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Original Article / Özgün Araştırma

Do Difficult Airway Techniques Predispose Obese Patients to Bronchospasm?

Zor Hava Yolu Teknikleri Obez Hastalarda Bronkospazma Neden Olur mu?

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Abstract / Öz

Objective: The existing evidence separately correlates morbid obesity with difficult intubation and bronchospasm. However, there is a lack of data on whether anaesthesia provider manipulations during difficult intubation contribute to an increased ratio of bronchospasm in these patients.

Methods: This is a retrospective analysis of data prospectively taken from 50 morbidly obese patients involved in a previously published study. A possible difficult intubation was preoperatively investigated by recording the following specific physical examination indices: Mallampati and Cormack–Lehane (CL) classifications, cervical spine mobility (CSM), thyromental distance (Td) and patients' ability to open their mouth (mouth opening). Bronchospasm was clinically detected by auscultation and confirmed by measuring peak airway pressures during mechanical ventilation. The Kruskal–Wallis H test was used for data analysis, followed by the Mann-Whitney U test as applicable.

Results: Different physical examination prognostic indices, including Mallampati and CL scales ($p<0.001$; the CSM excluded –$p=0.790$), showed that they are related to difficult intubation. Bronchospasm not attributable to difficult intubation was observed in six obese patients.

Conclusion: Patients with morbid obesity constitute an increased relative risk group as far as difficult intubation is concerned, particularly if preoperative findings support a relationship between the two variables examined. In our study, difficult intubation and the concomitant use of special equipment and manipulations did not contribute to an increased rate of bronchospasm in obese patients, but in view of the lack of data, a large number of more sophisticated studies are required to elucidate such an assumption.

Keywords: Obesity, bronchospasm, difficult airway, difficult intubation, physical examination of the upper airway

Amaç: Mevcut deliller, morbid obeziteyi zor entübasyon ve bronkospazm ile ayrı ayrı ilişkilendirmektedir. Ancak, zor entübasyon sırasında anestezistin uygulamalarının bu hastalarda bronkospazm oranının artmasına katkıda bulunup bulunmadığına dair yeterli veri bulunmamaktadır.

Yöntemler: Bu, daha önce yayınlanmış olan bir çalışmaya katılan 50 morbid obez hastadan prospektif olarak alınan verilerin retrospektif bir analizidir. Muhtemel bir zor entübasyon preoperatif olarak aşağıdaki spesifik fizik muayene ölçütleri kaydedilerek araştırıldı: Mallampati ve Cormack-Lehane (CL) sınıflamaları, servikal omurga hareketliliği (SOH), tiromental mesafe (Tm) ve hastaların ağızlarını açma yeteneği (ağız açıklığı). Bronkospazm, klinik olarak oskültasyon ile tespit edildi ve mekanik ventilasyon sırasında pik hava yolu basınçlarının ölçülmesiyle doğrulandı. Kruskal-Wallis H testi, veri analizi için kullanıldı, ardından Mann-Whitney U testi uygulandı.

Bulgular: Mallampati ve CL skalaları ($p<0,001$; SOH hariç $p=0,790$) dâhil olmak üzere, farklı fiziksel muayene prognostik indeksleri, bunların zor entübasyonla ilişkili olduğunu göstermiştir. Zor Entübasyonla ilişkilendirilmeyen bronkospazm, altı obez hastada görülmüştür.

Sonuç: Morbid obezitesi olan hastalar, zor entübasyon söz konusu olduğunda, artan bir relatif risk grubu oluşturmaktadır; özellikle preoperatif bulgular, incelenen iki değişken arasında bir ilişkiyi destekliyorsa. Çalışmamızda, zor entübasyon ve özel ekipman ve manipülasyonların eş zamanlı kullanımının, obez hastalarda bronkospazm oranının artmasına katkıda bulunmadığı tespit edilmiştir, ancak veri eksikliği nedeniyle, böyle bir varsayımı açıklığa kavuşturmak için çok sayıda, çok yönlü çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Obezite, bronkospazm, zor hava yolu, zor entübasyon, üst solunum yolunun fizik muayenesi

