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Originals

Analysis of Difficult Tracheal Intubation Based on Video Records Using a Macintosh Type Video Intubating Laryngoscope in Adult

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SUMMARY

To assess the incidence of the difficult intubation and evaluate its clinical characteristics, we analyzed 964 cases of video records of tracheal intubation by Macintosh type video laryngoscope (MVL ; X-Lite video® : Rüsch, Germany). The views during the laryngoscopy were recorded on a video system, and the number of intubation attempts and total attempt times were measured afterwards. The video laryngoscope grade (V-grade) was determined based on the Cormack & Lehane grade (C-grade), and its correlation with the Mallampati classes (MP), the number of intubation attempts, and total attempt time were analyzed. V-grade 3 was defined as a difficult intubation, and morphological measurement of the head and neck regions was performed postoperatively. Of the 964 patients, 522, 416, and 26 patients were classified into V-grade 1, 2 and 3, respectively, and the number and time of attempts significantly increased with the grade ($p < 0.05$). The V-grades were significantly correlated with the MP classes and the number and time of attempts ($p < 0.0001$). At least 1 of the 3 morphological measurement items was abnormal in the 26 patients with difficult intubation in visual assistance and recognition. The use of MVL might facilitate difficult intubation. Its video records were useful for analysis. The postoperative morphological feature was consistent with previous reports where MVL was not used.

Key Words : difficult tracheal intubation, video laryngoscopy, morphological measurement

INTRODUCTION

A Macintosh type video laryngoscope (MVL) equipped with a wide-angle lens and an opticfiberscope in the blade, a xenon illumination at the tip, and a charge-coupled device (CCD) camera in the handle has recently been developed. The laryngoscopic view is displayed on a TV monitor, simultaneously. The angle of the view is about 60°, which is wider than that of the visual field under direct vision (Fig. 1). The laryngoscopist observes the larynx either directly or via TV monitor, and the attending cooperative physicians can simultaneously watch the view through a monitor. Furthermore, combination with a video recording system allows recording and storage of MVL images.

Several investigators reported the efficacy of video assisted tracheal intubation in the difficult airway[1,2]. The incidences of the difficult intubation were studied by conventional laryngoscope which was difficult to obtain visual records[3～7]. Especially in these studies, Biebuyck et al.[8] and Bellhouse et al.[9] reported that one or more abnormal values in thyromental distance, and the degree of atlantooccipital joint extension and Mallampati classification (MP)[10] were noted in the difficult intubation

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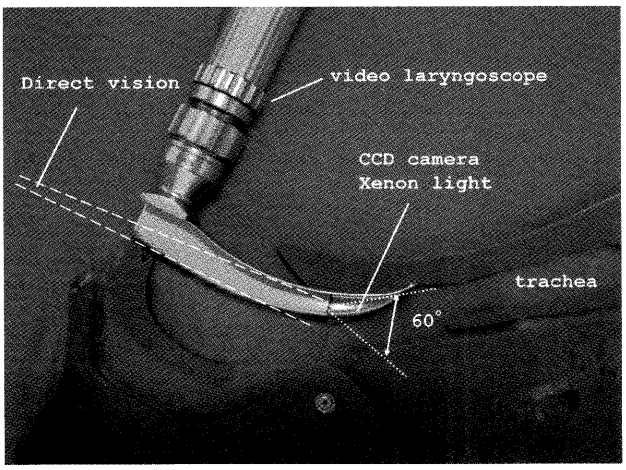

Fig. 1

patients. However, no study of difficult intubation was found that applied MVL in a large number of patients.

The purpose of this study was illustrating clinical picture of the difficult intubation using objective video records by MVL. The study was conducted ; 1. evaluation of the incidence of difficult intubation in daily practical use of MVL, and 2. examining whether the morphological features were consistent with previous reports in these difficult intubation cases.

MATERIALS AND METHODS

This study was approved by institutional ethical committee. The practical use of MVL (X-Lite video® : Rüsch, Kernen, Germany) was approved by institutional residency educational taskforce. MVL was used in 1,097 adult patients (age ≧ 15 years old) who underwent general anesthesia with tracheal intubation between October 2001 and September 2003. MVL was positively applied to patients in whom difficult intubation was predicted based on MP and patients undergoing surgery of the head and neck regions. MP was a relatively simple grading system which involves preoperative ability to visualize the faucial pillars, soft palate and base of uvula was designed as a means of predicting the degree of difficulty in laryngeal exposure[10]. Of the 1,097 patients, 26 patients of cervical myelopathy with limited extension and flexion whom required neck stabilization were excluded. In addition, 102 patients in whom preoperative evaluation of MP was not possible or the description was missing, and 5 patients with inadequate video recording were excluded. Thus, total 964 patients applied No. 3 blade with complete data set were investigated.

