A quantitative analysis of thyroid fine needle aspiration (FNA) using needles with different gauges

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Abstract
Objective: The aim of this study is to compare the results of three gauge (G) needles (22G, 23G and 25G) in terms of cell amount in thyroid fine needle aspiration (FNA). **Subjects and Methods:** In the retrospective study, a total of 443 patients undergoing FNA for the first time between 2017 and 2018 were included in the study, and assigned to 3 groups with 22-gauge, 23-gauge and 25-gauge needles, respectively. **Results:** The cell amount of a suspicion for the four diagnosis groups, including malignancy and malignant, benign nodules, follicular of undetermined significance (FLUS), and follicular neoplasia was mainly in the range of 0-10000, 0-300, 0-150, and 500-2500, respectively. The cut-off values of 22G needle 20000, 300, 1000, and 2500, while the cut-off values of 23G and 25G were 10000, 400, 1000, and 2500; 5000, 400, 1500, and 2000, respectively for the four diagnosis groups. **Conclusion:** Large-gauge needles resulted in more cellular specimens than small-gauge needles only in the cases of malignant tumors. Small-gauge needles resulted in a higher comfort level of the patients, and had no difference in cell number in nodules with abundant blood supply, compared with large-gauge needles.

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Introduction

Thyroid nodules occur with a relatively high frequency in general population, with an estimated prevalence of 13%-67% by sonographic evaluation [1]. In addition to benign nodules, papillary thyroid cancer (PTC) is a common endocrine malignancy, accounting for approximately 90% of differential thyroid cancers [2, 3]. As a simple and accurate method, ultrasonography (US)-guided fine needle aspiration (FNA) has a high sensitivity and specificity in the evaluation of malignant and/or benign lesions of the thyroid [4]. With the improvement of diagnostic technology, including ultrasonography and FNA biopsy, the early detection of thyroid nodules have increased rapidly in recent years [5, 6]. The current FNA needles range from 22 to 27 gauge (G) [7]. Larger-gauge needles will increase the possibility of blood contamination and had more complications, which may influence the interpretation of specimen, while smaller needles are responsible for inadequate material collection [8]. In western countries, 25 to 27G needles are mostly used. However, 22 to 23G needles are more commonly used in China. The most effective needle size for use in thyroid FNA needs to be further evaluated. Thus, we conducted this study to assess the value of different needle sizes in FNA through determining a cut-off level for adequate cell amount, accompanied by on-site pathological analysis.

Subjects and Methods

Study design and patients

The study was a retrospective research and was approved by the Ethics Committee of Hebei General hospital. Written informed consent has been collected from all the patients.

A total of 443 patients undergoing FNA for the first time between 2017 and 2018 were included in the study, who were between 22 and 65 years of age (mean age, 44 years; 280 females and 153 males). All 443 thyroid nodules were solid and larger than 0.5cm in diameter. Among all the patients, 90 were diagnosed with benign nodules, 90 were follicular of undetermined significance (FLUS), 90 were follicular neoplasia, and 163 were suspicious for malignancy and malignant by cytology.

US-guided FNA

A total of 443 subjects were assigned to 3 groups with 22-gauge, 23-gauge and 25-gauge needles, respectively. With the same aspirator in all cases, the number of patients diagnosed with benign nodules, FLUS, follicular neoplasia, and suspicious for malignancy and malignant by cytology were 30, 30, 30, 60 in 22-gauge needle group, 30, 30, 30, 53 in 23-gauge needle group, and 30, 30, 30, 50 in 25-gauge needle group. The needle was inserted into the nodule, and the aspiration procedure was performed by moving the needle back and forth within the nodule for approximately 7 to 10 oscillations (Figure 1).

Cytological analysis

The specimens were directly smeared on the glass slides and put in 95% alcohol immediately. One needle-punched specimen was smeared on two slides, examined the adequacy by two experienced pathologists blinded to interventions used in the present study (Figure 2). The criteria for adequacy were the presence of six groups of well-visualized follicular cells, with at least ten cells per group on each slide under a single ×100 microscope in the area with highest cellular density [9].

Statistical analysis

Quartile range percentile 75 was performed to describe the cut-off value. We compared 22G, 23G and 25G needles in the following categories: (1) the numeration of follicular cells, (2) the cut-off value for adequate cell amount. Group comparisons of categorical variables were performed using the χ^2 test. All statistical analyses were performed with SPSS statistical software (version 19.0, Chicago, USA). P values less than 0.05 were considered statistically significant.

