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ORIGINAL RESEARCH

Effects of age on emergency airway management

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Abstract

Background/Purpose: Age is considered a risk factor for a difficult airway (DA) and can serve as guidance towards a quick decision in the management of an emergency airway. However, the effect of age on a DA is seldom evaluated. This study investigated the effect of age on the difficulty of emergency airway management to anticipate DAs, which would allow physicians to provide alternative approaches beforehand, thereby increasing the quality of emergency airway management in elderly patients. **Methods**: A study form that recorded potential risk factors for a DA was designed. Research nurses and physicians who had performed tracheal intubation completed a case report form in the emergency department of a medical centre for over a year. Risk factors for a DA were identified using logistic regression. **Results**: We recorded 114 attempts during the study period. Difficult mask ventilation (60.9% vs 10.0%, $P < 0.001$), but not difficult intubation (29.7% vs 22.0%, $P = 0.355$), was more frequently observed among elderly people compared with nonelderly patients. **Conclusion**: Physicians should anticipate difficult mask ventilation in emergency airway management, especially in elderly people, and patients with sunken cheeks or a short and thick neck.

Keywords

Anatomy; Aging; Airway management; Difficult airway; Difficult mask ventilation; Difficult intubation; Elderly; Emergency airway management; Endotracheal intubation

1. Introduction

Difficult airway management is of paramount importance in anaesthesia. Both difficult intubation (DI) and difficult mask ventilation (DMV) can complicate endotracheal intubation. A DA is defined as that resulting in DI or DMV and can cause catastrophic events, especially in emergency airway management [1, 2]. Risk factors for a DA have been extensively studied. Several easy-to-use, weighted risk scales have been developed to improve the discrimination of a DA among healthcare professionals. When a DA is anticipated, guidelines suggest alternative approaches to reduce the risk of complications [3–5].

Age has been reported as a risk factor for DA, but the results are conflicting. Studies have indicated that patients with DI were older than those without DI (DI vs no DI: 50 vs 43 years of age [6]; 54 vs 46 years [7]; 55 vs 53 years [8]), but the incidence of DI did not differ between elderly people and younger people [9–12]. Data on the effect of age on DMV are more consistent in the literature. The mean age of those with DMV is 60 [13], 54 [14], 48 [15], and 75 [16] years compared with 50 [13], 42 [14], 42 [15], and 63 [16] years in those without DMV. The incidence of DMV in the older group was higher [17]; however, the effect of aging on DMV in elderly people was inconclusive [16].

Most predictors of a DA that depend on anatomic variations are similar to aging-related changes in the head, face, and neck [6–8, 18, 19]. Aging can cause dental loss, buccal hallowing, temporomandibular joint disc osteoarthritis, and joint changes in the head and neck [20–22], which can eventually lead to a combination of risk factors for a DA, such as a lack of teeth, sunken cheeks, limited mouth opening, and a short and thick neck [23], leading to concerns regarding the occurrence of a DA among elderly patients.

This study aimed to determine the effects of age on emergency airway management because the elderly population is increasing globally [12, 24, 25] and rapid decisions in the management of an emergent airway could be guided by age.

2. Methods

The study was approved by the institutional review board of Mackay Memorial Hospital, Taipei, Taiwan (protocol 11MMHISO64). All adult patients undergoing tracheal intubation in the emergency department of Mackay Memorial Hospital, Taipei, Taiwan, between 1 November 2011 and 31 December 2012 were included. After obtaining informed consent from patients or their legal representative, physicians performing the tracheal intubation reported outcomes on a case report form. A research nurse reviewed and recorded potential risk factors for DI or DMV on the same paper. The elements evaluated to determine risk factors for a DA

TABLE 1. Difficult airway incidence in nonelderly and elderly patients.