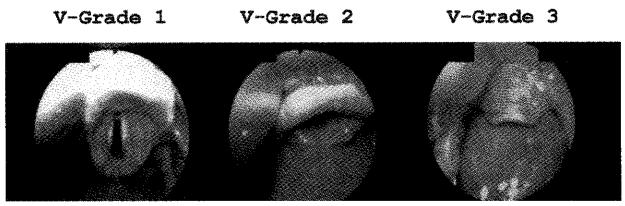

Fig. 2

Anesthesia was induced by intravenous or inhalation anesthetics with inhalation of 100% oxygen, and tracheal intubation was performed after muscle relaxant administration. The laryngoscopist was an anesthesiologist or a registered anesthetist, with or without a resident. Basically, attempting laryngoscopist underwent laryngoscopy and tracheal intubation by his or her direct vision except under the permission of referring video screen by attending anesthesiologist. The views during the laryngoscopy were recorded on the digital video system (DR-9W : Sony, Japan).

Since the laryngoscopic view in MVL is different from direct vision as shown in Fig. 1, the video laryngoscope grade (V-grade) with 3 categories derived from Cormack & Lehane grade [4] (C-grade) were newly defined as follows ; V-grade 1 : visualization of the entire laryngeal aperture, V-grade 2 : visualization of the posterior portion of the laryngeal aperture, and V-grade 3 : no visible rima glottides (Fig. 2). Using video records, the V-grade was identified as the best laryngoscopic view during insertion of the laryngoscope until completion of tracheal intubation. The number of intubation attempts was counted. The time during laryngoscopy was measured from the insertion until the completion of the tracheal intubation or until the laryngoscope was removed. In patients in whom intubation was attempted multiple times, the time for each attempt was added together (Total attempted time). To create a uniform measurement of video records, patient attributes blinded data was measured by the same anesthesiologist in all patients.

V-grade 3 was defined as a difficult intubation. Patients who had a difficult intubation were informed of their V-grade 3 classification. With these patients' written consent, the distance between the mentum and thyroid cartilage (tyromental distance) and the degree of atlantooccipital joint extension were measured postoperatively. To measure the thyromental distance, the patients extended

Table 1 Patient demographic data (n = 964)

		n
Age (years)	15～20	41
	21～50	335
	51～70	425
	>70	163
Gender	male	554
	female	410
ASA PS	1	397
	2	441
	3	122
	4	4
Intubation	oral	924
	nasal	40

Table 2 V-grade, numbers of attempts and attempt time in 964 case

	Video laryngoscope grade (V-grade)		
	1 (n = 522)	2 (n = 416)	3 (n = 26)
Numbers of attempts *	1.1 ± 0.4	1.3 ± 0.7	2.9 ± 1.0
Attempt time (sec) *	46.7 ± 39.5	66.7 ± 58.3	203.2 ± 101.1

* $P < 0.0001$ between V-grade

* $P < 0.0001$ between Video laryngoscope grade

Both numbers of attempts and attempt time were significantly increased by increment of V-grade.

Table 3 The relationship between Mallampati classes and video laryngoscope grades in 964 patients.

Mallampati class	Video laryngoscope grade		
	1	2	3
1	297	229	6
2	189	150	10
3	36	37	10

$P < 0.0001$

A significant correlation was observed between Mallampati classification and V-grade ($p < 0.0001$).

their heads to a maximum in the supine position, and the distance between the thyroid cartilage notch and the tip of the mentum was measured[9]. The degree of atlantooccipital joint extension was measured as the angle between the upper dentitions in a standing position while the neck was extended[8,9].

The measured values (the number of intubation attempts, the time during laryngoscopy, the distance between the mentum and thyroid cartilage and the degree of atlantooccipital joint extension) are presented as means ± SD. For comparison between the V-grades and the number of intubation attempts, and the time during laryngoscopy, factorial analysis of variance (Bonferroni/Dunn) was performed. Correlations between the V-grades and MP, the number of intubation attempts, and the time during laryngoscopy were analyzed by Spearman's rank correlation coefficient. Chi-square test was performed to compare the intubating difficulty and gender.

