Optimal needle size for thyroid fine needle aspiration cytology

Aki Tanaka¹, Mitsuyoshi Hirokawa², Miyoko Higuchi¹, Risa Kanematsu¹, Ayana Suzuki¹, Seiji Kuma², Toshitetsu Hayashi³, Takumi Kudo³ and Akira Miyauchi⁴

¹Department of Clinical Laboratory, Kuma Hospital, Kobe, Japan
²Department of Diagnostic Pathology and Cytology, Kuma Hospital, Kobe, Japan
³Department of Internal Medicine, Kuma Hospital, Kobe, Japan
⁴Department of Surgery, Kuma Hospital, Kobe, Japan

Abstract. Concerning the needle size for thyroid fine needle aspiration cytology (FNAC), 25–27-gauge needles are generally used in Western countries. However, in Japan, the use of larger needles (21–22-gauge needles) is common. The aim of our study was to determine the optimal needle size for thyroid FNAC. We performed ultrasound-guided FNAC for 200 thyroid nodules in 200 patients using two different-sized needles (22 and 25 gauge). For each nodule, two passes with the different-sized needles were performed. The order of needle sizes was reversed for the second group of 100 nodules. The second aspiration was more painful than the first, regardless of the needle size. An association with more severe blood contamination was more frequently observed with the use of 22-gauge needles (32.0%) than with the use of 25-gauge needles (17.5%) and in the second aspiration (37.5%) than in the initial aspiration (12.0%). The initial aspiration samples were more cellular than the second aspiration samples. Regarding the unsatisfactory and malignancy detection rates, there was no statistical difference between the needles. In three of seven markedly calcified nodules, it was difficult to insert 25-gauge needles into the nodules. In terms of the diagnostic accuracy and pain, either needle size can be used. We recommend using 22-gauge needles for markedly calcified nodules because 25-gauge needles bend more easily in such cases. We demonstrated that the initial aspiration tended to obtain more cellular samples and to be less contaminated. Thus, the initial aspiration is more important and should be closely attended.

Key words: Thyroid, Aspiration cytology, Fine needle aspiration, Needle size, Pain

THYROID FINE NEEDLE ASPIRATION CYTOLOGY (FNAC) has been demonstrated to be the most reliable preoperative diagnostic tool for thyroid nodules. Various procedures and techniques for thyroid FNAC have been proposed [1-6], but the optimal method has not been established. Concerning needle size, 25- to 27-gauge needles are commonly used in Western countries [1, 2, 4, 5]. However, in Japan, the use of larger needles, such as 21-gauge or 22-gauge, is common [6-8]. Few studies have compared the adequacy of samples obtained with different-sized needles [1, 5, 9-12], and the results were controversial. It is probably because many additional factors such as aspiration methods, smearing methods, experience of aspirators and property of thyroid nodule are involved. I decided to investigate the influence of the difference in needle thickness by eliminating as much as other possible parameters. The aim of our study was to determine the optimal needle size for thyroid FNAC.

Materials and Methods

The study protocol was reviewed and approved by the Institutional Review Board of Kuma Hospital (20170914-5). This study involved 200 consecutive patients that underwent FNAC for thyroid nodules. Ultrasound-guided FNAC was performed by a single cytopathologist (Hirokawa, M) at Kuma Hospital from August to October 2018. A 10 mL syringe (DS10mL, Nipro, Osaka, Japan) with two different-sized needles (22-gauge; 21GX1 1/2 RB GA and 25-gauge; 25GX11/2 RB GA, Nipro, Japan) was used. Ultrasound was performed using the LOGIQ P6 BT11 unit (GE Healthcare Co., Ltd., Hino, Japan) with the ML6-15 probe (GE Healthcare). For each nodule, two passes were performed using a pistol-type syringe holder during a few mintues. For 100 nodules, 22-gauge needles were initially used, followed by 25-gauge needles. For the next
100 nodules, the needle sizes were used in the reverse order. The order of the needles was selected alternately. The suction time was ≤3 s, and the negative pressure was <0.3 mL [6]. Aspirated materials were smeared by a press and release method [6]. When the samples were bloody, we tilted the glass slide, removed the excess material, and removed the bloody components flowing from the slide before smearing [6]. After smearing, the preparations were fixed by Cytorop (Alfresa, Osaka, Japan), which is a cytological fixative, and were stained using the Papanicolaou method.

