American Journal of Emergency Medicine (2005) **23**, 552–555

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The American Journal of Emergency Medicine

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Use of gum elastic bougie for prehospital difficult intubation☆

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Received 11 August 2004; revised 18 November 2004; accepted 8 December 2004

Abstract The objective of this study was to assess effectiveness of gum elastic bougie (GEB) in case of difficult intubation occurring in the prehospital settings. After manikin training to GEB handling, physicians were recommended to use GEB as first alternative technique in case of difficult intubation. Intubating conditions and details of patients requiring GEB-assisted laryngoscopy were recorded over 30 months. Among the 1442 extrahospital intubations performed, 41 patients (3%) required GEB. Gum elastic bougie allowed successful intubation in 33 cases (78%) and 8 patients sustained a second alternative technique. One patient was never intubated, another 1 required rescue cricothyroidotomy. Twenty-four (60%) GEB patients had associated factors for difficult intubation such as reduced or limited cervical spine mobility, morbid obesity, cervicofacial trauma, and ears, nose, and throat neoplasia. The success rate of GEB was 75% and 94%, respectively, depending on whether associated factors for difficult intubation are present or not. No adverse events associated to GEB use were noted.

1. Introduction

The gum elastic bougie (GEB) is an old tool widely used in European countries in case of difficult tracheal intubation occurring in the operating room [1-4]. Gum elastic bougie is a 60-cm-long tracheal tube introducer fabricated from a braided polyester base with a resin coating and a smooth angled distal tip. During direct laryngoscopy, when glottis is not visualized, GEB is passed blindly behind the epiglottis. Progression of the bougie within the trachea is confirmed by clicks felt (due to distal tip of the bougie stumbling over tracheal rings) and distal holdup (bronchus tree) limiting insertion at 30 to 40 cm from dental arcades. The tracheal tube is then railroaded over the GEB while direct laryngoscopy is maintained. Several studies performed at induction of general anesthesia have reported its effectiveness when optimal laryngeal landmarks could not be obtained under direct laryngoscopy [2,5,6]. This device has been exported outside the operating room and has become a cornerstone for difficult airway management in

Presented as an abstract at the annual meeting of the Société Française d'Anesthésie et de Réanimation, Paris, France, September 2003.

Support was provided solely from departmental sources.

☆ This work was performed in the Service d'Aide Médicale Urgente of Henri-Mondor University Hospital and Paris XII School of Medicine.

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doi:10.1016/j.ajem.2004.12.005

some EDs [7,8]. Recently, we have validated the efficiency of a simple algorithm to manage unanticipated difficult airway occurring in anesthetized patients using GEB as first alternative technique in case of difficult laryngoscopy [9]. We have demonstrated 80% success rate of GEB. Because airway management of prehospital emergency patients resembles that of unanticipated difficult airway anesthetized patients, we have hypothesized that GEB might be of similar interest out of the hospital. We have conducted an observational study to determine the success rate and safety of GEB as first-line alternative technique in case of difficult intubation occurring in prehospital intensive care medicine.

2. Methods

This monocenter study was performed in the suburbs of Paris (Val de Marne, population 1 300 000) by our local prehospital emergency medical unit (SMUR) between February 2001 and July 2003, according to French ethic laws. Our SMUR is equipped with 5 mobile intensive care units (MICUs) and its annual activity is about 10 000 medical emergency out-of-hospital interventions.

A MICU unit is composed of a vehicle driver, a nurse anesthesiologist, and either a senior emergency physician (>90% of cases) or a senior anesthesiologist. In France, extrahospital tracheal intubation is always performed by or under the control of a physician.

Forty-five intubators (23 emergency physicians, 5 anesthesiologists, and 17 nurses specialized in anesthesia) were involved in this study. Before joining the MICU team, specialized nurses were requested to have an experience of more than 4 years of intubation in operating room conditions and emergency physicians had at least 3 years of prehospital and inhospital emergency medicine experience (with a mean of 30 intubations per year). During the study period, a senior anesthesiologist was always on call in case of severe airway management difficulties encountered by the emergency physicians. This senior anesthesiologist was motorized to rapidly assist airway management on the scene of difficult intubation.

Before introducing GEB in the prehospital emergency medicine, the medical team of our SMUR adhered to an intense theoretical and practical formation (training manikin, Laerdal) with GEB handling. After completion of this initial formation, GEB (Eschmann tracheal tube introducer; Sims Portex, Hythe, UK) was available in all medical vehicles of the SMUR. The standard airway equipment on vehicles comprises laryngoscope with Macintosh blades (cold light) of different sizes, a GEB, a retrograde intubation kit, a cricothyrotomy kit, and an intubating laryngeal mask airway (ILMA).

