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Corresponding Author
S. Punita Priya,
Department of Anaesthesiology and Pain Relief, Kidwai Memorial Institute of Oncology, Bangalore, India
punitamd2011@gmail.com

Author Designation
[1]Professor and Head
[2-4]Assistant Professor

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Accuracy of Two Measurements Using Different Anatomical Facial Landmarks for Determining the Appropriate Size of Oropharyngeal Airway: A Prospective Comparative Cross-Over Study

[1]B.H. Arathi, [2]G.C. Namratha, [3]B.O. Roopa and [4]S. Punita Priya
[1-4]Department of Anaesthesiology and Pain Relief, Kidwai Memorial Institute of Oncology, Bangalore, India

ABSTRACT
Several external facial measurements are recommended for selecting the appropriate size of Guedel's oropharyngeal airway. This study compared two guidelines: the distance from the corner of the mouth to the angle of the mandible (DAM) and the maxillary incisors to the angle of the mandible (DIM), as per American Heart Association and European Resuscitation Council guidelines, respectively. This prospective crossover study included 78 patients without features of a difficult airway. Airways corresponding to DAM and DIM measurements were inserted post-induction and muscle relaxation, grouped as DAM and DIM, respectively. Adequacy of ventilation was assessed via chest expansion and ventilator-delivered tidal volume. The tip position was evaluated using a flexible fiberoptic bronchoscope. In the DAM group, chest expansion and tidal volume (397.6±57.7 ml) were significantly better than the DIM group (335.1±70.2ml., P<0.001). The tip was ideally placed above the glottis in all DAM group patients, ensuring a clear glottic view. In the DIM group, only 23% had ideal placement., 76.9% experienced tip-induced epiglottis obstruction, with 14.1% showing complete blockage. Complications, including oropharyngeal bleeding and epiglottis injury, were observed in 12 DIM group patients. The DAM-based Guedel's airway size provided superior ventilation and ideal tip placement compared to the DIM-based approach.

INTRODUCTION

The risk of upper airway collapse increases in unconscious or anaesthetized patients because a low central drive decreases the activity of the pharyngeal dilator muscles[1,2]. An oropharyngeal airway helps relieve such upper airway obstruction as it moves the tongue and hypopharyngeal structures forward, improving airway patency[3]. Although the airway is simple to use, it is important to select an appropriate size. If the airway is too small, its distal end will be obstructed by the tongue, resulting in inadequate ventilation[4] and, if too big, there is a risk of traumatic injury to the surrounding laryngeal structures. Various internal structures and external landmarks have been studied for choosing the right size of an airway[5-9]. To estimate an appropriate airway size of an oropharyngeal airway, the distance between the maxillary incisors and the angle of the mandible has been recommended by the European Resuscitation Council guidelines[10]. In contrast, the American Heart Association guidelines recommend the use of the distance between the corner of the mouth and the angle of the mandible[11]. Despite these guidelines, there are few studies[5,6] to show the utility of these external facial measurements for the selection of an appropriate airway size and no study is available to support the recommendation in the Indian population. In the present study, we use both airway sizes based upon the two guidelines, aiming to determine which of the two guidelines resulted in the ideal position of the tip of the airway and mask optimal ventilation.

MATERIALS AND METHODS

This prospective crossover study was conducted after obtaining due clearance from the ethical committee. Written informed consent will be obtained from all patients. We included adult patients aged between 20 to 60 years with ASA risk stratification of grade I and II and those who gave due consent. Patients with known anatomical abnormalities of their airways, those with a history of Difficult intubation, Cervical spine injury, or lesions with a mouth opening of >2cm and those who refused to take part in the study were excluded. On arrival of the patient to the operation theater, with head neutral position, the distance corresponding to the external facial landmarks was measured (DIM-distance from incisor to angle of mandible and DAM-distance from angle of the mouth to angle of mandible) using a thread (fig. 1.). Two airways corresponding to these distances (DIM and DAM) were chosen using the measured distance, rounded down to the nearest whole number. For example, if the measured corner of the mouth to the angle of the mandible distance was 9.6cm, a size 9 airway was chosen. The airway sizes were chosen according to the International Organization for Standardization standard: the size marked on the airway indicates the shortest (straight line) distance from the lower outside edge of the flange to the outside of the distal end. All standard monitors including non-invasive blood pressure monitor, pulse oximeter, EtCO2 monitor and ECG were connected. Pre-oxygenation was done with 100% oxygen for 3 minutes, induction of anaesthesia was done using inj. Propofol (1.5mg/kg), inj. Fentanyl 1mg/kg and Inj. Rocuronium 1.2mg/kg was given intravenously. After 90 seconds, the airway corresponding to DAM was first chosen and inserted with the head remaining in a neutral position. An adequate seal was achieved with the face mask after the insertion of the airway. Volume control mode of ventilation was initiated with the target volume set at 8ml/kg (ideal body weight). The maximum tidal volume that could be delivered by the ventilator in the first six breaths was noted as 'TV(DAM)'. Six breaths were standardized to allow optimal ventilation by the mask after insertion of the airway either by manuveuring of the head if required (extension) or by providing an optimal seal (minimum air-leak) and to provide enough time for the ventilator to reach the set volume. The chest expansion with each of the airway was classified into three grades defined as mentioned in (Table 1). Following this, a flexible fibreoptic bronchoscope (FOB) was inserted upto the tip of the oropharyngeal airway avoiding going beyond or stimulating the oropharynx. The endoscopic view was graded accordingly as (fig. 2)-1 or partially obstructed with tongue, 2 or clear and 3 or passing beyond epiglottis. (Table 1) The same steps were followed in the same patient after the insertion of the airway corresponding to the DIM. The delivered tidal volume in the DIM group [TV(DIM], the grade of chest expansion, and the endoscopic view were noted. The depth of anaesthesia was maintained during the process by administration of intermittent bolus of Inj. Propofol 10mg IV every 5min. Oxygenation was maintained by giving 3-4 rescue breaths every 5min.

