smears with cellular trauma and cellular degenerations were shown to be generally the same in both techniques of FNAC and FNCS in a study by Agnihotri and Agnihotri (2018) (24).

Results when compared for the parameter of retention of architecture supported the FNAC technique, however the result was not statistically significant. More cellular material obtained by FNAC technique in our study probably results in more cells with retained architecture. This was in concordance with the findings reported by Maurya et al. (2010) which favored FNAC where there was excellent retention of appropriate architecture (25).

The overall diagnostic yield and adequacy were similar in both FNAC and FNCS techniques in our study. The results were not statistically significant. These results were in concordance with a previous study by Tublin et al. (2007) (17). However, Degirmenci et al. (2007) observed a statistically significant higher yield of diagnostically adequate sample with FNCS technique while Maurya et al. (2010) observed the contrary (25, 26). Santos and Leiman (1988) who were the first to compare these two techniques observed that the number of unsuitable specimens in their study was not different with both techniques (13). This was comparable with our study and study of Agnihotri and Agnihotri (2018) (24). Our study showed that FNAC provides diagnostically superior smears compared to FNCS, however were not statistically significant. Kamal et al. (2002) and Raghuveer et al. (2002) on the other hand observed that diagnostically superior samples were obtained by FNCS technique, but this was not statistically significant and hence does not prove the clear superiority of FNCS over FNAC (23, 27).

There was no major complication associated with FNAC and FNCS techniques observed in our study, the only complication being localized pain. Generally, the most common complication associated with fine needle cytology of thyroid nodule sampling are slight local pain and minor hematoma (28, 29). This complication is self-limited with low morbidity. Infection, vasovagal reactions, recurrent laryngeal nerve paralysis and needle tract tumor seeding are rare complications that may be encountered (30).

The limitation of this study was the small sample size used which could cause a small but possible risk of bias. Thus, the results obtained should be interpreted with caution.

Conclusion

In conclusion, operator personal preference and anecdotal experience influences the decision to perform either ultrasound guided FNAC or FNCS of thyroid nodules. Both techniques have their own advantages and disadvantages. In this study, it was observed that both techniques resulted in similar sample adequacy rates and there was no clear superiority of one technique over the other. In our opinion, both FNAC and FNCS technique can be used in tandem to achieve better diagnostic accuracy and to avoid unnecessary repeated sampling if inadequate samples were obtained.

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Competing interests

The authors declare that they have no competing interests.

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