RESULTS

The background factors of the patients are shown in Table 1. Patients aged 21 – 70 years accounted for 78.8% of the patients, and the ASA classification was 1 – 2 in 86.9% of the patients. Nasotracheal intubation was performed in 40 patients (4%).

All patients were indicated and applied # 3 MVL blades. In 964 patients, 522 patients (54.1%) were identified as V-grade 1, 416 (43.2%) were identified as V-grade 2 and 26 (2.7%) were identified as V-grade 3. The numbers of attempts and the attempt time increased significantly ($p < 0.0001$) according to increments of V-grade (Table 2). There were also significant correlations between the V-grade, the number of attempts and the total attempt time ($p < 0.0001$, respectively). No correlation was observed between the intubating difficulty and gender. The correlation between V-grade and MP is shown in Table 3. A significant correlation was observed between V-grade and MP ($p < 0.0001$). From our data, detection of difficulty in intubation, designating MP class 3 as positive (difficult) and 1 and 2 as negative (not difficult), the sensitivity and specificity were 38.5% and 92.2%, respectively. The effective rate was 90.8%; the positive predictive value was 12%; and the negative predictive value was 98.2%.

The measured values in the 26 patients classified into V-grade 3 are shown in Table 4. Although no patient was unable to be intubated, tracheal intubation was not successful using MVL in 3 patients (Cases 2, 4, and 8). The No. 3 blade for MVL was too short for these 3 patients, and a No.4 blade for a conventional Macintosh laryngoscope was used. For the 5 patients for whom difficult intubation was predicted before surgery (Cases 12, 13, 21, 22, and 25), a fiberoptic bronchoscope, Styletscope®

Table 4 Twenty-six cases of difficult tracheal intubation

Case no.	Age (years)	Gender	Diagnosis	Mallampati classfication	Thyromental distance (cm)	Atlantooccipital joint extension (degrees)	Numbers of attempts	Total attempt time (sec)
1	81	M	Laryngeal tumor	1	5.5	25	2	125
2	68	F	Syringomyelia	1	5.0	18	4	245
3	68	F	Maxillary tumor	1	5.0	35	2	100
4	71	M	Lung cancer	1	6.0	20	5	220
5	81	M	Laryngeal tumor	1	5.5	25	2	34
6	61	M	Benign prostatic hyperplasia	1	5.5	37	3	172
7	68	M	Lung cancer	2	6.5	30	4	230
8	64	F	Pulmonary arteriovenous fistula	2	6.0	32	3	235
9	62	F	Cholecystolithiasis	2	5.0	22	3	200
10	58	M	Tongue cancer	2	5.5	45	2	116
11	24	F	Cataract	2	5.0	34	3	130
12	24	F	Cataract	2	5.0	34	1	97
13	38	M	Sleep apnea syndrome	2	5.5	15	3	300
14	67	F	Cholecystolithiasis	2	5.0	44	4	349
15	34	M	Pneumothorax	2	5.5	32	3	300
16	17	M	Dermal burn	2	3.5	35	1	50
17	76	F	Maxillary tumor	3	5.0	37	2	49
18	50	F	Breast cancer	3	5.5	35	2	150
19	56	F	Lung cancer	3	4.5	36	4	290
20	70	M	Liver cancer	3	6.5	37	3	198
21	17	M	Dermal burn	3	3.5	25	3	405
22	62	M	Lingual cancer	3	5.5	25	3	200
23	38	M	Liver cancer	3	5.0	35	3	245
24	31	F	Thyroid tumor	3	4.5	28	4	316
25	38	M	Liver cancer	3	5.0	35	3	161
26	61	M	Deviation of the nasal septum	3	5.0	35	4	367

- Macintosh # 4 blade was needed in cases 2, 4 and 8 because MVL # 3 blade was too short.
- Intubations succeeded in the combination of assisting device (s) in cases 12, 13, 21, 22 and 25.
- At least 1 out of 3 parameters (MP, thyromental distance and atlantooccipital joint extension) was abnormal in all cases.

(Nihon Koden, Japan), or the Trachlight lightwand was used as an assistive instrument. In the postoperative morphological measurement of the head and neck regions in the 26 V-grade 3 patients, the thyromental distance was 5.2 ± 0.7 cm, and the degree of atlantooccipital joint extension was 31.6 ± 7.4°. Twenty-six patients with difficult intubation had abnormality in at least 1 of the 3 measurement predictors, MP (≥3), the thyromental distance (normal ≥6.5 cm), and the degree of atlantooccipital joint extension (normal ≥35°). All 3 variables were abnormal in only 3 patients (Cases 21, 22, and 24), and 2 variables were abnormal in 16 patients. No complications caused by MVL itself were recognized in any patients.