Fig. 1. Picture Showing Measurement of A. DIM-Distance From Incisor to Angle of mandible, B. DAM-Distance From Angle of the Mouth to Angle of Mandible) Using a Thread (C)

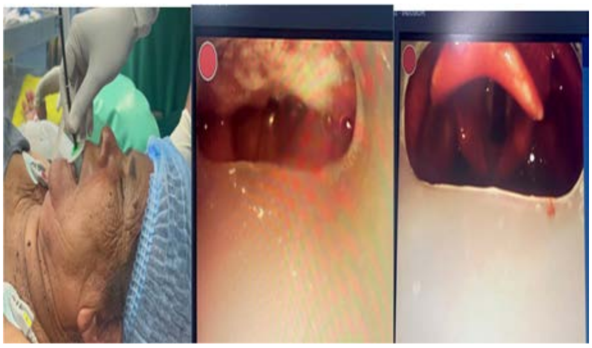

Fig. 2: Flexible Fibreoptic Bronchoscope (FOB) was Inserted Up to the Tip of the Oropharyngeal Airway. Endoscopic view was Graded as-1 or Partially Obstructed with Tongue, 2 or Clear and 3 or Passing Beyond Epiglottis

Table 1. Defined Grades of Chest Expansion and Endoscopic View:

Chest expansion:
Grade 1-Clear (defined as the presence of adequate chest expansion).
Grade 2-Partial obstruction (defined as the presence of adventitious sounds like snoring with sufficient chest expansion).
Grade 3-Complete obstruction (defined as the absence of chest expansions).
Endoscopic view:
Grade 1-Partial obstruction (Defined as the presence of adventitious sounds like snoring in sufficient chest expansion)
Grade 2-Clear (Defined as adequate chest expansion)
Grade 3-Complete obstructions (Defined as the absence of chest expansions)

The TV delivered, grade of chest expansion and the postion of the tip of the airway by endoscopic view were compared in both the groups. The collected data underwent subsequent statistical analysis to derive meaningful results.

Data Analysis: Data was entered in a Microsoft Excel sheet (Microsoft Corporation, Redmond, USA). Statistical analysis was done using the software: IBM SPSS Version 2.0. A descriptive summary was employed to present the study results, utilizing frequencies, percentages, graphs, means, medians (with interquartile ranges) and standard deviations. The statistical significance was assessed at the 5% level using probability (p) values. The level of significance was denoted as "p," with the following interpretations: $p>0.05$ indicated not significant, $p<0.05$ indicated significant, $p<0.01$ indicated highly significant and $p<0.001$ indicated very highly significant. Categorical variables (Chest Expansion and Endoscopic Grade) were analyzed with the chi-square test, while continuous variables (Distance of facial landmarks and Expired Tidal Volume) were evaluated using the independent t-test.