To evaluate the intensity of pain, the patients answered a questionnaire immediately after the procedure. The questionnaire comprised the following three options, 1) the initial aspiration was more painful than the second aspiration, 2) the second aspiration was more painful than the initial aspiration, and 3) the initial and second aspirations were almost equally as painful. The amount of blood contamination was evaluated by visual inspection, when the cytopathologist expressed the aspirated samples on the preparations. Microscopic evaluation was performed by two cytotechnologists (Ito, A and Higuchi, M) without any information on clinical findings and aspiration methods. The cellularity of the obtained sample was classified as being more or less than 1.5 times the cut-off value. Cytological evaluation was performed on the basis of the Bethesda System for Reporting Thyroid Cytopathology [13]. Statistical analyses were performed using Chi-squared test, and differences were considered significant at p-values <0.05.

Results

Table 1 presents the results of thyroid FNAC using 22- and 25-gauge needles. Seventy-six patients (38.0%) experienced greater pain in the aspiration using 22-gauge needles than in the aspiration using 25-gauge needles. In contrast, 55 patients (27.5%) experienced greater pain in the aspiration using 25-gauge needles than in the aspiration using 22-gauge needles. The second aspiration (46.0%) was reported to be more painful than the initial aspiration (19.5%), regardless of the size of the needle. In cases wherein the initial aspiration was performed using a 22-gauge needle, 25.0% and 41.0% of the patients experienced greater pain with the use of 22- and 25-gauge needles, respectively. In cases wherein the initial aspiration was performed using a 25-gauge needle, 51.0% and 14.0% of patients experienced greater pain with the use of 22- and 25-gauge needles, respectively. The pain was related not to the needle size, but to the aspiration number; and second aspiration was significantly more painful than the initial aspiration (p < 0.001). Blood contamination was almost the same in 101 nodules (50.5%). An association with more severe blood contamination was more frequently observed on using 22-gauge needles (32.0%) than on using 25-gauge needles (17.5%) and in the second aspiration (37.5%) than in the initial aspiration (12.0%). In both the 22- and 25-gauge initial aspiration groups, more severe blood contamination was more frequently observed in the second aspiration. Thus, the larger needle size (22-gauge, p < 0.001) and the second aspiration (p < 0.001) were associated with significantly more severe blood contamination. The cellularity of the samples was 40.0% and 29.0% with the use of 22- and 25-gauge needles, respectively. The samples in the initial aspiration were more cellular than those in the second aspiration (p < 0.05), regardless of the needle size. However, when the 25-gauge needle was used in the initial aspiration, the cellularity between the initial and second aspirations did not differ. No significant complications were encountered.

Table 2 presents the cytological results of samples obtained using 22- and 25-gauge needles. The nondiagnostic/unsatisfactory rates of the 22- and 25-gauge needles were 18.5% and 21.0%, respectively. Of seven cases with markedly calcified nodules (Fig. 1), in one case using a 22-gauge needle and three using 25-gauge needles, it was difficult to insert the needles into the nodules, because the needles bent. The malignancy detection rates of 22- and 25-gauge needles were 14.5% and 11.0%, respectively. There was no statistical difference between 22- and 25-gauge needles with regard to the non-diagnostic/unsatisfactory rate and the malignancy detection rate. Among 12 nodules showed moderate to severe vascular flow signal, there was no significant difference between needle sizes and other parameters we evaluated.

Discussion

Thyroid FNAC is an invasive diagnostic procedure that is typically associated with local pain and/or discomfort during or after the aspiration [4, 14]. The procedure is generally minor, transient, and tolerated by the patients, and local anaesthesia for the pain is not generally administered [2, 4, 14]. The severity of the pain may be related to the needle size, number of passes, length of aspiration time, location of the nodules, insertion portion, experience of operator, and character of patients [15], but the available evidence is not sufficient. Lee et al. reported that there was no statistical difference between experienced and less experienced radiologists in terms of the severity of pain experienced by the patients [16]. It is believed that the pain increases with increasing needle size [14]. However, Carpi et al. reported that large needle aspiration biopsy after fine needle aspiration biopsy did
Jung et al. did not observe statistical differences between the 23- and 21-gauge needle groups in terms of pain severity [12]. Our results indicated that there was no significant difference between 22- and 25-gauge needles in terms of the severity of pain during the procedure in this study. Additionally, we found that the second aspiration was more painful than the initial aspiration, regardless of the needle size. This finding suggests that thyroid FNAC should be performed as few times as possible.

Blood contamination is frequently encountered in thyroid FNAC and may contribute to inadequate cytological results [14, 18-20]. In our study, an association with more severe blood contamination was more frequently observed with the use of 22-gauge needles than with the use of 25-gauge needles. In addition, both the 22- and 25-gauge needle initial aspiration groups frequently exhibited more severe blood contamination in the second aspiration. Therefore, thyroid FNAC re-aspirations should be performed cautiously. A short aspiration time, low negative pressure, and capillary technique can minimize blood contamination [1, 4, 6, 7, 9, 21]. When the samples are bloody, we recommend our method; in this study, we tilted the glass slide, removed excess material, and removed the bloody components flowing from the slide before smearing [6].