Variable	< 65-years of age (n = 50; 43.9%)	≥ 65-years of age (n = 64; 56.1%)	*P* value*
Age, mean (SD), y	49.4 (10.1)	78.6 (8.2)	< 0.001
Female	39.0 (78.0)	34 (53.1)	0.006
DI	11 (22.0)	19 (29.7)	0.355
DMV	5 (10.0)	39 (60.9)	< 0.001

*DI: difficult intubation; DMV: difficult mask ventilation; *Student's t-test or Pearson's $\chi 2$ test. NOTE: Unless specified otherwise, all values are presented as n (%).*

TABLE 2. Physical appearance characteristics of nonelderly and elderly patients.

Variable	< 65-years of age (n = 50; 43.9%)	≥ 65-years of age (n = 64; 56.1%)	*P* value*
A lack of teeth	2 (4.0)	28 (43.8)	< 0.001
Sunken cheeks	1 (2.0)	15 (23.4)	0.001
Double chin	1 (2.0)	13 (20.3)	0.003
Receding mandible	0	2 (3.1)	0.503†
A short and thick neck	2 (4.0)	13 (20.3)	0.011
Limitation of neck movement	3 (6.0)	10 (15.6)	0.109
Kyphosis	3 (6.0)	7 (10.9)	0.509†
Sputum impaction	12 (24.0)	25 (39.1)	0.088

**Student's t-test, Pearson's $\chi 2$ test, or †Fisher's exact test. NOTE: All values are presented as n (%).*

included body shape; teeth or sputum existence; cheek, chin, mandible, neck, and spine shape; neck movement; mouth opening size; and thyroid gland-to-mental, sternal notch-to-mental, and thyroid gland-to-sternal notch distances, which could affect trachea intubation and mask fit [14, 15, 17, 18]. All patients, except those who were comatose, underwent adequate induction anaesthesia before the procedures.

Generally, physicians only have seconds to minutes to make decisions when preparing for emergent airway management [26]. Therefore, the definition of a DA in the study was derived from simple and clear criteria from the literature [6, 8, 10–14, 17, 18, 27]. DI was defined as emergency physicians having difficulty with endotracheal intubation [7]. DMV was defined as the emergency physician being unable to perform one-person bag-valve-mask ventilation to maintain oxygen saturation above 90% by using 100% oxygen and positive pressure ventilation or being unable to prevent or reverse signs of inadequate ventilation within 30 seconds [28, 29] when setting up an artificial airway. The observed signs of inadequate mask ventilation include a gas flow leak around the mask, poor chest movement, and oxygen desaturation. DMV with one-person mask ventilation is resolved using a two-handed, two-person mask ventilation technique or by changing the mask ventilation. Patients with head, face, or neck trauma, head and neck cancer, upper airway obstruction by blood or food impaction, or burn injuries were excluded to focus on anatomic changes caused by the normal aging process.

The emergency chief resident physicians or certified registered nurses at the workstation initiated mask ventilation and intubation, and the attending staff made all clinical decisions regarding airway management (i.e. patient position, mask size, direct laryngoscope blade, and use of cricoid pressure). Mask ventilation was performed using an advanced silicon rubber reusable half mask face piece (Teleflex Medical Inc., Research Triangle Park, NC). The intubation operator assessed the degree of mouth opening by the distance between the upper and lower incisors when the mouth opened as wide as possible [12]. Thyromental, thyrosternal, and sternomental distances were measured separately when the head and neck were fully extended and the mouth closed, from the thyroid cartilage to the mandibular mentum, the thyroid cartilage to the suprasternal notch, and the suprasternal notch to the mandibular mentum, respectively. The laryngoscopic view was graded using the Cormack-Lehane score: grade I, if part of the vocal cord is visible; grade II, if only the arytenoids are visible; grade III, if only the epiglottis is visible; and grade IV, if the epiglottis is not visible [30]. The Mallampati test was divided into the four following classes: class I, if the soft palate, fauces, uvula, and pillars are visible; class II, if the soft palate, fauces, and uvula are visible; class III, if the soft palate and base of uvula are visible; and class IV, if the soft palate invisible is not visible [6].