RESULTS AND DISCUSSIONS

Seventy eight patients were included in the study including 24 male patients and 54 female patients aged between 20-60 years. Their characteristics, airway assessment findings are as shown in (Table 2). Mean Facial landmark measurements among these patients, that is, the average distance from corner of the mouth to the angle of the mandible (DAM) and that of the maxillary incisors to the angle of the mandible (DIM) distances were 8.1+/-0.4 and 9.5+/-0.7cm respectively as shown in (Table 3). and the difference was highly significant. The difference in mean Tidal volume (TV) delivered by the ventilator, at the sixth breath after insertion of the airway, were found to be highly significant (P<0.001) (Table 4). The DAM group had a significantly higher mean TV (397.6±57.7ml) compared to the DIM group (335.1±70.2ml). In all the patients in whom airway was selected based on DAM (DAM group), the lung expansion studied as grade of chest expansion was adequate (grade 1) as shown in (Table 5). Whereas, in patients in whom the airway selected was based on DIM (DIM group), partial obstruction was seen in 49 patients (62.8%) and complete obstruction was seen in 11 patients (14.1%). This was found to be highly significant (p<0.001). When the position of the tip of the airway when selected based on DAM as compared to DIM group was noted by the fibreoptic view, it was observed as in (Table 6). that the tip of the airway was ideally placed just above the glottis in all patients in the DAM group. However, in 60 patients (76.9%) of the DIM group, the tip pushed the epiglottis causing obstruction or minor bleeding. Bleeding in the oropharynx as a complication was noticed in about 11 patients in the oropharyngeal airway passed beyond the epiglottis tip.

Table 2. Patient Characteristics, Demographics and Airway Assessment Findings (n=78)

Patient characteristics	Values (n=78)	Percentage (%)
Gender		
male	24	30.8
female	54	69.2
Mallampatti grade		
Grade 1	15	19.2
Grade 2	63	80.2

Table 3. Mean Facial Landmark Measurements

Measurement	Number(N)	Mean(cm)	Standard deviation	P-value
Distance from corner of the mouth to the angle of the mandible (DAM)	78	8.1	0.4	<0.001
Distance from maxillary incisors to the angle of the mandible (DIM)	78	9.5	0.7	

Table 4. Mean Tidal Volume (TV) Achieved by the Ventilator in the Groups.

Mean tidal volume (TV)	Number(n)	Mean(ml)	Standard deviation	P-value
Distance from corner of the mouth to the angle of the mandible (DAM)	78	397.6	57.7	<0.001
Distance from maxillary incisors to the angle of the mandible (DIM)	78	335.1	70.2	

Table 5. Chest Expansion Grades in Both the Groups

Chest expansion	DAM group	DIM group	P-value
Grade 1	78 (100%)	18 (23.1%)	<0.001
Grade 2	0 (0%)	49 (62.8%)	
Grade 3	0 (0%)	11 (14.1%)	

Table 6. Fibreoptic Views at the Distal End

Endoscopic grade	DAM group	DIM group	P-value
Grade 1	0 (0%)	0 (0%)	<0.001
Grade 2	78 (100%)	18 (23.1%)	
Grade 3	0 (0%)	60 (76.9%)	

The best-fit airway for an individual was defined as positioning of the distal end of the airway as close as possible to the tip of the epiglottis without any obstruction by the tongue, which allows effective mask ventilation and does not cause traumatic injury to the laryngeal structures. Airway size selected on the basis of the corner of the mouth to the angle of the mandible distance, rather than maxillary incisors to the angle of the mandible, was more appropriate for achieving adequate ventilation and an ideal position of distal end of the airway.

In the DIM Group: 76% had airway placed beyond the epiglottis. 62.82% among this group had partial obstruction during mask ventilation and 14.1% had complete obstruction during ventilation. This was attributed to either impaction of the distal end of the airway in the vallecula or entry of the epiglottis into the airway lumen. Therefore, using maxillary incisors to the angle of mandible as a facial landmark was not appropriate to achieve adequate ventilation and ideal position of the tip of the airway. This was in contrast to the findings by Kim[5] who suggested maxillary incisors to the angle of the mandible was a better landmark than the corner of the mouth to the angle of mandible. In this study however, the tip of the airway placed beyond the epiglottis was also considered to be an ideal placement of the airway. The complications and the obstruction during ventilation that could occur was not considered. In our study, we found that the placement of the tip of the airway beyond epiglottis did not provide ideal mask-ventilation conditions.

CONCLUSION

The corner of the mouth to the angle of the mandible is a more accurate landmark for airway size selection, ensuring optimal positioning and effective mask ventilation. Placement of the airway tip beyond the epiglottis, associated with using maxillary incisors to the angle of the mandible, led to higher obstruction rates. These findings highlight the need to refine airway selection criteria to minimize ventilation complications.

Limitations: We could not study the gender-based variation in the anatomical facial landmark. Secondly, there were no reference studies in the Indian population for comparison. Further studies in the Indian population are needed to study the influence of racial origin and anatomical variation on facial landmarks.

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Conflict of Interest: None.

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