As integral part of our local prehospital difficult airway management, GEB was recommended as the first-line alternative technique in case of difficult intubation defined by a number of failed tracheal access attempts under direct laryngoscopy (>2) with optimal head position (head extension in the absence of cervical immobilization) and external laryngeal manipulation (backward, upward, and right pressure). One intubation attempt under direct laryngoscopy was defined by an advancement of the tracheal tube toward the glottis followed by its removal from oral cavity. If 2 successive insertions of GEB failed at trachea intubation, the difficult airway management algorithm recommended second-step alternative techniques of intubation depending on physicians' preference and experience. A call for help to a senior anesthesiologist was mandatory in case of difficult ventilation scenario or if GEB-assisted intubation failed.

Before starting the study, all emergency care providers of the SMUR received an oral formation on the study's design, query form completion, and the algorithm of airway management. Cormack and Leane laryngeal view classification drawing was photocopied on each data sheet (grade 1, whole larynx visible; grade 2, partial view of vocal cords; grade 3, only epiglottis visible; grade 4, no part of larynx visible). All anesthetized (rapid sequence) or cardiac arrest patients in the care of our SMUR who requested rescue intubation and for whom tracheal access failed after 2 direct laryngoscopy attempts were included with the query form available in all vehicles systematically completed immediately after the airway management process.

Circumstances and clinical conditions of the airway management, characteristics of difficult laryngoscopy patients, intubation difficulty score, and details of the intubating process were recorded (Table 1). The success rate of GEB was calculated [10].

Airway care providers had to document the following parameters for all patients: estimated or known height and weight, history of ears, nose, and throat (ENT) disease, objective cervical mobility, cervical immobilization, and history of maxillofacial disease.

The relative position of the intubator and the patient and occurrence of complications, such as macroscopic inhala-

Table 1 Intubation difficulty scale from Adnet et al [10]

Parameter	Score
No. of attempt >1	N_1
No. of operators >1	N_2
No. of alternative techniques	N_3
Cormack grade 1	N_4
Lifting force required	
Normal	$N_5 = 0$
Increased	$N_5 = 1$
Laryngeal pressure	
Not applied	$N_6 = 0$
Applied	$N_6 = 1$
Vocal cord mobility	
Abduction	$N_7 = 0$
Adduction	$N_7 = 1$
IDS = sum of scores	N_1-N_7

tion, dental trauma, arterial oxygen desaturation, and hemodynamic instability, were recorded.

3. Results

During the study period, 1442 patients required intubation. Six hundred forty were cardiac arrest patients and 802 had a spontaneous cardiac activity the moment of airway management. Of the 802 patients with persistent cardiac activity, 771 (95%) received succinylcholine. Among the 1442 emergency cases, 186 were trauma patients, the remaining (1266) were medical patients.

Forty-one (3%) patients required GEB-assisted tracheal intubation challenge. Difficulties at laryngoscopy were encountered by 28 of 45 potential intubator of our SMUR emergency team. Three airway care providers were concerned 3 times, 7 twice, and 18 once. Median (SD) intubation difficulty score and Cormack grade for these 41 patients were 8 (2.2) and 4 (0.2), respectively. Twenty-eight patients (68% of GEB patients and 2% of all patients) were classified as Cormack grade 4. Gum elastic bougie allowed rapid successful intubation in 33 cases (78%); 24 at the first attempt, and 9 at the second. Rescue oxygenation was mandatory for 2 difficult mask ventilation patients after failed GEB challenge. Cricothyroidotomy was performed in 1 patient because of an allergic laryngeal angioedema and the resuscitation process was conducted while the second patient was ventilated then intubated through the ILMA.

A potential difficult airway management was anticipated in 24 (60%) of GEB patients that demonstrated associated factors for difficult intubation (AFDI) such as reduce cervical spine mobility (n = 7), morbid obesity (n = 7), ENT neoplasia (n = 7), cervicofacial trauma (n = 2), and allergic angioedema (n = 1). Seven patients with failed GEB that were intubated with a second-step alternative technique (ILMA [n = 1], retrograde intubation [n = 1], blind nasal intubation [n = 1], or by the rescue senior anesthesiologist under direct laryngoscopy [n = 4]) were among the 24 patients with AFDI.

Table 2 Characteristics of patients with or without AFDI

	Patients with evident AFDI (n = 24)	Patient without AFDI (n = 17)
H/F	17/7	12/5
Age	52 ± 15	59 ± 13
Cormack 2/3/4	3/4/17	1/6/10
IDS	8 ± 2	8 ± 2
Failure GEB	7	1
AFDI		
Morbid obesity	7	
Reduced cervical mobility	7	
Upper airway distortion	8	
Maxillofacial trauma	2	

The success rate of GEB was 75% and 94%, respectively, depending on whether AFDI are present or not. Most failed GEB-assisted intubation occurred in patients suffering from ENT neoplasia, with 95% GEB success rate in other patients with AFDI. All but 1 difficult laryngoscopy patients free from AFDI (n = 17) were intubated with GEB demonstrating a 95% (16/17) success rate. Clinical conditions, characteristics of difficult laryngoscopy patients, and details of the intubating process are reported in Table 2. No specific complication associated with GEB was noted.