2.1 Statistical analysis

The primary outcome was the measure of the effect of age on DA. The secondary outcome was the effect of age-related anatomy on DA in elderly people. All analyses were performed using the statistical software package for Windows SAS 9.4 (SAS Institute Inc., Cary, NC). Patients were divided into an elderly group (aged ≥ 65 years) and a nonelderly group (aged < 65 years) [31]. Categorical variables are described using frequency distributions, reported as a number and percentage (%). Continuous variables are reported as the mean ± standard deviation. Logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals to identify independent

TABLE 3. Anatomic measurement variables of the head and neck in nonelderly and elderly patients.

Variable	< 65-years of age (n = 50; 43.9%)	≥ 65-years of age (n = 64; 56.1%)	*P* value*
BMI ≥ 24 (kg/m^2)	20 (40.0)	29 (45.3)	0.570
Mouth opening (cm)			
< 3	12 (24.0)	12 (18.8)	0.275
3 - 3.99	22 (44.0)	22 (34.4)	
≥ 4	16 (32.0)	30 (46.9)	
Thyromental distance (cm)			
< 6	6 (12.0)	14 (21.9)	0.532
6 - 6.99	10 (20.0)	11 (17.2)	
7 - 7.99	23 (46.0)	24 (37.5)	
≥ 8	11 (22.0)	15 (23.4)	
Sternomental distance (cm)			
< 10	4 (8.0)	7 (10.9)	0.312
10 - 12.99	19 (38.0)	30 (46.9)	
13 - 13.99	8 (16.0)	13 (20.3)	
≥ 14	19 (38.0)	14 (21.9)	
Thyrosternal distance (cm)			
< 6	12 (24.0)	26 (40.6)	0.082
6 - 7.99	28 (56.0)	23 (35.9)	
≥ 8	10 (20.0)	15 (23.4)	
CL classification			
1	8 (16.0)	8 (12.5)	0.751
2	24 (48.0)	28 (43.8)	
3	15 (30.0)	21 (32.8)	
4	3 (6.0)	7 (10.9)	
Mallampati classification			
1	16 (32.0)	14 (21.9)	0.416
2	21 (42.0)	28 (43.8)	
3 or 4	13 (26.0)	22 (34.4)	

*BMI: body mass index; CL classification: Cormack-Lehane classification; *Student's t-test or Pearson's $\chi 2$ test. NOTE: All values are presented as n (%).*

risk factors for DMV among individual characteristics. Statistical significance was set to an alpha level of 0.05.

3. Results

Table 1 presents the demographics and characteristics of patients enrolled in the study. During the study period, 114 adult patients received tracheal intubation at the emergency department. In total, 64 patients (56.1%) were elderly. Most nonelderly patients were women. Furthermore, 26.3% of the patients had DI, and 38.6% had DMV. DI incidence was 29.7% and 22.0% in the elderly and nonelderly group, respectively. The elderly group exhibited DMV more frequently than did the nonelderly group (60.9% vs 10.0%, $P < 0.001$).

The appearance of the elderly patients differed from that of the nonelderly patients in the study (Table 2). The elderly patients were more likely to display a lack of teeth (43.8% vs 4.0%), sunken cheeks (23.4% vs 2.0%), a double chin (20.3% vs 2.0%), or a short and thick neck (20.3% vs 4.0%). The anatomic measurement variables of the head and the neck indicated no significant differences between the nonelderly and elderly patients (Table 3).

We further analysed the data through logistic regression to identify possible factors associated with DMV. Table 4 presents the crude and adjusted OR of DMV based on the aging-related anatomy changes of the head, face, and neck. The crude OR of the DMV rate significantly increased in elderly individuals (OR = 14.04) who were overweight (OR = 2.16), had a lack of teeth (OR = 4.08), had sunken cheeks (OR = 9.37), and had a short and thick neck (OR = 32.20). However, the crude OR of the DMV rate was significantly decreased in patients with a thyrosternal distance larger than six cm (OR = 0.35). The adjusted risk of DMV also indicated that elderly patients, patients with sunken cheeks, and those with a short

TABLE 4. Logistic regression results: crude and adjusted odds ratios for significant predictors of difficult mask ventilation.