DISCUSSION

In 1996, Haas[11] reported that attaching a fiberscope onto the laryngoscopic blade improved C-grade more than the external view. By attaching a fiberscope onto the laryngoscopic blade, improved education of technique as well as better results during difficult intubation were expected. The MVL employed in the current study embedded an optic and illuminating fiberscope in the conventional Macintosh blade. This meant that shape and handling did not differ from the conventional Macintosh laryngoscope ; however, the endoscopic view was improved. This system allowed the laryngoscopist to obtain views either directly or through the endoscopic view, simultaneously. This essential feature of MVL

allowed for effective education, especially in novice residents[12].

Several video intubating laryngoscopes have become popular. Some of them have been reported as being effective in difficult intubating cases[1, 2]. However, no reports analyzing difficult intubations in a teaching hospital where MVL is used for daily practice were seen.

The definition of difficult intubation varies. The American Society of Anesthesiologists (Anesthesiology) defines difficult intubation as requiring 3 attempts or more by a skilled physician or as requiring 10 minutes or more[13]. In another definition, inability of intubation by an anesthesiologist after 2 attempts is designated as a difficult intubation[3]. In this study, intubation was attempted 3 or more times in 18 patients, but no patient required 10 minutes or longer. C-grades 3 – 4 were designated as difficult intubation, but there were many problems with this designation method[4]. Judgements had to be made within a short time, and bias by the physicians who made the judgements was likely to occur. In contrast, in this study, video records of the laryngoscopic views were evaluated carefully and accurately by only one anesthesiologist postoperatively.

MP is widely known as a method of predicting difficult intubation, and a 3 or higher MP class is considered a high risk for difficult intubation[13]. However, the absence of correlation between MP and difficult intubation has been reported[6, 7]. In this study, 83 patients were MP class 3, and 10 were V-grade 3 (difficult intubation). A significant correlation was observed between the MP classes and V-grades. Mallampati reported that the incidence of MP class 3 was 7.14% in 210 cases, whereas our result was 8.6% in 964 cases[10]. The difference of distribution in the Mallampati classification between races has not been reported. Karkouti et al. reported MP class 3 in 75 cases (16.3%) and difficult intubation in 38 cases out of 461 cases[5]. These previous studies were carried out mostly in patients of Western descent, whereas our patients were mostly of Oriental descent. Skeletal difference might affect difficulty ; however, our results were consistent with those of previous studies. In contrast, 6 difficult intubations were observed in MP class 1 patients. In these patients, either the thyromental distance or the degree of atlantooccipital joint extension was abnormal. Biebuyck reported that 100% prediction of intubation difficulty was possible by the morphological measurement of these 3 predictors ; MP, thyromental distance, and the degree of atlantooccipital joint extension[8, 9]. Our study also supported that abnormality in 1 of 3 morphological measurements, especially in the thyromental distance, corresponded to V-grade 3, and difficult intubation.

The anatomical factors affecting difficult intubation and their solutions are classified into 3 categories. The first is mouth opening limitation and partial loss of teeth, which may disturb insertion of the laryngoscope. When insertion of a laryngoscope is impossible, a fiberoptic bronchoscope or the Trachlight lightwand may be required. The second is narrowing of the larynx and the tracheal diameter, and this can be dealt with by changing to a smaller tube. The third is an inability to directly observe the larynx due to morphological abnormality, deformity, and tumours in the oral cavity. MVL with a wide-angle visual field improves these factors. This simple feature facilitates decision, manipulation, and assistance by the attending physician. Especially, laryngeal compression improved the view in most case ; however, it deteriorated the view in some case[14, 15]. The effect of laryngeal compression was confirmed easily by both the laryngoscopist and the attending physician.

Video laryngoscopy is an innovation in tracheal intubation. Recording and storage of images is possible without having to learn specific techniques. These records enable accurate classification of difficult intubation. If a patient with difficult intubation in the past has video records and requires future surgery, an anesthesiologist can review the past video records, preparing for better airway management. In conclusion, the use of MVL may facilitate difficult intubation in visual assistance and recognition. The postoperative morphological features were consistent with previous reports that did not use MVL.

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