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Introduction

There is clear evidence that obesity is considered an independent risk factor for difficult intubation (1) and can cause faster oxygen desaturation and hypoxemia during induction of general anaesthesia compared to normal patients, thereby significantly increasing morbidity and mortality during surgery (2, 3). Therefore, obese patients elected for surgery need a thorough preoperative upper airway evaluation to specify all the indices during physical examination that may predict difficult intubation (4-7). In patients lacking a history of allergy or bronchial asthma, mechanical irritation of the upper airway that occurs in endotracheal intubation often leads to bronchospasm (8) and increased airway pressures of the respiratory system, which may be reversible with the aid of inhaled bronchodilators (9). Current studies concerning bronchospasm during intubation make extensive reference to the cause (mechanical irritation or allergic reaction), but no distinction has been drawn yet between simple and difficult intubation, and more specifically, whether difficult intubation increases the ratio of bronchospasm (10, 11).

In accordance with the above observations, a retrospective study was planned based on patients with severe to morbid obesity [body mass index (BMI) ≥35 kg m^{-2}] who electively underwent abdominal surgery. The main aims were as follows:

(a) To evaluate the recording of maximum prognostic indices during preoperative physical examination, and thus to determine difficult intubation in obese patients early on

b) To ascertain whether there is any relationship between increased rate of bronchospasm and difficult intubation, concomitant alternative manipulations or the use of intubation equipment techniques such as cricoid pressure or gum elastic bougie that are used to ensure airway intubation.

Methods

This retrospective investigation follows our previous study titled 'Bronchospasm in obese patients undergoing elective laparoscopic surgery under general anaesthesia', involving 50 obese patients (BMI ≥35 kg m^{-2}) who underwent sleeve gastrectomy surgery and 50 non-obese patients (BMI <35 kg m^{-2}) who underwent other laparoscopic general surgery procedures (12). The previous study approved by the Institution Ethics Committee was conducted at a tertiary care University Hospital over a 2-year period. It confirmed the increased appearance of bronchospasm in obese patients and was registered in the 'Clinical Trials' international trial registry (ClinicalTrials.gov Identifier: NCT01488643). Patients included in the present study were from the pool of data of the previous study, so there were the same inclusion criteria as written informed consent and age >18 years. Similarly, exclusion criteria were a history of psychiatric disease or mental disorder, use of habit-forming drugs and inability to follow preoperative orders. Morbidly obese patients can have profound cardio-respiratory dysfunction, which remains undetected due to reduced mobility; thus, all obese patients were evaluated with standardised anaesthetic preoperative assessment according to the rules of the Association of Anaesthetists of Great Britain and Ireland (2007) (13).This study only considered information regarding obese patients. Further, as in a retrospective study, there were no randomisation, nor 'blinding' issues.

Demographic characteristics collected were age, gender, weight, BMI and American Society of Anesthesiologists (ASA) classification.

To predict a possible difficult intubation, the Mallampati and Cormack-Lehane (CL) classifications were used along with cervical spine mobility (CSM), thyromental distance (Td) and patients' ability to open their mouth (mouth opening). The Mallampati scale ranges from class 1, where all oropharyngeal structures are visible to class 4, with the soft palate not visible in a patient sitting upright with mouth maximally open and tongue protruded (14). The CL scale ranged 1-4 and was evaluated by an otorhinolaryngologist using a flexible fibre optic bronchoscope. The CSM scale, where patients should be able to touch their chin to their chest and extend their neck backwards was a 3-point scale, with 1 indicating 'full movement' and 3 indicating 'completely immobilised' (16). Patients' mouth opening was classified as 1=mouth opening ≤4 cm and 2=mouth opening >4. Td value (distance from the lower border of the mandible to the thyroid notch with the neck fully extended) was 1 when Td was ≤7 cm and was 2 when Td was >7 (16).

Our clinical data concerned bronchospasm and difficult intubation. Bronchospasm detected by auscultation (intense wheezing) was confirmed by tidal volume reduction (hypoventilation) and increased peak airway pressures, prolonged expiration with visible upslope on the capnogram and bronchospasm caused arterial blood oxygen desaturation and hypoventilation according to repeated arterial blood gas samples, following insertion of a radial arterial line. The groups concerning bronchospasm were regarded as 1 if bronchospasm occurred and as 0 if not.

