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RESEARCH

INVESTIGATING THE FREQUENCY AND CAUSES OF DIFFICULT MASK VENTILATION IN INTRAOPERATIVE IN GERIATRIC PATIENTS

ABSTRACT

Introduction: The sunken cheeks of edentulous elderly patients may cause mask ventilation to be ineffective or even impossible. The aim of this study was to identify the frequency and causes of difficult mask ventilation in geriatric patients.

Materials and Method: This study was completed prospectively in 8 months, and included 264 patients that were ≥65 years old, undergoing elective operations. Difficult mask ventilation form 1 (demographic data, mouth opening measurements, mallampati score, thyromental and sternomental distance, mandibular protrusion test, neck movement and circumference, the presence of beard in male patients and their dental situation) and difficult mask ventilation form 2 (their experience as a mask ventilation user, difficulty of mask ventilation, using the opioid/neuromuscular blocker agent in induction of anaesthesia and maintenance of the airway) were completed.

Results: Surgical intervention was performed in 7948 (29%) patients aged 65 years and above. A total of 254 patients were included in the study. Patients were mean aged 72±6 and 58.7% male. Overall, 68.9% of patients had no teeth, whereas 31.1% had normal teeth/fixed prosthesis. 32.7% of patients had grade 1 difficult mask ventilation, 54.7% had grade 2 and 12.6% had grade 3 difficult mask ventilation. Grade 4 difficult mask ventilation was not observed. In male patients had beard 26.2% in grade 1, 46.3% in grade 2 and 66.7% had in grade 3 difficult mask ventilation.

Conclusion: In this study, the incidence of difficult mask ventilation in the geriatric patient population was 12.6%. The independent risk factors for difficult mask ventilation were identified as male gender, thickened neck circumference, the presence of a beard in male patients and the experience of the anaesthesiologist.

Key Words: Geriatric; Anaesthesia; Patient; Difficult Mask Ventilation.

ARAŞTIRMA

GERİATRİK HASTALARDA İNTRAOPERATİF ZOR MASKE VENTİLASYONU SIKLIĞININ VE NEDENLERİNİN ARAŞTIRILMASI

ÖZ

Giriş: Yaşlı ve dişsiz hastalarda yanakların çökük olması nedeniyle maske ventilasyonu efektif olmayabilir hatta imkansızlaşabilir. Bu çalışmanın amacı geriatrik hastalarda zor maske ventilasyonun sıklığının ve nedenlerinin saptanmasıdır.

Gereç ve Yöntem: Bu çalışma, 8 aylık bir dönemde, prospektif olarak, 65 yaş ve üzeri, 264 hasta ile elektif operasyon geçirenlerde yapıldı. Zor maske ventilasyon form 1 (Demografik veriler, mallampati skoru, ağız açıklığı, tiromental ve sternomental mesafe, mandibular protruzyon testi, boyun hareketleri, boyun çevresi, erkek hastalarda sakal bıyık varlığı ve dişlerinin durumu) ve zor maske ventilasyonun form 2 (maske ventilasyonu uygulayıcısının deneyimi, maske ventilasyon zorluğu, indüksiyonunda opioid/nöromuskuler ajan kullanımı, hava yolu idamesinin nasıl yapıldığı) kaydedildi.

Bulgular: Altmış beş yaş ve üstü 7948 (%29) hastaya cerrahi girişim yapıldı. Çalışmaya toplam 254 hasta dahil edildi. Hastaların ortalama yaşı 72±6 ve %58,7'si erkek idi. Hastaların %68,9'unun dişsiz, %31,1 dişlerinin normal/sabit protez olduğu gözlendi. Hastaların %32,7'si grade 1, %54,7'si grade 2 ve %12,6'sı grade 3 zor maske ventilasyonu olarak saptandı. Grade 4 zor maske ventilasyonuna hiç rastlanmadı. Erkek hastalarda sakal varlığı %26,2 grade 1, %46,3 grade 2 ve %66,7 grade 3 zor maske ventilasyonu olanlarda tespit edildi.