Results

A sum of 443 solid thyroid nodules were evaluated, with 150, 143, and 140 used 22G, 23G and 25G needles, respectively for US-FNA. The demographic characteristics of patients in the 22G, 23G and 23G groups were presented in Table 1. The cell amount was a measurement data with positive skewness distribution. The frequency table used for cell amount statistical description was shown in Tables 1-4. The cell number of suspicious for malignancy and malignant

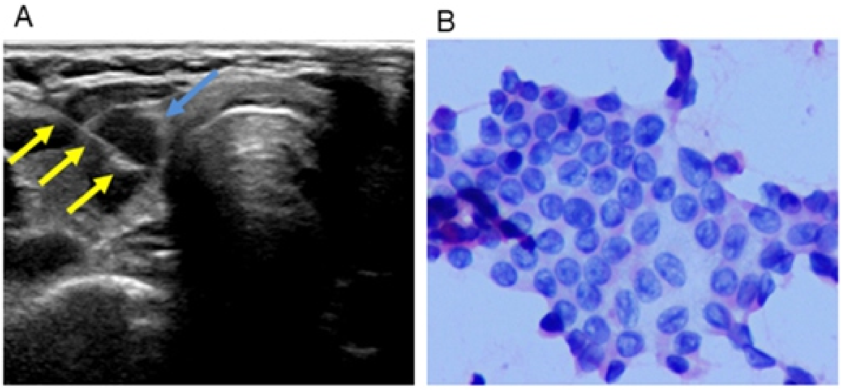

Figure 1. The FNA process and cytopathological result of a thyroid nodule. A: a hypoechoic nodule in the left lobe of the thyroid indicated by the blue arrow, about 17mm in size, and the needle path of FNA indicated by the yellow arrow. B: The cytopathological result of papillary carcinoma (eosin staining, ×400).

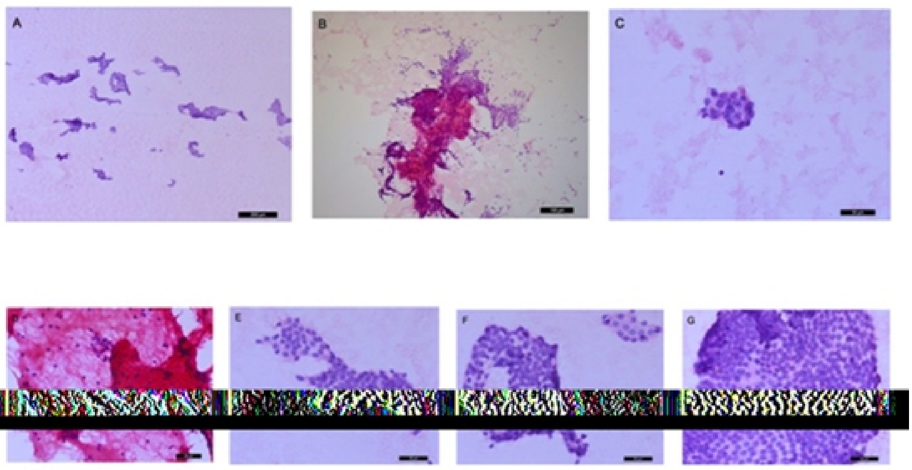

Figure 2. The illustration of the cellularity. A: >10,000 cells, B: 2500 cells (not including the cells covered by blood cells) under a low magnification; C and D: cell number from 10 to 20 at 400x magnification. E, F, and G: cell number about 150, 250 and 700 at 400x magnification.

Table 1. *The cell amount by 22G, 23G and 25G needles of suspicious for malignancy and malignant.*

Group	<5000	5000-10000	10000-15000	15000-20000	20000-25000	25000-30000	>30000	Cut-off value	
22G	24	16	5	1	6	1	7	20000	c^2=32.0757
23G	35	6	4	4	1	1	2	10000	P=0.0013
25G	40	8	1	1	0	0	0	5000	
Total	99	30	10	6	7	2	9		

Table 2. *The cell amount by 22G, 23G and 25G needles of benign nodules.*

Group	<100	100-200	200-300	300-400	400-500	500-600	>600	Cut-off value	
22G	4	13	6	3	2	1	1	300	c^2=4.2605
23G	5	10	6	4	2	1	2	400	P=0.9783
25G	5	12	5	3	4	0	1	400	
Total	14	35	17	10	8	2	4		

Table 3. *The cell amount by 22G, 23G and 25G needles of FLUS.*

Group	<100	100-500	500-1000	1000-1500	1500-2000	2000-25000	>25000	Cut-off value	
22G	1	20	3	4	2	0	0	1000	c^2=11.9714
23G	2	19	4	2	3	0	0	1000	P=0.2870
25G	2	10	7	8	2	1	0	1500	
Total	5	49	14	14	7	1	0		

