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Flexible, tapered-tip tube facilitates conventional orotracheal intubation by novice intubators

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Abstract
Orotracheal intubation is the standard technique for airway management, but several untoward airway complications are possible with this method. To avoid airway trauma caused by the tube tip during intubation, the Parker Flex-Tip tube (PFT), which has a flexible, tapered tip, was developed. It has been reported that the PFT facilitates fiberoptic orotracheal intubation and introducer-guided tracheal intubation. In this study, we compared the PFT *to* a standard endotracheal tube (SET), regarding the time of intubation during conventional orotracheal intubation and the incidence of postoperative sore throat and hoarseness. One hundred and thirty-four patients scheduled for elective anesthesia using orotracheal intubation were randomized to either the PFT or SET and 132 completed the study. The intubators were classified into three groups: staff anesthesiologists, inexperienced anesthesiologists, and anesthesia trainees. The tube was selected by another anesthesiologist and the time required for intubation was measured. PFT did not shorten the time required for intubation and did not reduce the incidence of sore throat and hoarseness. However, a detailed analysis revealed that the PFT decreased the time required for intubation in the anesthesia trainee group. The PFT may help novice intubators to conduct a smooth intubation.

Key words Airway trauma · Conventional orotracheal intubation · Flexible and tapered tip · Glottis · Novice intubators

Orotracheal intubation is the standard technique used for airway management, but several untoward complications, including blunt injury of the pharynx, larynx, esophagus, and trachea, are possible with this method [1]. To avoid airway trauma caused by the tube tip during intubation, various improved endotracheal tubes have been developed. The Parker Flex-Tip tube (PFT; Parker Medical, Englewood, CO, USA) is a disposable plastic endotracheal tube which has a flexible, tapered tip, and has been developed to minimize or prevent airway injury caused by the tube tip during intubation. There have been two reports of the advantages of the PFT, showing that the shape of the PFT facilitates both fiberoptic orotracheal intubation [2] and introducer-guided tracheal intubation [3]. Similar tubes with tapered tips have also been developed, and they have been shown to facilitate fiberoptic intubation and intubation through an intubating laryngeal mask [4–8]. However, there has been no report on the efficacy of the PFT for conventional orotracheal intubation.

In this study, we compared the PFT to a standard endotracheal tube (SET) regarding the time of intubation during conventional orotracheal intubation and the incidence of postoperative sore throat and hoarseness associated with the airway damage. In addition, we investigated whether levels of skill in orotracheal intubation affected these parameters.

This study was approved by the Ethics Committee of Okazaki City Hospital, and written informed consent was obtained from each patient. One hundred and thirty-four patients (68 male and 66 female) scheduled for elective surgery of the abdomen, surface of the body, or four limbs, under general anesthesia with orotracheal intubation, were enrolled in this study. Exclusion criteria were as follows: age younger than 20 or older than 75 years, American Society of Anesthesiologists physical status greater than II, body position other than supine position, patients who required mechanical ventilation after the surgeries, patients with communication disorder, and patients for whom difficulty in intubation was anticipated (Mallampati score grater than III). The two tubes compared were an SET PV soft

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tube; Fuji Systems, Tokyo, Japan and the PFT (Parker Medical). Both tubes are made of polyvinyl chloride, and are similar in appearance, except for their tips. The sizes of both tubes were 8.0 mm internal diameter (ID) for males and 7.5 mm ID for females. A stylet was used in all cases. The intubators were classified into three groups: two staff anesthesiologists (SA), who had more than 10 years' experience of anesthesia; two inexperienced anesthesiologists (IA), who had a half-year experience of anesthesia; and six anesthesia trainees (AT), who had less than 2 weeks' experience of anesthesia (this group had experienced 14 cases of intubation, on average, during the 2 weeks before this study).