The intubation procedure was divided into laryngoscopy (Lar; easy or difficult: e, d) and endotracheal intubation (Int; easy, difficult or impossible: e, d or imp), thus giving 4 pairs of difficulty. Pair 1=eLar–eInt, Pair 2=dLar–eInt, Pair 3=dLar–dInt and Pair 4=dLar–impInt [no impossible intubation occurred in our sample; hence, the recorded pair values (scale) ranged up to 3]. Pair 2 corresponded to the use of external laryngeal manipulation (cricoid pressure) (17) to allow the anaesthesia provider to gain visual contact with the vocal cords. According to literature, a difficult laryngoscopy could lead to a relatively easy intubation with the Back and Backwards Upwards Rightwards Pressure (Back and BURP) manipulations (18-20), whereas a difficult intubation could not be improved irrespective of the manipulations. Therefore, Pair 3 corresponded to the use of special equipment (gum elastic bougie and fiberoptic bronchoscope) for achieving intubation. Obviously, there were described cases with an easy laryngoscope, which was followed by a difficult intubation due to

tumours, burns or previous local area deformities that could be attributed to tracheotomy (21, 22). In our study, no patient had any of the above conditions, and hence, there was no reference for this combination (pair eLar-dInt).

A strict protocol was followed concerning basic preparation where a difficult airway was predicted in the induction to anaesthesia. This involved notifying the patient, ensuring that special equipment and a reasonably experienced laryngoscopist were present in the room, checking for the absence of resistive patient muscle tone and finally, placing the patient in an optimal sniffing position and providing preoxygenation before induction to anaesthesia (23).

Anaesthesia was induced using intravenous midazolam 2 mg, propofol 3 mg kg^{-1} and fentanyl 150 µg. Cisatracurium 0.2 mg kg^{-1} was given to facilitate endotracheal intubation. All medication doses were calculated based on the ideal body weight. Anaesthesia was maintained with sevoflurane at 1.2 end-tidal monitored anaesthesia care (corrected for age), combined with fentanyl and remifentanil (12). The management of any difficult airway was completed according to the basic algorithm of the Difficult Airway Society (24).

Statistical analysis

The nonparametric Kruskall–Wallis H test was used for data analysis, and in case of a significant difference, a Mann-Whitney U test was performed to establish the pairs of the grouping variable that showed this difference. A difference was considered significant when $p<0.05$ using the IBM Statistical Package for Social Sciences (IBM, SPSS Statistics, version 22, Armonk, NY, USA) for data analysis.

Results

Of the 50 patients enrolled in this study, 16 were men and 34 women, with an average age of 41 years and an ASA score close to 3 (Table 1). The mean weight was 132.44 kg, thus reaching an average BMI of 46.3 kg m^{-2}.

Table 2 shows the results obtained using the Kruskal–Wallis H test to establish whether intubation distributions were the same (null hypothesis [NH]) with regard to bronchospasm and whether the distributions of all other factors, such as Mallampati, mouth opening, CSM, Td and CL were similar (NH) with regard to intubation. There were no significant differences ($p=0.08$) concerning the 3 pairs of intubation difficulty and their distributions in the 2 groups of bronchospasm. All factors describing the intubation difficulty, such as Mallampati and mouth opening, except CSM, were found to have significant differences in their distributions with regard to the variable 'intubation'.

The rejection of NH was combined with a Mann–Whitney U test post-hoc to establish the pair of groups that differed with regard to 'intubation', while the bronchospasm groups (0, 1) showed no statistical difference. All intubation difficulty factors had significant differences between Pairs 1 and 2, whereas only CL and mouth opening factors had significant differences between Pairs 1 and 3. Finally, there was no significant difference between Pairs 2 and 3. Considering the absence of impossible intubation in our sample, grade 4 for intubation was omitted, giving the data presented in Table 3.