Sonuç: Bu çalışmada geriatrik hasta popülasyonunda zor maske ventilasyonu sıklığı %12.6 olarak bulundu. Erkek cinsiyet, boyun çevresinin kalın olması, erkek hastalarda sakal varlığı ve anestezistin tecrübesi zor maske ventilasyonu için bağımsız risk faktörü olarak saptandı.

Anahtar Sözcükler: Geriatrik; Anestezi; Hasta; Zor Maske Ventilasyonu.

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INTRODUCTION

Mask ventilation forms the basis of airway management. Providing mask ventilation before endotracheal intubation or other methods (e.g. tracheostomy or cricothyrotomy) is a basic but potentially life-saving airway technique that allows oxygenation and ventilation in patients without a reliable airway. Difficulty or failure in managing the airway of patients is an important factor in increased morbidity and mortality linked to anaesthesia (1).

Geriatric patients are now encountered more frequently in daily anaesthetic practice because of increased life expectancy, which continues to rise with increased living standards, and developments in anaesthesia, surgical techniques and medication that enable more difficult and complicated medical interventions (2). During anaesthesia induction, difficult or impossible mask ventilation accompanied by difficult intubation cause life-threatening complications in 0.4% of adult anaesthesia cases (3). Especially in geriatric patients, reduced upper airway tonus increases the possibility of airway obstruction, which can render mask ventilation difficult (4). Indeed, mask ventilation in old, toothless patients with sunken cheeks may be ineffective and even impossible. Thus, lack of teeth in geriatric patients is a known independent risk factor for difficult mask ventilation (DMV) (5). The incidence of DMV is observed to vary between 0.07% and 16% (3, 6–12). In addition to lack of teeth, Langeron et al. (13) identified having a beard, a body mass index (BMI)> 26 kg/m^2, or history of snoring, as well as being aged>55 years as independent risk factors for DMV. Kheterpal et al. (3) also found limited or severely limited mandibular protrusion, abnormal neck anatomy, sleep apnea, snoring, and body mass index of 30 kg/m^2 or greater were independent predictors of grade 3 or 4 DMV and difficult intubation.

The aim of this study was to determine the frequency and causes of DMV in geriatric patients.

MATERIALS AND METHODS

This study was completed from November 2012 to Jun 2013 at a University Medical Faculty Anaesthesiology and Reanimation Department. Permission for the study was obtained from the Non-interventional (non-invasive) Clinical Research Assessment Commission on 15th November 2012 (protocol no. 787-GOA), and informed consent was obtained from all patients.

This was a prospectively planned study in which patients aged ≥65 with planned elective operations were identified from the daily surgery program one day in advance. The Difficult Mask Ventilation (DMV 1) form 1 was used to record the patients' age, gender, weight, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status, Mallampati score, mouth opening measurement, thyromental distance, sternomental distance, mandibular protrusion tests, neck movements, neck circumference, presence of a beard in male patients and dental situation.

Patients taken to the operating room were subjected to routine monitoring of their heart rate, systolic arterial pressure, diastolic arterial pressure, mean arterial pressure, 3 lead electrocardiography (Derivation II) and peripheral oxygen saturation before anaesthesia induction.

Where patients wore false teeth, their teeth were removed prior to anaesthesia induction. Black rubber masks were used in the study. The proper mask size was decided according to a variety of facial features of each patient. All the patients were preoxygenised with 100% oxygen for 3 min by using a face mask. The anaesthetic administrator selected the type and dose of agents used during anaesthesia induction. During induction, 100% oxygen was administered with mask ventilation. The person who performed the mask ventilation completed the DMV 2 form. Via this form, the following was recorded: their experience as the ventilation operator (resident or specialist anaesthesiologist), opioid agent(s) of using for general anaesthesia induction and neuromuscular blocker agent during mask ventilation and experience of using the airway maintenance device; moreover, if the patient was intubated, the Cormack–Lehane score was recorded. The degree of DMV was defined as per the work by Han et al. (6) as follows: Grade 0: spontaneous respiration, ventilation without mask; Grade 1: ventilation with mask; Grade 2: mask ventilation with oral airway or other adjuvant (neuromuscular blocker agents); Grade 3: DMV (insufficient or unstable ventilation, or mask ventilation with two people) and Grade 4: ventilation impossible with mask.

