



Application of a novel vibrating device for fine-needle aspiration

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Abstract

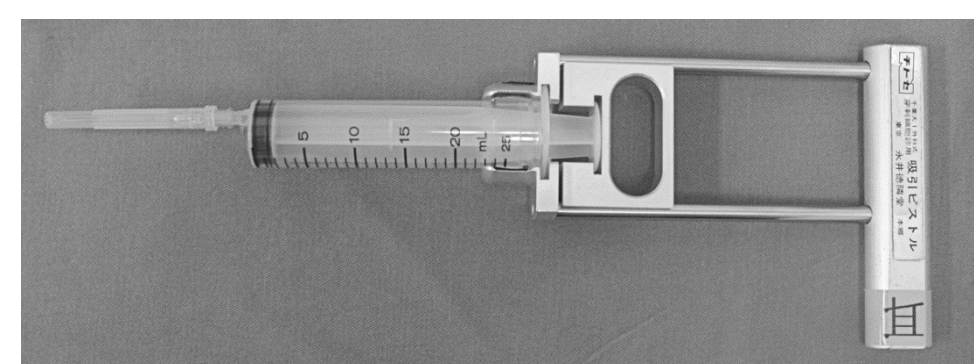
Objective: FNAC is a valuable diagnostic technique. However, the procedure involves back-and-forth motions of a needle within a mass, which can lead to unexpected complications. We have developed a novel device and sampling techniques that use vibration and rotation instead of back-and-forth motions.

Methods: The new device consists of a vibrating motor fixed to the stopper of a 5-mL syringe with its piston. A 22-gauge needle attached to the 5-mL syringe is used for FNAC. Samples were obtained from resected specimens using the following four procedures: suction only; suction and vibration for 5 seconds; suction and 180° rotation of the syringe; and suction, vibration for 5 seconds, and 180° rotation of the syringe. Samples were also obtained using the conventional technique. The numbers of well-visualized follicular groups on glass slides were counted to compare the amounts of cellular material obtained using the five different procedures. Next, 415 patients with thyroid nodules underwent ultrasound-guided FNAC to evaluate the rate of inadequacy.

Results: Sufficient amounts of material were obtained from resected specimens using suction, vibration and rotation, and using the conventional technique. Inadequate thyroid FNAC material was obtained in 12.3% of cases.

Conclusions: The new device and sampling techniques for thyroid FNAC collected sufficient amounts of adequate material and allowed safe and precise control of the device. Our device and sampling techniques are expected to be widely used not only for thyroid FNAC sampling but also for sampling from other anatomical sites.

Introduction



A 21-gauge needle attached to a 20-mL syringe with a pistol-type holder

Fine-needle aspiration cytology (FNAC) is usually performed using a 21- to 25-gauge needle attached to a 10- or 20-mL syringe, with or without a pistol-type holder. **Samples are obtained by back-and-forth cutting motions of the needle within a mass, with vigorous suctioning.**

Serious concerns of the conventional technique

- **Back-and-forth cutting motions of the needle are dangerous.**

These back-and-forth motions within lesions are sometimes associated with unexpected complications¹. If the tip of the needle accidentally contacts several important structures and organs in the head and neck, complications may result.