Table 1. Patient characteristics

	Mean±SD	
Sex (M/F)	16/34	
Weight	132.44	17.82
BMI	46.3	6.97
ASA	3.16	0.37
Age	40.96	9.6

Table 2. Grouping variable between bronchospasm and intubation is the factor bronchospasm and that between all other factors (Malampati, Td, CL and CSM) and intubation is the factor intubation. For a complete explanation of these variables, see text in the Methods section

Bronchospasm (groups) (0,1)	Intubation (3 pairs-3 groups) Significance (2-tailed)	Mallampati (1–4) scale	Mouth opening (1,2) (groups)	Thyromental distance (1,2) (groups)	Cormack Lehane (1–4) (scale)	Cervical spine mobility (1–3) (scale)
0.08		0.003	0.003	0.004	<0.001	0.790

Kruskal–Wallis H test for ordinal data

Table 3. Statistical differences in intubation difficulty factors. The variables 'bronchospasm', and 'CSM' were omitted as long as there was no statistical difference in the previous test (Kruskal–Wallis H test)

Intubation (1–3 groups)	Mallampati (1–4)	CL (1–4)	Td (1,2)	Mouth opening (1,2)
1 vs. 2	0.001	<0.001	0.001	0.005
1 vs. 3	0.723	0.003	0.512	0.001
2 vs. 3	0.049	0.444	0.262	0.390

Mann–Whitney U test. Post-hoc comparisons between groups - Significance (2-tailed) CSM: cervical spine mobility; CL: Cormack-Lehane scale; Td: thyromental distance.

Discussion

In this study, all prognostic factors of difficult intubation except CSM were associated with intubation difficulty (Table 2). Moreover, two factors (CL and mouth opening) responded well with the factor intubation, particularly when intubation was easy, regardless of the difficulty in laryngoscopy (Pair 1 vs. 2; Table 3). The same logic was applicable to Pair 1 vs. Pair 3, showing a clear distinction between easy laryngoscope intubation and difficult laryngoscope intubation. Surprisingly, the study showed difficult laryngoscopy to be of limited value in predicting intubation problems (Pair 2 vs. Pair 3). The above discrepancies (CSM data - intubation Pair 2 vs. Pair 3 concerning CL and mouth opening), including Td, which only seems to be of predictive value in easy intubation, may be due to the small size of our sample. Furthermore, even though CSM is a rather important predictor for intubation (16, 25), the average age of our population was 41 years; thus, no individual experiencing problems associated with ageing were present, such as arthritis or spine deformations, which prevent the full range of neck movement. Obviously, there is at least partial agreement with current literature (16, 26), where predictors, such as CL, Td and mouth opening, play an important role in difficult intubation, with the CL score described as the most reliable prognostic factor (26) and the other two as useful guides in avoiding upper airway complications (27). Although the Mallampati scale is related to intubation prognosis (p=0.003), it did not seem to respond well to intubation, given that there were cases where the scale recorded was 1–2 and yet intubation was difficult and vice versa. According to these observations, we tend to agree with other studies (28-30) in which the Mallampati classification is considered a prognostic intubation index, but not as sensitive as the CL scale. Evidently, CL classification has to be performed by a doctor in another specialty, which is almost prohibitive in routine preoperative examination.

This study showed that in line with our initial hypothesis, given that nothing is fully predictable by any one specific method and that anaesthesia providers may face the possibility of difficult intubation in obese patients, different approaches should be used to gather as much information as possible during physical examination. If time suffices, elective surgery should be preceded by thorough clinical evaluation and recording in obese patients (31, 32).

In case of the second hypothesis, regarding whether difficult intubation leads to bronchospasm due to manipulations or the use of specific equipment, our results show (p=0.08) that there is no such relation. The fact that all obese patients who presented with bronchospasm (6 out of 50, a very high rate compared to the general population) were in the easy intubation group shows that induction to anaesthesia may trigger different mechanisms in obese patients. These mechanisms may be attributed to chronic lung inflammation, which in combination with mechanical irritation during intubation can lead to bronchial hyperactivity and consequent bronchospasm (33). Perhaps such a patient should undergo certain preoperative immunological tests or tests substantiating the existence of increased bronchial excitability (e.g. metacholine or histamine inhalation challenge tests), the results of which could form a reliable prognostic index for dealing with perioperative bronchospasm.

Conclusion

Given that anaesthesiologists may be called upon to deal with difficult intubation and/or bronchospasm during morbid obesity surgery, all the information derived from history, physical examination or previous exam is essential. Nevertheless, the present study shows that difficult intubation does not increase the likelihood of bronchospasm. Further studies are needed to not only clarify this finding but also improve outcome in this kind of surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from University of Thessaly, Medical School (Assembly of Special Arrangement, 2nd meeting/ 02-02-2011/Secretary Certification protocol number: 4196/29-09-2016).

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