Exclusion Criteria

The patients that were<65 years old, had experienced previous chin/facial surgery or radiotherapy in the neck region, had an ASA score of 5–6, were operated on under sedoanalgesia and regional anaesthesia, or those that were emergency cases were excluded from the study. The day case surgical patients who were admitted to the hospital on the day of their operation were excluded from the study because preoperative assessment could not be completed. Furthermore, only patients operated on in the central operating rooms were included in the study, and patients with missing or erroneous DMZ 1 or DMZ 2 forms were excluded.

Statistical Analysis

Data obtained from this research were entered into a database created using the SPSS 15 (Statistical Package for Social Sciences) program, and the statistical analyses of the data were performed using the same program. Numerical variables are presented as the median, minimum, maximum and range values. Whether numerical variables and subgroups were normally distributed was determined normality by graphing the data or normality in the light of sample size. Where variables were not normally distributed, they were analysed using non-parametric methods, i.e. Kruskal–Wallis and Mann–Whitney U tests. Categorical variables were recorded as frequencies and percentages in diagonal tables; the distributions of these variables were compared using the Chi Square test. All the tests had 1st type error margins and $\alpha = 0.05$, and they were bilaterally tested. Where the p values were <0.05, the difference between the groups was accepted as statistically significant.

RESULTS

During the 8 months, 27,381 surgical interventions were performed, and their distribution within the study is shown in Figure 1. Of the patients analysed, 20% had cardiovascular surgery, 23% had urologic surgery, 19% had brain surgery, 18% had general surgery, 7% had chest surgery, 6% had orthopaedic surgery, 3% had gynaecological and obstetric surgery, 1% had plastic surgery and 1% had ear, nose and throat surgery. The demographic data of the patients is shown in Table 1.

It was found that 32.7% of patients were classed as Grade 1 DMV cases, 54.7% as Grade 2 DMV and 12.6% as Grade 3 DMV, whereas Grade 4 DMV was not found. For patients with Grade 1, 2 and 3 DMV, the relationships between physical examination components is shown in Tables 2 and 3.

When comparing patients with Grade 1, 2 and 3 DMV, there were statistically significant differences between the groups in neck thickness (mean 42 cm) ($p< 0.001$). Therefore, pairwise comparisons were conducted. When Grade 3 DMV patients were compared with Grade 1 and 2 DMV patients in terms of gender, being male was significantly more