The tube was selected by another anesthesiologist (controller) according to the envelope method, with the type of tube written inside the envelope. When the patient entered the operating room, the controller opened the envelope, prepared the tube in concealment, and placed the tube in the intubator's right hand during laryngoscopy. If the intubator could not see the glottis, another anesthesiologist assisted the laryngoscopy and/or attempted cricoid pressure. If the intubator failed to intubate, mask ventilation was resumed and intubation was reattempted. The series of trials was limited to no more than two times per one intubator. The incidence of failed intubation, including esophageal intubation, was noted. To investigate whether the shape of the tip affected the easiness of intubation, the time required for intubation was recorded. Operating room personnel measured the time interval from the passage of the tip of the tube through the right angle of the patient's mouth until the time when the assistant pulled off the stylet and the intubator held the tube with the left hand. Cases in which it was difficult to pull off the stylet smoothly were excluded from this study. When the intubator failed to intubate in the first trial, the time required for intubation in the second trial was regarded as the data. After intubation, the intubator recorded the difficulty of intubation according to Cormack and Lehane's grade. In each patient, anesthesia was induced with intravenous propofol, 1.5–2.5 $mg \cdot kg^{-1}$, and maintained with sevoflurane (1%–2%), oxygen, and nitrous oxide. Fentanyl was administered as needed, and 0.1–0.2 $mg \cdot kg^{-1}$ vecuronium was used as a muscle relaxant. The cuff pressure was kept at 20 cmH_2O, with intermittent measurement by cuff pressure manometer in all patients. In the recovery room and a day after the operation, each patient was interviewed, concerning sore throat and hoarseness, by another controller. The use of postoperative analgesic agents was also investigated.

Statistical analysis was performed with Student's *t*-test or one-way factorial analysis of variance (ANOVA), combined with Scheffe's test. Incidences of postoperative sore throat and hoarseness were analyzed by the χ^2 test. Differences with probability values of less than 0.05 were considered statistically significant.

A total of 134 patients were enrolled in this study, and 132 of them completed the study. Two were excluded because the stylet was difficult to pull off smoothly, and this affected the time required for intubation. The SET was used in 66 patients and the PFT in 66. Each intubator group (SA, IA, and AT) used the SET for 22 patients (male/female ratio 11:11) and the PFT for 22 patients (male/female ratio 11:11). No significant differences in age, height, weight, Cormack and Lehane's grade, or rate of usage of a nasogastric tube were found among patient groups, endotracheal tubes (SET and PFT), intubators (SA, IA, and AT), or combinations of endotracheal tubes and intubators (SA/ SET, SA/PFT, IA/SET, IA/ PFT, AT/ SET, and AT/ PFT). The only difference was that anesthesia time with the AT group was longer than that with the SA group ($P < 0.05$). Intubation was successfully completed at the first trial in the SA and IA groups. In the AT group, the tip of the tube did not pass the glottis at the first trial in 6 AT/SET patients and 5 AT/PFT patients, but intubation was completed in the second trial. Esophageal intubation occurred in 1 AT/SET patient. The usage of intraoperative fentanyl did not significantly differ among the groups. Morphine, pentazocine, or diclofenac was used for postoperative analgesia. No significant differences were found among the groups in dose or frequency of postoperative analgesic agent (data not shown). Regarding the probability that the intubators may have seen the type of tube during intubation, the intubators were asked about this after the study. All answered that no-one could recognize the type of the tube, because the two tubes were so similar that they could not differentiate between them in the oral cavity.

The time required for intubation did not significantly differ between SET and PFT (Fig. 1A). The time required for intubation decreased with increase in experience (Fig. 1A). To investigate whether the level of skill in orotracheal intubation affected the time required for the SET versus that for the PFT, the time was compared in each intubator group. Only in the AT group, was the time for the PFT less than that for the SET (Fig. 1B). For the SA and IA groups, there was no significant difference in time required for intubation between the SET and the PFT. In regard to airway complications such as sore throat and hoarseness, there were no significant differences for any combinations of tubes and intubators (Table 1).