4. Discussion

We observed about 3% difficult intubation requiring more than 2 laryngoscopic attempts in our emergency out-of-hospital patients. We demonstrated the effectiveness and safety of the GEB proposed as the first-line alternative technique in difficult laryngoscopy patients; 80% of these patients were rapidly intubated with this device.

We have chosen GEB to facilitate tracheal intubation of emergency difficult airway patients because of its simplicity of use, convenience, efficiency, and low cost. In addition, we have observed on manikin a very short learning process of this pocket-sized ready-to-use airway device. Although popular in the United States, we preferred to challenge GEB rather than the stylet because it was demonstrated in hospital studies to be systematically more efficient at assisting intubation [5,11]. Moreover, a recent report has demonstrated more than 95% success rate of tracheal intubation associated with the use of the GEB in case of unpredicted difficult laryngoscopy, which contrasts with our results [12].

Several factors can explain the lower efficiency of GEB to facilitate tracheal intubation in our emergency out-of-hospital difficult laryngoscopy patients. First, most of operating room studies that have demonstrated the interest of GEB included selected patients. Anticipated difficult airway and emergency patients were excluded from these trials. None of the patients included in these studies had factors that were shown to increase the risk of difficult intubation such as 60% (24/41) of the difficult laryngoscopy patients that we have managed. Interestingly, we demonstrated a 94% (16/17) success rate of the bougie in difficult laryngoscopy patients that were free (n = 17) from AFDI. All but 1 (7/8) bougie failure was observed which occurred in difficult laryngoscopy patients with AFDI. In the 24 difficult laryngoscopy patients with AFDI, we demonstrated a 75% success rate of bougie. Surprisingly, both groups of difficult laryngoscopy patients, with (n = 24) or without (n = 17) AFDI, were similar in mean Cormack score (3.5 and 3.6, respectively), suggesting that AFDI are determining factors for more difficult GEB-assisted intubation. Among difficult laryngoscopy patients with AFDI, most failed bougie-assisted intubation (3/7) occurred in patients suffering from ENT neoplasia, with 95% (16/17) success rate of bougie in morbidly obese patients and those

with reduced cervical spine mobility and cervicofacial trauma. Our results confirm a recent prospective study conducted in similar conditions. Gum elastic bougie efficiency was challenged in elective anesthetized patients as a first alternative technique in case of unexpected difficult laryngoscopy. The authors demonstrated that GEB allowed rapid tracheal intubation in 80% of difficult laryngoscopy patients [9]. We believe that unexpected difficult airway management of elective anesthetized patients is somehow comparable to that of prehospital anesthetized or cardiac arrest patients.

The second factor that may have influenced overall GEB success rate is related to environmental intubation circumstances. Indeed the interaction between the patient and the operator body positions at intubation seems to be of particular importance. The lying position of the patient on the ground, such as we experienced in almost half of our difficult laryngoscopy patients, was demonstrated to be an independent risk factor for prehospital difficult intubation [13]. This specific interplay between the operator and the patient, directly linked to prehospital emergency medicine, might have induced additional difficulties at laryngoscopy. The third factor that could explain a lower success rate than previously reported with GEB may be the high incidence of Cormack grade 4 reported in our study. Gum elastic bougie is classically attended to facilitate intubation in difficult laryngoscopy Cormack grade 2 and 3 patients. In our prehospital population, 27 of 41 patients were classified as Cormack grade 4 at the first laryngoscopy, and blind (with regard to laryngeal landmarks) tracheal intubation was attempted. Finally, the last factor that has probably influenced our results concerns the experience of the physicians that performed initial laryngoscopy. In the present study, most of the physicians in charge of the intubation were emergency physicians whose experience in difficult airway management is certainly less accurate than that of experienced anesthesiologist. Surprisingly, when a rescue senior anesthesiologist was requested (4/41), its evaluation of the Cormack score was systematically lowered by 1 grade as compared with that scored by the emergency physician. This observation may explain 4 difficult laryngoscopy patients which had experienced failed GEB attempts that were finally intubated under standard laryngoscopy by the senior rescue anesthetist. The results and success rate we report may not be completely exportable to other system of prehospital care using less educated care providers. We are aware that specialized physician aboard emergency ambulance is relatively uncommon out of European countries. However, we recommend using GEB as the first strategy in case of difficult intubation because this simple device is very easy to use. Although efficiency of GEB has not been evaluated in non medical personal, our educational program of medical student and paramedics has showed us that the learning curve of GEB was extremely short on the dummy and clinical acquisition of the technique of GEB-assisted tracheal intubation was immediate. Because of these reasons we recommend GEB handling to be taught to any care provider performing laryngoscopy.

In summary, our prehospital study outlines the major interest and safety of GEB to assist tracheal intubation of emergency patients. We have demonstrated that this simple device allowed rapid intubation of nearly 80% of prehospital patients with difficult direct laryngoscopy.

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