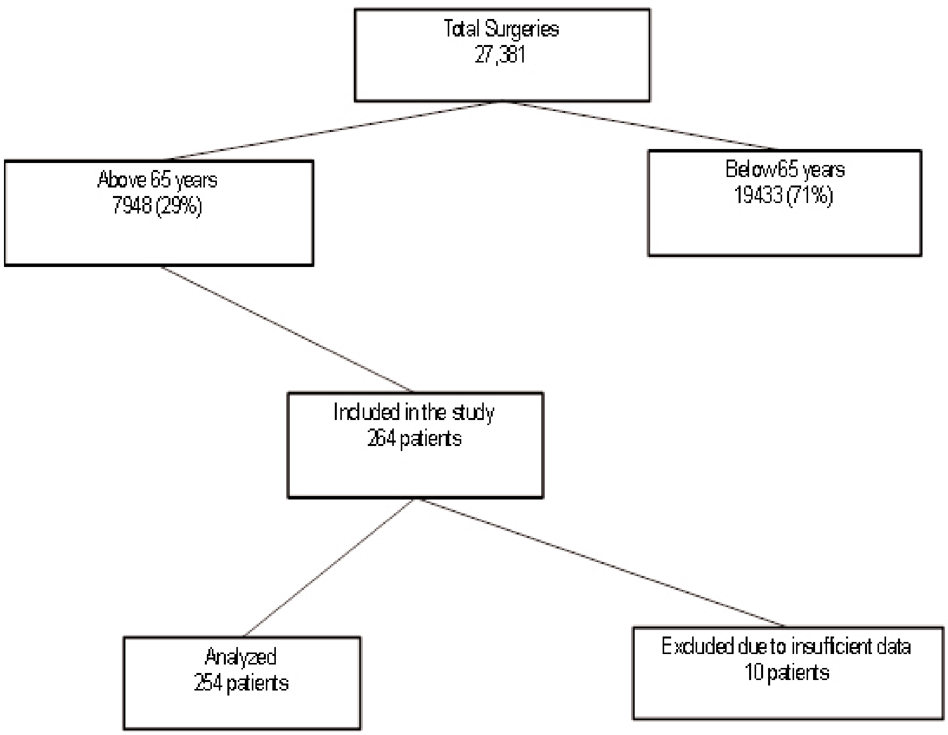

Figure 1— Flow chart.

Table 1— Demographic Data of the Patients and the Grade of Difficult Mask Ventilation.

Demographic Data	Grade 1 Mask Ventilation n= 83 32.7%	Grade 2 Mask Ventilation n= 139 54.7%	Grade 3 Mask Ventilation n= 32 12.6%	p
Age (year) (mean±sd)	72±6	73±5	74±7	-
Weight (kg) (mean±sd)	72±14	75±12	74±13	0.242
Height (cm) (mean±sd)	165±9	165±9	168±9	0.149
BMI (kg/m^2) (mean±sd)	26.94±5.16	27,65±4,90	26,09±4,72	0.216
Gender (M/F) (n)	41/42	82/57	26/6	0.008*
ASA Class (1/2/3) (n)	0/55/28	-/91/48	-/18/14	0.571

*: p< 0.05

Table 2— Grade 1, Grade 2 and Grade 3 Mask Ventilation the Relationship Between Physical Examination Components.

Risk Factor	Grade 1 Mask Ventilation n (%)	Grade 2 Mask Ventilation n (%)	Grade 3 Mask Ventilation n (%)	p
Mallampati (1/2/3/4)	28/32/21/2	33/63/39/4	10/8/11/3	0,153
	33.7/38.6/25.3/2.4	23.7/45.3/28.1/2.9	31.3/25/34.4/9.4	
Cormach-Lehane (I/II/III/IV)	40/21/3/1	53/46/5/1	13/4/2/2	<0.001*
	61.5/32.3/4.6/1.5	50.5/43.8/4.8/1.5	61.9/19/9.5/9.5	
Mean mouth opening (cm) (min-max)	4 (3-6)	4 (3-6)	4 (3-6)	0.453
Thyromental distance (cm) (mean±SD)	10±1	10±1	10±1	0.446
Sternomental distance (cm) (mean±SD)	16±2	17±2	16±1	0.538

Table 3— Grade 1, Grade 2 and Grade 3 Mask Ventilation the Relationship Between Other Physical Examination Components.