Regarding the adequacy of the samples, no significant difference between finer and thicker needles has been demonstrated [1, 10, 12, 22, 23]. The use of 21-gauge needles results in more cellular specimens than those obtained with finer needles, but it may not provide an increased diagnostic accuracy [11]. However, Degirmenci

not increase the reported discomfort or pain [17].

### Table 1 Comparison between 22- and 25-gauge needles in thyroid fine needle aspiration cytology

|                  | 22-G > 25-G | 22-G ≃ 25-G | 22-G < 25-G | Initial > Second | Initial ≃ Second | Initial < Second |
|------------------|-------------|-------------|-------------|------------------|------------------|------------------|
| **Pain**         | n (%)       | n (%)       | n (%)       | n (%)            | n (%)            | n (%)            |
| 22-G Initial     | 25 (25.0%)  | 34 (34.0%)  | 41 (41.0%)  | 25 (25.0%)       | 34 (34.0%)       | 41 (41.0%)       |
| 25-G Initial     | 51 (51.0%)  | 35 (35.0%)  | 14 (14.0%)  | 14 (14.0%)       | 35 (35.0%)       | 51 (51.0%)       |
| **p**            | 0.000       | 0.122       | 0.000       | 0.111            | 0.000            | 0.000            |
| **Total**        | 76 (38.0%)  | 69 (34.5%)  | 55 (27.5%)  | 39 (19.5%)       | 69 (34.5%)       | 92 (46.0%)       |
| **p**            | 0.111       | 0.000       | 0.000       | 0.111            | 0.000            | 0.000            |

### Table 2 Results of thyroid aspiration samples obtained using 22- and 25-gauge needles

|                  | ND/UNS | Benign | AUS | FN | SFM | Malignant |
|------------------|--------|--------|-----|----|-----|-----------|
| **22-gauge needle** |        |        |     |    |     |           |
| 25-gauge needle   | 42 (21.0%) | 124 (62.0%) | 3 (1.5%) | 9 (4.5%) | 0 (0%) | 22 (11.0%) |
| 22-gauge needle   | 37 (18.5%) | 119 (59.5%) | 7 (3.5%) | 8 (4.0%) | 0 (0%) | 29 (14.5%) |

ND/UNS, Nondiagnostic/unsatisfactory; AUS, Atypia of undetermined significance; FN, Follicular neoplasm; SFM, Suspicious for malignancy
et al. reported that the use of finer needles (24- to 25-gauge needles) decreased the rate of inadequate materials [4]. Major complications were not encountered during or after FNAC with either 21- or 27-gauge needles [22]. In our study, there was no statistical difference between the 22- and 25-gauge needles in terms of the unsatisfactory rate and the malignancy detection rate, regardless of the significant differences in cellularity and blood contamination. The results may have been affected by other factors, such as the smearing technique or diagnostic ability.

In our study, it was difficult to insert the needles into markedly calcified nodules, because the needles bent. Therefore, we recommend using larger, firmer needles for calcified nodules, because 25-gauge needles are flexible.

In conclusion, concerning the diagnostic accuracy and the pain, either 22- or 25-gauge needles can be used. We recommend using 22-gauge needles for markedly calcified nodules, because 25-gauge needles bend more easily in such cases. Interestingly, the initial aspiration was less painful, less contaminated, and more cellular than the second aspiration in our study. These results are more significant than those pertaining to differences in needle size. Thus, we should be aware that the initial aspiration is more important and should be more closely attended to than the second aspiration. Recently, the usual management of atypia of undetermined significance and follicular neoplasm incorporates the option of molecular testing, and the samples are obtained by FNAC [13, 24]. However, there is no statement on the needle sizes used at that time. According to our results, an influence of the needle sizes for the accuracy is probably minimal, but a further study is required to confirm it.

Disclosure

None of the authors have any potential conflicts of interest associated with this research.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Ethics Statement

The authors confirm that the study complies with the guidelines of the ethics committee of Kuma hospital and that all subjects provided informed consent.