Predictor	Crude OR (95% of CI)	*P* value	Adjusted OR (95% of CI)	*P* value
Age $\geq$ 65 y (ref, $<$ 65 y)	14.04 (4.91-40.18)	$<$ 0.001	8.64 (2.25-33.15)	0.002
Gender	0.60 (0.28-1.32)	0.205	1.58 (0.46-5.38)	0.466
BMI $\geq$ 24 (ref, $<$ 24 kg/m^2)	2.16 (1.00-4.66)	0.050	2.78 (0.82-9.43)	0.100
A lack of teeth	4.08 (1.69-9.80)	0.002	1.17 (0.31-4.38)	0.821
Sunken cheeks	9.37 (2.49-35.26)	$<$ 0.001	17.83 (3.27-97.12)	$<$ 0.001
Double chin	NA			
A short and thick neck	32.20 (4.05-256.03)	0.001	26.85 (2.64-273.14)	0.005
Limitation of neck movement	2.02 (0.63-6.46)	0.237		
Kyphosis	1.67 (0.45-6.13)	0.442		
Sputum impaction	1.57 (0.71-3.50)	0.265		
Mouth opening $\geq$ 3 (ref, $<$ 3 cm)	1.06 (0.42-2.68)	0.902		
Thyromental distance $\geq$ 6 (ref, $<$ 6 cm)	0.73 (0.27-1.92)	0.518		
Sternomental distance $\geq$ 10 (ref, $<$ 10 cm)	0.32 (0.09-1.17)	0.084		
Thyrosternal distance $\geq$ 6 (ref, $<$ 6 cm)	0.35 (0.16-0.79)	0.011	0.46 (0.14-1.54)	0.207

BMI: body mass index; CI: confidence interval; OR: odds ratio; NA: not available.

and thick neck had a significantly higher risk of DMV; the adjusted OR were 8.64, 17.83, and 26.85, respectively.

4. Discussion

A one-year prospective analysis of 114 patients requiring tracheal intubation at the emergency department was performed to evaluate clinical characteristics, the frequency of the occurrence of DA, and associations between aging-related changes in the head, face, and neck and DMV. Elderly patients were more likely to have DMV than DI. Some of the aging-related changes, such as sunken cheeks, a double chin, and a short and thick neck, were associated with the occurrence of DMV.

A DA, including DI and DMV, require alternative airway management to resolve the difficulty in endotracheal intubation [32–35], which is an important consideration among emergency physicians because of its potential for rapid progression in clinical conditions [6]. Most of the identified predictors of a DA that depend on anatomic variations are comparable to the aging-related changes of the head, face, and neck anatomy [20, 23].

Age is a determining factor of DI. Patients with DI were determined to be older than those without DI [6–8]. Age changes the anatomy of the head, face, neck, and oropharyngeal cavity and affects laryngoscopic view during endotracheal intubation that plays a crucial role in the degree of difficulty of airway management [11, 23, 36]. However, we demonstrated that being elderly did not predict DI (Table 1). The finding is comparable with previous study [9]. When DI determined by laryngoscopic view with Cormack-Lehane classification system, patients aged 40 to 59 years had the highest grading indicating a high difficulty level in endotracheal intubation [10, 11]. During emergency airway management, nonelderly adults experienced DI more frequently than the others [12].

Our study revealed that age may predict DMV. The appearance of the head, face, and neck and the posture differed between elderly people and young adults [22, 23], which may contribute to DMV. In the literature, patients with DMV were older than those without DMV [13–15, 17]. A lack of teeth [15, 17], a double chin [14], and a high Mallampati class [15, 17, 18] are identified predictive factors of DMV in the studies. These results are in line with our findings. As displayed in Table 1 and Table 2, elderly people tend to display DMV, and they are more likely to lack teeth or have sunken cheeks, a double chin, and a short and thick neck. Moreover, the study demonstrates that being elderly is an independent factor in predicting DMV in emergency airway management (Table 4).

5. Conclusions

Aging significantly changes the body, head, face, and neck anatomy, which increases the risk of DMV but not DI. Physicians should be aware that elderly people are at risk of DMV during the management of emergency airways, especially patients with sunken cheeks or a short and thick neck.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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