Physical Examination Components	Grade 1 Mask Ventilation n (%)	Grade 2 Mask Ventilation n (%)	Grade 3 Mask Ventilation n (%)	p
Mandibular protrusion tests	71/8/4	110/24/5	30/2/-	0.106
Class A/ B/ C	85.3/9.6/4.8	79.1/17.3/6.3	93.8/6.3/-	
Neck movements				
Normal	76 (91.6)	125 (89.9)	27 (84.4)	0.520
Limited extension/flexion	7 (8.4)	14 (10.1)	5 (15.6)	
Presence of beard in male				
Yes	11 (26.2)	37(46.3)	18 (66.7)	0.004*
No	31 (73.8)	43 (53.8)	9 (33.3)	
Dental situation				
No teeth	52 (62.7)	97 (69.8)	26 (81.3)	0.147
Normal or fixed prosthesis	31 (37.3)	42 (30.2)	6 (18.8)	

*: p< 0.05

likely to be a risk factor for DMV in Grade 3 DMV patients (vs. Grade 1, p= 0.004; vs. Grade 2, p= 0.032). When the neck circumference of Grade 1 DMV patients was compared with that of Grade 2 and 3 DMV patients, the neck circumference was significantly greater in Grade 2 (p= 0.002) and Grade 3 (p= 0.001) patients. Thus, the neck circumference was a risk factor for increased difficulty of mask ventilation. In those surveyed patients, 44.1% had a history of snoring, whereas 55.9% had no history of snoring.

Resident and specialist anaesthesiologists performed mask ventilation for 89% and 11% of patients, respectively. The mask ventilation was statistically significant differences between experience of anaesthesiologist (p= 0.005). The anaesthesiologists ventilating Grade 1 DMV patients were found to have more mask ventilation experience than those ventilating Grade 2 DMV patients; moreover, mask ventilation became easier as experience increased (p= 0.001).

Opioids were used for anaesthesia induction in 91.7% patients, but were not used in 8.3% patients. At the induction stage, neuromuscular blocker agents were used for 56.3% patients and not used for 43.7% patients. When Grade 1, 2 and 3 DMV patients were compared, there was no statistically significant differences in the opioids used during anaesthesia (p= 0.051) or the neuromuscular blocker agent used during induction (p= 0.086).

After mask ventilation, 14.6% patients maintained their airway by using the classic laryngeal mask airway (LMA), 1.6% by the Proseal LMA, 0.4% by the Fast track LMA, whereas 75.2% had an endotracheal tube inserted. In 8.3% cases, other methods (tracheostomy or mask ventilation) were used to maintain the patient's airway.

DISCUSSION

Mask ventilation is the primary airway technique enabling lung ventilation before the insertion of any airway device in a patient with insufficient respiration. It is the most basic but often the most important technique for airway management; indeed, difficulties or failures in airway management most frequently cause morbidity and mortality linked to anaesthesia (7).

In the literature, the incidence of DMV is observed to vary between 0.07% and 16% (3,5, 8–10,13-15). In our study, the frequency of DMV (i.e. DMV Grade 3) was 12.6%. The reasons for variation in DMV among studies include the fact that no standardised protocol exists for DMV cases, different age groups of patients are studied, and the personal skills of the researchers and the subjective criteria used to define DMV differ. In our study, we used the DMV scale of Han et al. (6). Although this scale is not widely used in mask ventilation studies, it was selected here because it is easily understood, quick and practical to use.

Many different age groups have been studied in the research regarding the incidence and causes of DMV. Yildiz et al. (14) studied 576 patients aged 18–65 years, and excluded patients>65 years. Of these patients, those with easy mask ventilation had an average age of 42±16 years, those with moderately DMV were aged 50±15 years and those with DMV were aged 48±12 years. Rose et al. (8) investigated all age groups, as observed in the study by Asai et al. (9) (even infants aged<1 years), whereas El-Orbany et al. (15) studied all age groups>18 years. In a study conducted by Racine et al. (5), the average age of the patients was 71±11 years, the range of patients being 60–82 years. In contrast to these studies, we investigated only individuals aged ≥65 years.

A study of the data on 3 years of anaesthesia records from 37 centres in Denmark found that DMV was observed unexpectedly in 808 of 857 cases (94%), but when DMV was expected (218 cases), it was observed in only 49 (22%) cases (10). Based on this study, an estimate of the accuracy of the prediction of airway management by anaesthesiologists in routine practice was published.