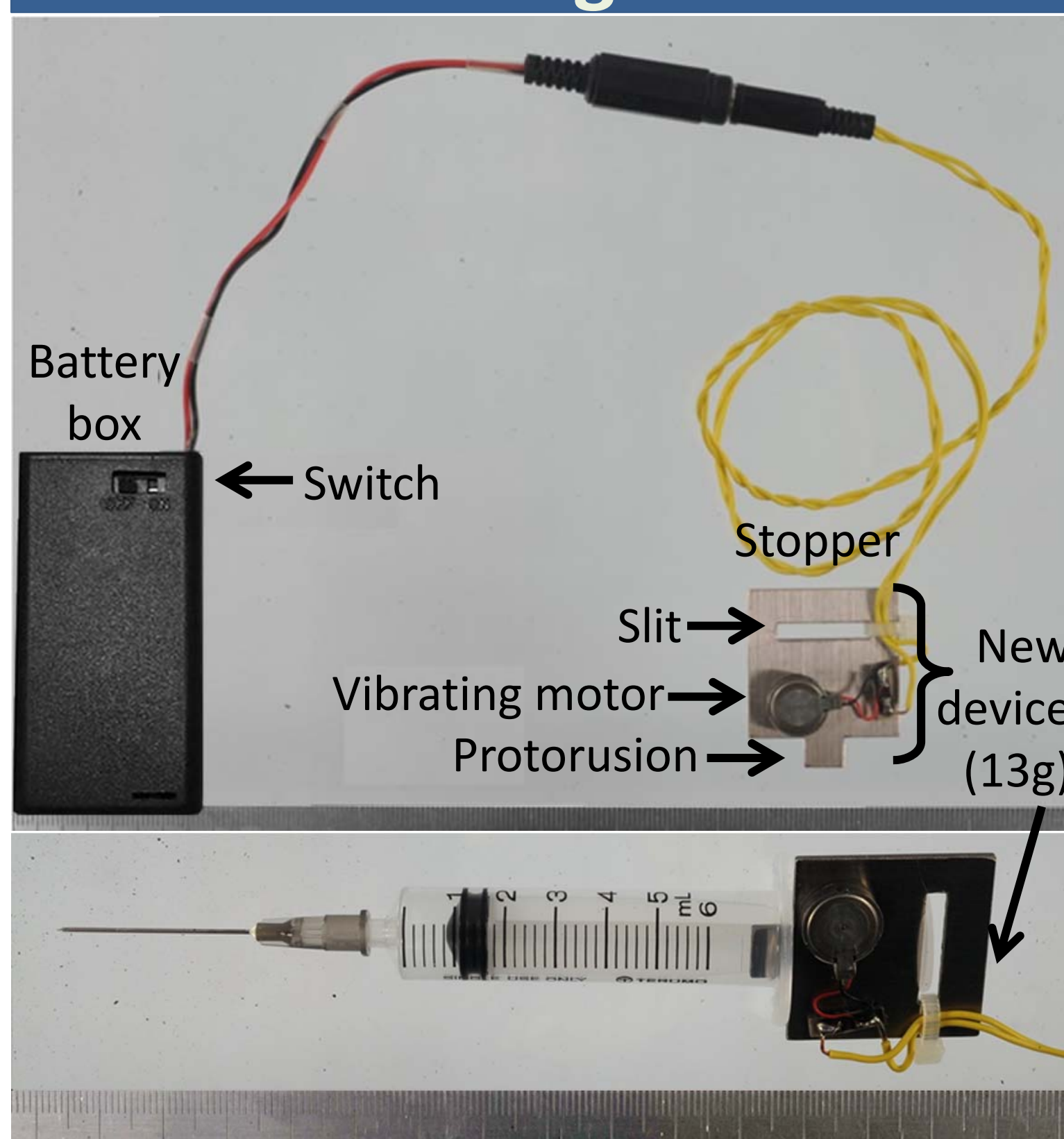
- **Difficulty of precise control of a big syringe under strong suction**

A 10- or 20-mL syringe equipped with a holder is so large that it is difficult to control precisely under strong suction in the range of 10–20 mL negative pressure, particularly when acquiring samples from a small mass, so at least two people are needed to obtain samples safely during FNAC.

Therefore, we develop

- **a novel device that is smaller than the usual 20-mL syringe with its holder.**
- **new sampling techniques that use vibration and rotation to obtain samples instead of back-and-forth motions.**

Design of the new device



The new device consists of a vibrating motor attached to the stopper of a 5-mL syringe and its piston.