Table 4. *The cell amount by 22G, 23G and 25G needles of follicular neoplasia.*

Group	<100	100-500	500-1000	1000-1500	1500-2000	2000-2500	>25000	Cut-off value	
22G	0	0	1	1	18	9	1	2500	c^2=7.6029
23G	0	1	2	1	18	8	0	2500	p=0.6676
25G	0	1	3	4	15	7	0	2000	
Total	0	2	6	6	51	24	1		

was mainly in the range of 0-10000, with the most concentrated range of 0-5000. The Chi-Square statistic was 32.0757 (P=0.0013). The cell number of benign nodules was mainly in the range of 0-300, and the most concentrated range was 100-300 (P=0.9783). The cell numbers of FLUS and follicular neoplasia were mainly in the range of 0-1500 and 500-2500, with the most concentrated range of 100-1500 and 1500-2500, respectively (P=0.2870, and P=0.6676). The cut-off value of 22G needle for a suspicion of malignancy and malignant, benign nodules, FLUS and follicular neoplasia were 20000, 300, 1000, and 2500, respectively. Similarly, the cut-off value for a suspicion for the four diagnosis groups were 10000, 400, 1000, and 2500 for 23G, and 5000, 400, 1500, and 2000 for 25G, respectively.

Discussion

This study estimated the value of different needle sizes in FNA through determining a cut-off level for adequate cell amount, and found that 25G needle had the lowest cut-off level for suspicion of malignancy and malignant. While the cut-off levels for benign nodules, FLUS and follicular neoplasia were similar among different G-needle groups.

The diagnostic efficacy of thyroid FNA can be significantly improved with the guidance of sonography [10, 11]. Fine needle aspiration of the thyroid is the predominant method used to obtain tissue for microscopic analysis when evaluating nodules for malignancy, especially papillary thyroid carcinoma [12-14]. In the literature, 20-27G needles were usually used for thyroid FNA [15-18]. Recently, Uzunkaya et al. (2017) found that needle size was an important factor that affected the adequacy of samplings [19]. Dong et al. (2021) found that 25G needles obtained the highest scores of sample quality in thyroid FNA, compared with 22G and 23 G needles, and suggested 25G needle to be the first choice for thyroid FNA in routine work" [20]. However, Saraph et al. (2021) compared the diagnostic trate between 23G and 25 G needles, and found that there was no statistically significant difference between the 25G and 23G needles in terms of non-diagnostic rates (35.7%, 31.9%; P=0.494) [21]. With the inconsistent findings, how to choose a suitable needle size needs to be further explored. Therefore, in this study, we evaluated the most commonly used needle sizes in China, including 22G, 23G, and 25G. The results indicated that for a suspicion of malignancy and malignant, 25G needle had the lowest cut-off level. While the cut-off levels were similar among different needle sizes for benign nodules, FLUS and follicular neoplasia.

The cell count was measured manually in this study. Specialized training was required to perform cytologic evaluations correctly because the adequacy rates can be affected by various factors, including the needle type, size, and lesion characteristics [22]. In addition, once cell count was done at the time of rapid on-site evaluation, the aspirator was informed to stop, instead of based on needle size, nodule size, and nodule category.

The cell number of a suspicion of malignancy and malignant was related to the needle size. The cut-off levels decreased as the increasing of needle diameter, with statistical significance (P<0.05). The results indicated that relatively large-gauge needles could be used when targeting a suspicious malignant nodule, which needed less puncture times to obtain a certain amount of cells. However, Tangpricha et al. (2001) found that although 21G needles resulted in more cellular specimens than 25G, the diagnostic accuracy might not be increased [7]. The rates of achieving adequate specimen cellularity varied from 68%-96.6% [23, 24]. The different rates might be due to two to five aspirations performed for each nodule [25, 26].

However, the cell number of benign nodules, FLUS and follicular neoplasia were not related to needle size. The cell number was mainly in the range of 0-300 for benign nodules, 0-1500 for FLUS, and 500-2500 for follicular neoplasia. The abundant blood supply of the nodules might contribute to the consistence in different needle groups. In accordance with previous reports [16, 18], the number of cells was affected by the nature of the nodule, that fewer cells of nodules with abundant blood supply. Some researchers suggested 25G and thinner needles for markedly hypervascular nodules [16]. Since hypervascularity was expected to increase the rate of bloodstained material and make the microscopic examination more difficult, some suggested thinner needles for re-aspiration when marked bloodstained material was seen initially [25]. In the literature, FNA with large-gauge needles may yield more hemorrhagic specimens [7, 18]. A study of thyroid gland FNA demonstrated that the root cause of most errors in the FNA diagnosis was poor specimen quality and a tendency to bleed easily, instead of misinterpretation by cytologist in good samples [27].

Our study had several limitations. First, the retrospective design of this study might cause a selection bias. Particularly, the sampling technique might have improved over time with experience. Second, in this study, the cell number on a single slide varied greatly. In addition, it was hard to avoid the errors of cells counting.

In conclusion, large-gauge needles resulted in more cellular specimens than small-gauge needles only in the cases of malignant tumors. Small-gauge needles had a higher comfort level for patients, and had no difference in cell number in nodules with abundant blood supply, compared with large-gauge needles.

The authors declare that they have no conflicts of interest.

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