In our study a total of 254 patients were investigated and grade 4 DMV was not encountered. A study by Kheterpal et al. (3) on 22,660 patients found the rate of grade 4 DMV was 0.16% (n=37), while another study by the same researcher identified the rate of grade 4 DMV as 0.15% (n=77) in 53,041 patients given mask ventilation (16). In a study of 576 patients by Yıldız et al. (14) they stated they did not encounter grade 4 DMV. When the literature is examined, these studies were completed on very broad patient series and we see the rate of grade 4 DMV is very low.

Physical characteristics of patients such as gender, BMI, mouth opening, thyromental distance that have some effect on difficult mask ventilation. In our study we did not identify a statistically significant relationship between BMI and difficult mask ventilation. As body mass index> 30 kg/m^2 (3) is reported as a risk factor for difficult mask ventilation, BMI> 26 kg/m^2 (13) may be an independent risk factor for difficult mask ventilation. In our study the mean BMI was 26.8 kg/m^2, however the lower number of patients compared to the other two studies may have caused this result.

Our data indicated DMV is significantly higher in male than female patients; this finding is consistent with those of other studies. For example, Yildiz et al. (14) and Kheterpal et al. (16) found that the male gender was an independent risk factor for DMV and impossible mask ventilation, respectively. In theory, the differences in bone structure, soft tissue and fat deposition in males compared with females creates a tendency for upper airway collapse in males. Similarly, the activation or control of pharyngeal dilator muscles in males can lead to pharyngeal collapse. The difference in respiratory control mechanisms between the genders is also used to explain why male patients are prone to obstructive sleep apnoea syndrome (17). In several studies of DMV, oropharyngeal disproportion, sleep apnoea syndrome and male gender were among the causes of airway collapse (3,10,13). Thus, being male appears to be a predisposing factor for airway collapse, which can increase the difficulty of mask ventilation.

We found that the presence of beards among Grade 3 DMV patients was significantly higher than that in Grade 1 DMV patients, which suggests that beards are a contributing factor to DMV patients. Previous studies have also found that beards were an independent risk factor for DMV in male patients (3,10,13). Long and thick beards or moustaches prevent the mask from fully fitting on the face, resulting in gas leaks.

In our study we did not identify a statistically significant relationship between DMV and thyromental distance and sternomental distance. However, Kheterpal et al. (3) found that thyromental distance of less than 6 cm was an independent risk factor for grade 4 difficult mask ventilation. In our study the fact that the thyromental distance of patients was not low (mean 10 cm) is one of the reasons for not finding it a determining factor for DMV.

With an aging population a prevalence of edentulous patients increased above 60 % among individuals aged ≥65 yr (18). Face mask ventilation of these edentulous patients is often difficult because of the inadequate fitting of the standard mask to the face (19). In addition, because of a reduction in muscle tone under general anesthesia, the air space in the oropharynx is reduced, and posterior displacement of the tongue, soft palate and epiglottis tend to close the airway (20). In old patients with no teeth, sunken cheeks may make ventilation with a mask ineffective; perhaps even impossible (21). In a study of 300 toothless patients, Racine et al. (5) observed 16% DMV. In our study, the 12.6% rate of DMV comprised patients with and without teeth; therefore, the presence of patients with teeth may have reduced the relative incidence of DMV in our study. We found no link between lack of teeth and mask ventilation; however, other studies have shown that mask ventilation is more difficult in toothless patients. For example, in those aged>65 years, lack of teeth, as well as reduced tissue elasticity and muscle tonus, may result in insufficient and ineffective mask ventilation (11). In addition, because the mask does not always fit correctly on the cheeks of toothless patients, severe air leaks may occur. A study by Conlon et al. (12) found that the frequency of toothlessness was 60% in patients aged ≥65 years, which is higher than that in other age groups. Langeron et al. (13) reported that toothlessness was an independent risk factor for DMV.