In this study, the PFT did not decrease the required time for intubation compared to the SET in the SA and IA groups. Only in the AT group was the time decreased. In addition, PFT did not reduce the incidence of postoperative sore throat and hoarseness compared with that for the SET, in any groups. Regarding

Table 1. Incidence of postoperative sore throat and hoarseness

				POD 0		POD 1	
		No. of patients	Incidence	Sore throat	Hoarseness	Sore throat	Hoarseness
SET		66	29	21	10	8	7
PFT		66	28	19	10	10	4
SA		44	17	11	3	8	4
IA		44	18	14	7	4	2
AT		44	22	15	10	6	5
SA	SET	22	8	6	1	5	3
	PFT	22	9	5	2	3	1
IA	SET	22	9	8	4	2	1
	PFT	22	9	6	3	2	1
AT	SET	22	12	7	5	1	3
	PFT	22	10	8	5	5	2
All patients		132	57	40	20	18	11

POD, postoperative day; SET, standard endotracheal tube; PFT, Parker Flex-Tip tube; SA, staff anesthesiologists; IA, inexperienced anesthesiologists; AT, anesthesia trainees

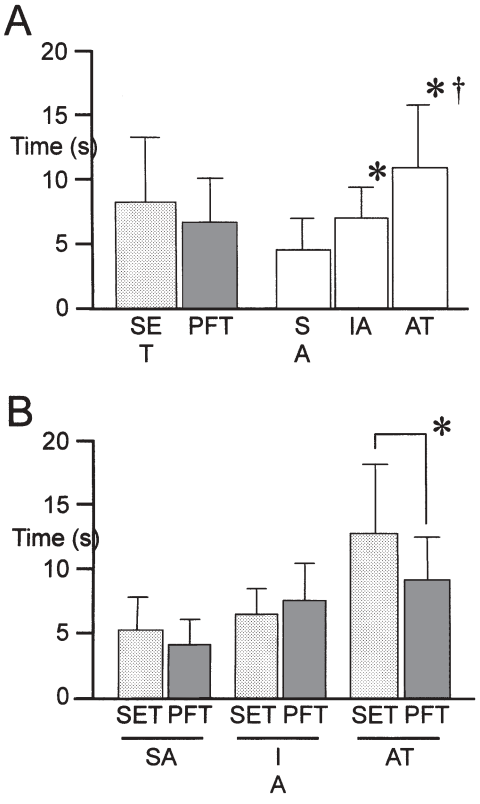

Fig. 1. A Times required for intubation (mean ± SE) according to each parameter. There was no statistically significant difference between the two tubes (*left*). The time required for intubation decreased with increase in experience (*right*); $^{*}P < 0.05$ versus SA; $^{\dagger}P < 0.05$ versus IA. **B** The PFT significantly decreased the time required for intubation only in the AT group. $^{*}P < 0.05$; SET versus PFT in each intubator group. *SET*, standard endotracheal tube; *PFT*, Parker Flex-Tip tube; *SA*, staff anesthesiologists; *IA*, inexperienced anesthesiologists; *AT*, anesthesia trainees

postoperative sore throat and hoarseness, the use of the flexible, tapered tip of the PFT has been expected to minimize or prevent airway injury. However, in addition to the endotracheal tube, the laryngoscope and nasogastric tube can also injure soft tissues in any area of contact. The duration of the presence of an endotracheal tube in place during anesthesia also affects the incidence of postoperative sore throat or hoarseness [9]. In our study, the rate of usage of a nasogastric tube, the incidence of esophageal intubation, and the use of postoperative analgesic agents which may affect postoperative sore throat did not significantly differ among the groups. However, whether the insertion of the laryngoscope and the insertion of nasogastric tubes were smooth was not considered in this study, so these factors may have affected the result. Although the anesthesia time for the AT group was longer than that for the SA group, it did not affect the incidence of postoperative sore throat and hoarseness.

In our study, the time required for intubation was defined as mentioned; however, this time includes factors other than the net time required to pass the tip of the tube through the glottis. Intubation skills differ among anesthetist and groups, consequently, times required for intubation may vary among different groups, being modified by other factors, but the results in anesthetists of comparable skill but with different tubes may indicate differences in time required between the tubes. In our study, the PFT significantly decreased the time required for intubation only for the AT group.

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