References

1. Cerit M, Yücel C, Göçün PU, Poyraz A, Cerit ET, et al. (2015) Ultrasound-guided thyroid nodule fine-needle biopsies—comparison of sample adequacy with different sampling techniques, different needle sizes, and with/without onsite cytological analysis. Endokrynol Pol 66: 295–300.
2. Layfield LJ, Cibas ES, Gharib H, Mandel SJ (2009) Thyroid aspiration cytology: current status. CA Cancer J Clin 59: 99–110.
3. Zajdela A, Zillhardt P, Voillemot N (1987) Cytological diagnosis by fine needle sampling without aspiration. Cancer 59: 1201–1205.
4. Baloch ZW, Cibas ES, Clark DP, Layfield LJ, Ljung BM, et al. (2008) The National Cancer Institute Thyroid fine needle aspiration state of the science conference: a summation. Cytojournal 5: 6.
5. Titton RL, Gervais DA, Boland GW, Maher MM, Mueller PR (2003) Sonography and sonographically guided fine-needle aspiration biopsy of the thyroid gland: indications and techniques, pearls and pitfalls. AJR Am J Roentgenol 181: 267–271.
6. Hirokawa M, Suzuki A, Miyauuchi A (2018) Thyroid fine-needle aspiration and smearing techniques. VideoEndocrinology 5. DOI: 10.1089/ve.2018.0119.
7. Shimode Y, Tsuji H, Fukuhara T, Kawakami O, Tsutsumiuchi T, et al. (2017) Examination of selective low-pressure fine needle aspiration cytology under ultrasound guidance. Yonago Acta Med 60: 209–212.
8. Maeda H, Kutomi G, Satomi F, Shima H, Mori M, et al. (2016) Clinicopathological characteristics of thyroid cancer misdiagnosed by fine needle aspiration. Exp Ther Med 12: 2766–2772.
9. Degirmenci B, Haktanir A, Albayrak R, Acar M, Sahin DA, et al. (2007) Sonographically guided fine-needle biopsy of thyroid nodules: the effects of nodule characteristics, sampling technique, and needle size on the adequacy of cytological material. Clin Radiol 62: 798–803.
10. Hanbidge AE, Arenson AM, Shaw PA, Szalai JP, Hamilton PA, et al. (1995) Needle size and sample adequacy in ultrasound-guided biopsy of thyroid nodules. Can Assoc Radiol J 46: 199–201.
11. Tangpricha V, Chen BJ, Swan NC, Sweeney AT, de las Morenas A, et al. (2001) Twenty-one-gauge needles provide more cellular samples than twenty-five-gauge needles in fine-needle aspiration biopsy of the thyroid but may not provide increased diagnostic accuracy. Thyroid 11: 973–976.
12. Jung SJ, Kim DW, Baek HJ (2018) Comparison study of the adequacy and pain scale of ultrasound-guided fine-needle aspiration of solid thyroid nodules with a 21- or 23-gauge needle for liquid-based cytology: a single-center study. Endocr Pathol 29: 30–34.
13. Baloch ZW, Cooper DS, Gharib H, Alexander EK (2009) Clinical complications following thyroid fine-needle biopsy: a systematic review. Clin Endocrinol (Oxf) 71: 157–165.
14. Leboulleux S, Borget I, Labro S, Bidault S, Vielh P, et al. (2013) Frequency and intensity of pain related to thyroid nodule fine-needle aspiration cytology. Thyroid 23: 1113–1118.
15. Lee YJ, Kim DW, Jung SJ (2013) Comparison of sample adequacy, pain-scale ratings, and complications associated with ultrasound-guided fine-needle aspiration of thyroid nodules between two radiologists with different levels of experience. Endocrine 44: 696–701.
16. Carpi A, Rossi G, Nicolini A, Iervasi G, Russo M, et al. (2013) Does large needle aspiration biopsy add pain to the thyroid nodule evaluation? PLoS One 8: e58016.
17. Redman R, Zalaznick H, Mazzaferr E, Massoll NA (2006) The impact of assessing specimen adequacy and number of needle passes for fine-needle aspiration biopsy of thyroid nodules. Thyroid 16: 55–60.
18. Cappelli C, Pirola I, Gandossi E, De Martino E, Agosti B, et al. (2009) Fine-needle aspiration cytology of thyroid nodule: does the needle matter? South Med J 102: 498–501.
19. Crothers BA, Henry MR, Frat M, Frates MC, Rossi ED (2009) Non-diagnostic/unsatisfactory. In: Ali SZ, Cibas ES (eds) The Bethesda System for Reporting Thyroid Cytopathology (2nd). Springer Nature, New York: 1–6.
20. Polyzos SA, Anastasialakis AD (2009) Clinical complications following thyroid fine-needle biopsy: a systematic review. Clin Endocrinol (Oxf) 71: 157–165.
21. Zhang L, Liu Y, Tan X, Liu X, Zhang H, et al. (2017) Comparison of different-gauge needles for fine-needle aspiration biopsy of thyroid nodules. J Ultrasound Med 37: 1713–1716.
22. Cibas ES, Ali SZ (2017) The 2017 Bethesda system for reporting thyroid cytopathology. Thyroid 27: 1341–1346.