In our study, we found a strong relationship between the thickness of a patient's neck circumference and DMV. The neck circumference of the patients with Grade 2 and 3 DMV was greater than that of patients with Grade 1 DMV, and as the neck circumference increased, mask ventilation became more difficult. In a study on radiation therapy in the neck region, Kheterpal et al. (16) found that the neck circumference was an independent risk factor for impossible mask ventilation. Similar to our study, Khan et al. (21) also identified a relationship between the neck circumference and DMV. Nafiu et al. (23) found a clear relationship between loud snoring, abdominal obesity, sleep apnoea syndrome and bronchial asthma in patients with greater neck circumference, and observed that children with greater neck circumference had higher Mallampati scores, more DMV particularly after anaesthesia induction and exhibited upper airway obstruction in the postoperative care unit. In our study, the frequency of upper airway obstruction increased in the patients with thicker necks, and we suggest that this made mask ventilation more difficult. In contrast, we found no significant relationship between neck movement and DMVs; however, the evaluation of the patients' neck movement was somewhat subjective and this may have affected this result.

In this study, we observed a significant difference in the experience of the anaesthesiologist ventilating Grade 1 and Grade 2 DMV patients. In particular, anaesthesiologist with an average of 4 years' experience ventilated patients with Grade 1 DMV, whereas those that ventilated Grade 2 DMV patients had an average of 3 years' experience. Therefore, we suggest that as the experience of the anaesthesiologist increases, the rate of easy mask ventilation also increases. We consider that the higher-than-expected number of patients in the Grade 2 DMV group is linked to a reduction in effective mask ventilation performed by less experienced anaesthesiologist.

In our study, DMV was unaffected by the use of opioid agents during anaesthesia; however, in the previous studies, a high dose of opioid agents has been linked to DMV (24-26). Anaesthesiologist has decided the opioid doses in our study because of DMV incidans may lesser. To compare the effect of opioids on DMV, it would be necessary to use a standardised dose. We also found no significant relationship between the use of neuromuscular blocking agents during anaesthetic induction and DMV. Similarly, Godwin et al. (26) showed that the use of neuromuscular blocking agents in patients with normal airways did not affect mask ventilation. However Warters et al have reported (27) neuromuscular blockade facilitates mask ventilation. They have discussed the implications of this finding for unexpected difficult airway management and for the practice of confirming adequate mask ventilation before the administration of neuromuscular blockade. Their data showed that these medications have significant effects to ease mask ventilation with neuromuscular blockage in practical management of difficult or impossible mask ventilation.

Ikeda et al. (28) investigated the systematic effects of muscle relaxants on mask ventilation during anaesthesia administration with normal upper airway anatomy protecting the neutral head and mandibular position in supine pose. Their hypothesis was that muscle relaxants improve adequate mask ventilation in anesthetized subjects. They have found that rocuronium administration did not change adequate mask ventilation efficacy, and succinylcholine administration improved adequate mask ventilation by 30% in association with pharyngeal fasciculation.

This study has some limitations. Firstly, the subjective evaluation of the patients' neck movement, and lack of a clear measurement for this factor, is an issue. We acknowledge that assessing neck movements using objective criteria would have provided results that were more appropriate. Secondly the duration of mask ventilation was not recorded. Thirdly the doses of opioids and neuromuscular blocking agents used during mask ventilation were not recorded. In addition, the 254 patients assessed in this study represent a rather small population. A larger patient population would enable the collection of additional data that could be considered more reliable. No patient for whom fast-track LMA was used had LMA inserted due to a difficult airway but rather for educational purposes.

Sufficient mask ventilation is the most basic and important skill not just in anaesthesia induction but for reliable airway management during successful resuscitation. As a result knowing the risk factors for DMV in patients with planned elective operations and reliable mask ventilation management may be useful. Our results suggest male gender, thick neck circumference, the presence of beards in male patients and the experience of the anaesthesiologist were all identified as independent risk factors for DMV in intraoperative setting.

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