The vibrating motor

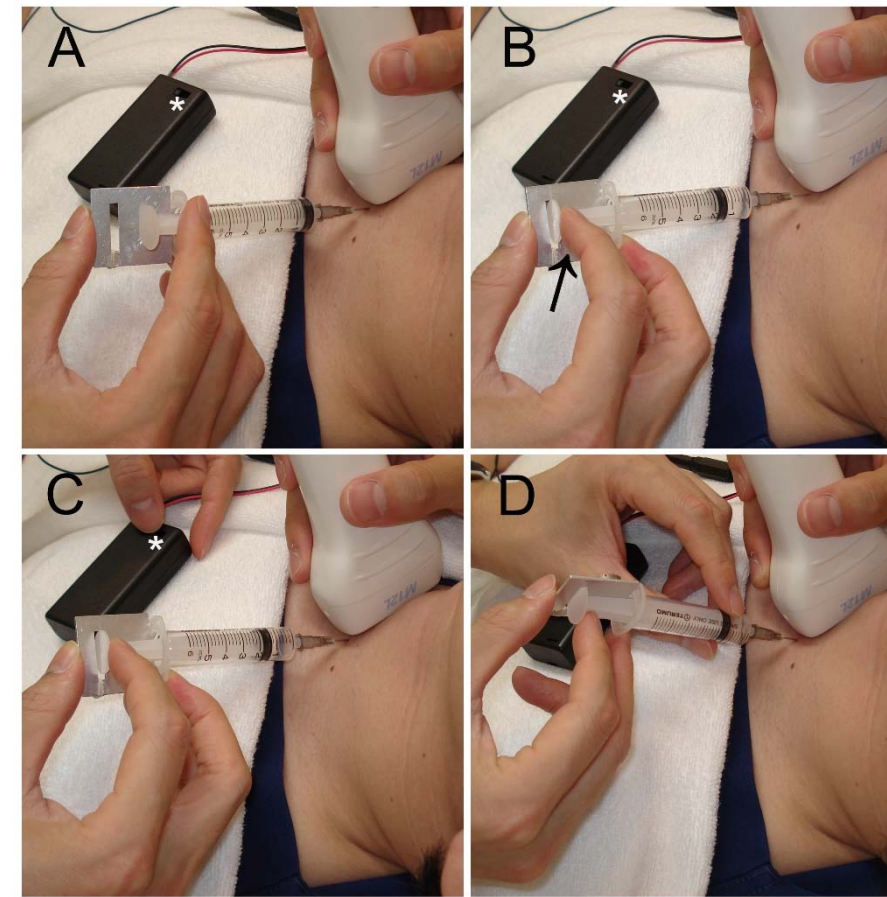
- 12 mm in diameter
- 3.4 mm thick
- Vibration at a frequency of 220 Hz

The stopper

- Made from aluminum
- Approximately 30 × 30 × 1.5 mm
- With a protrusion next to the 5-mL syringe and a slit next to the piston

When the stopper is attached to a 5-mL syringe and its piston, **negative pressure with 1-mL suction** is maintained. Based on Boyle's Law, this creates sufficient vacuum because only a very small volume of dead space is required in the needle. The calculated negative pressure in a 5-mL syringe under 1 mL of suction is **0.85 atm, which is sufficient to obtain samples.**

Thyroid FNAC using the new device and our sampling techniques



A: The needle is passed through the overlying skin and inserted into a target nodule.
B: One hand is used to position the piston against the slit in the device (arrow) and suction with 1 mL negative pressure is applied.
C: The vibrating motor is turned on with the other hand.
D: Samples are obtained immediately using suction, vibration for 5 seconds, and 180° rotation of the syringe. *: Switching of the vibrating motor

Methods and Materials

To evaluate the amounts of aspirated cellular material

Six of these patients who were diagnosed with papillary thyroid carcinoma underwent hemi-thyroidectomy surgery at Tenri Hospital. The six resected specimens were used to examine amounts of cellular material obtained by the following five procedures:

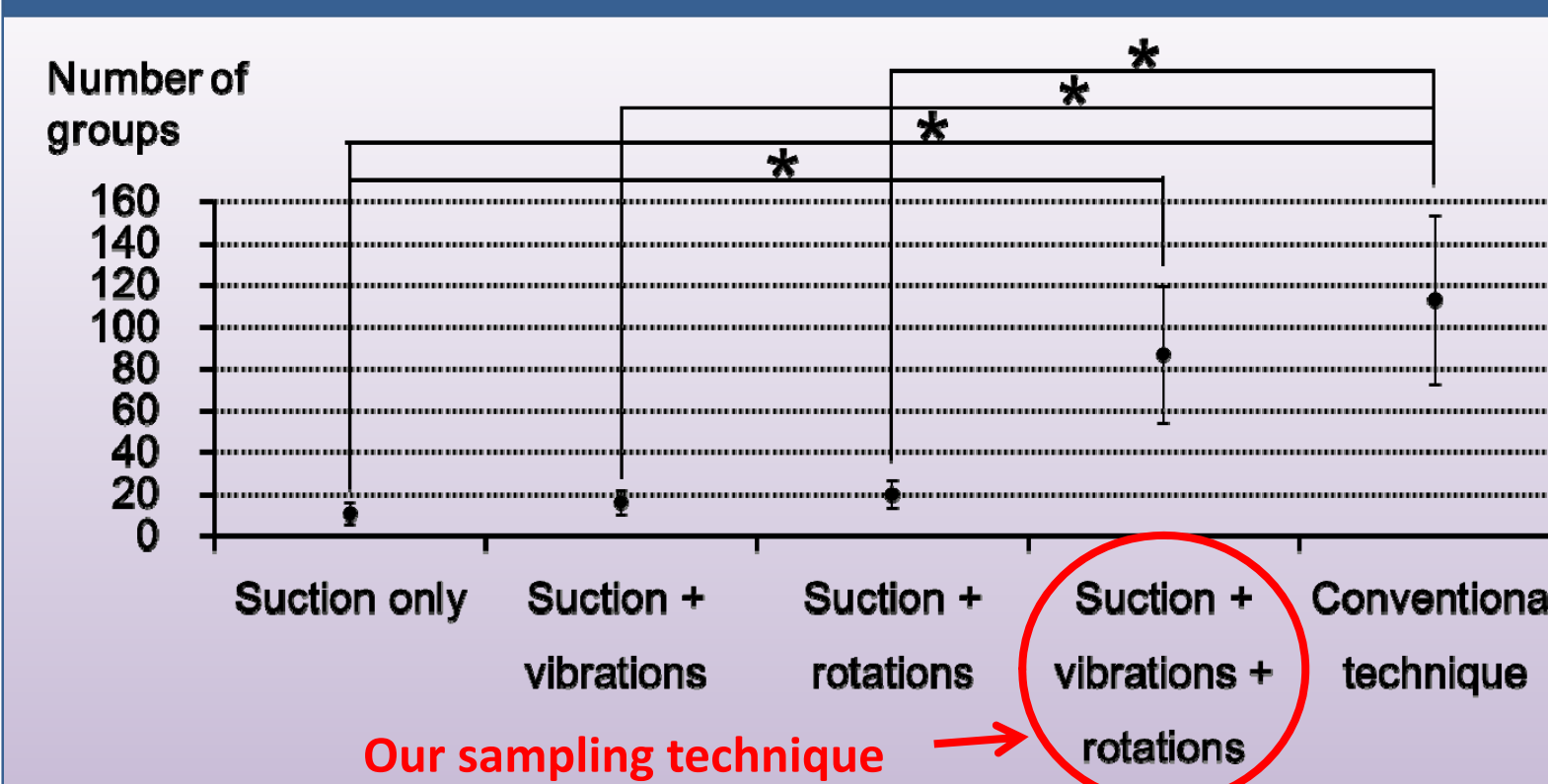
- Suction only
- Suction and vibration for 5 seconds
- Suction and 180° rotation of the syringe
- **Suction, vibration for 5 seconds, and 180° rotation of the syringe** (Our sampling technique)
- The conventional technique, with back-and-forth cutting motions using a 20-mL disposable syringe equipped with a pistol-type holder

To evaluate inadequate rate

From 2009–2011, 415 patients who had undergone ultrasound-guided FNAC for thyroid nodules with 3–62 mm in diameter, without thyroid cysts, were enrolled in this study. All patients provided informed consent prior to ultrasound-guided FNAC and hemi-thyroidectomy. We compared the results obtained using our device and sampling techniques with those of 588 patients with thyroid nodules who underwent ultrasound-guided FNAC using the conventional technique in 2007–2009.

The criteria for adequacy were based on the Bethesda system for reporting thyroid cytopathology.^{2, 3}

Results



The mean numbers of follicular groups obtained using suction only, suction and vibration, and suction and rotation were 10.7, 16.0, and 19.9, respectively. The mean numbers obtained using our techniques versus the conventional technique were 86.8 and 113.1, respectively.

Significantly larger numbers of follicular groups were obtained using suction, vibration, and rotation than by using suction only ($p = 0.036$). The numbers obtained using the conventional technique were also significantly larger than with suction only, suction and vibration, and suction and rotation ($p = 0.014, 0.014, \text{ and } 0.018$, respectively).

Inadequate rate

Our new device and sampling technique	The conventional technique
12.3%* of 415 patients	18.2% of 588 patients
16.9%* of 130 patients with nodules ≤ 10 mm	35.2% of 88 patients with nodules ≤ 10 mm

Asterisks (*) indicate statistical significance at $p < 0.001$ with chi-square test.

No serious complications occurred.

Discussion

- Sufficient amounts of material were obtained with our novel device and sampling techniques, as well as using the conventional technique.
- Inadequate rate of samples obtained using our new device and sampling technique is significantly lower than that using the conventional technique.
- Moreover, our novel device is small enough to provide more precise control during tissue sampling, and no serious complications occurred.
- Our new device and sampling techniques that use vibration and rotation instead of back-and-forth motions are considered safe.

Conclusions

- These results demonstrate the efficacy of our new device and sampling techniques on thyroid FNAC.
- Using this new device and novel techniques, we are able to collect sufficient samples and perform the procedure safely with precise control.

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