

How to Cite:

Rai, A., Sharma, N., Jain, S. K., Varshney, R. K., & Bhatnagar, S. (2022). Predicting difficult intubation in apparently normal subjects: An anthropometric study. *International Journal of Health Sciences*, 6(S3), 5609–5616. <https://doi.org/10.53730/ijhs.v6nS3.7185>

Predicting difficult intubation in apparently normal subjects: An anthropometric study

Alisha Rai

PG Student, Department of Anatomy, TMMC & RC, Moradabad, UP, India

*Corresponding author email: dralisharai478@gmail.com

Nidhi Sharma

Professor, Department of Anatomy, TMMC & RC, Moradabad, UP

Email: drnidhivarshney@gmail.com

S. K. Jain

Professor & HOD, Department of Anatomy, TMMC & RC, Moradabad, UP

Email: drskjain2005@rediffmail.com

Rohit K. Varshney

Professor, Department of Anesthesia, TMMC & RC, Moradabad, UP

Email: drrohit.editor@gmail.com

Supriti Bhatnagar

Assistant Professor, Department of Anatomy, TMMC & RC, Moradabad, UP

Email: dr.supriti.bhatnagar@gmail.com

Abstract---One of the major problems faced by health care professionals is the prediction of airway difficulties in apparently healthy subjects. Failed endotracheal intubation is a well-known reason for increased morbidity of patients including brain damage or even death. This study is focused on parameters used for prior determination of airway for predicting difficult intubation in healthy Indian populations. This study was done on 500 healthy individuals. Neck parameters were measured including inter-incisal distance, neck circumference, thyro-mental distance and sterno-mental distance. Mallampati classification and mandibular protrusion test were also carried out. Statistical analysis was done using SPSS software (V.25). MC class 3 and 4 percentages were higher in males in comparison to females. Mandibular protrusion test grade A and B percentage was higher in females while class C percentage was higher in males. The comparison of baseline values of the neck parameters (inter-incisal distance, neck circumference, thyro-mental distance and sterno-mental distance) was statistically significant (<0.05) in both genders. The purpose of the study is to find out the baseline values of

parameters involved in assessing methods for difficult intubation in healthy Indian population. Besides this, the uniqueness of the study is that it gives separate values in both the genders which will help in better prediction. This study will also prove to be helpful in better designing of the equipment utilized in the management of airway since racial variation is seen.

Keywords---anthropometry, difficult airway, neck parameters.

Introduction

Maintaining the patient's airway after administration of general anesthesia is the essential part of the airway management^[1]. The difficult airway has been described as a medical scenario in which medical professional has difficulties with central airways face mask breathing, insertion of endotracheal tube, or in both^[2]. Airway evaluation involves sequence of bedside clinical examinations. These methods help in detecting issues related to airway care and hence planning the appropriate procedures to deal them. The influence of different elements like structural variations, airway diseases, and prior treatments is significant on the chances of success of airway management^[3]. Every medical professional has experienced the icy fear of realizing that normal anatomic features cannot be viewed during intubation in emergency conditions. In a medical emergency, even a brief disruption in gaseous exchange might lead to disastrous effects such as neurological damage or even death, therefore maintaining a clear airway is the prime responsibility^[4]. The challenge of attaining a clear airway depends greatly on structural as well as other specific clinical characteristics, and recognizing the individual with a restricted airway is critical in care planning^[5]. In these cases, more suitable and reliable methods of airway assessment are required.

Different studies suggest that parameters used in methods of airway assessment show racial variation^[2,4]. The majority of referred values in different airway assessment methods are based on western population^[1,6]. The values of these parameters cannot be extrapolated to the Indian population as Indians are anthropometrically different as compared to the Western population^[6]. The present study focuses on the baseline values of parameters included in preoperative airway evaluation in Indian population. These values will help the medical professionals in better assessment of their patients preoperatively. Further, proper planning for any difficulty in intubation and preparation of equipment will reduce patient morbidity and death. The anthropometric measurements will also prove to be helpful in the designing of the equipment for Indian population.

Material and Method

This study was done in Teerthanker Mahaveer Medical College after an approval from the College Ethical Committee (TMU/IEC/20-21/101) for a period of 1 year. A total of 500 healthy subjects (262 females and 238 males) were included in this study above the age of 18 years and falling in the category of American Society of Anesthesiology physical status 1 and 2^[5]. Subjects with upper airway pathology,

neck spine injury, abnormality of head and neck region and pregnant women were excluded^[6]. A proper written, informed consent was taken before commencing the measurements. In addition, short presentation was given so that all the members could be accustomed with the measurement methods. The demographic details (name, age, sex and region) were recorded in Performa sheet. The parameters Inter-incisal distance (IID)^[7], Thyro-mental distance (TMD)^[8], Sterno-mental distance (SMD)^[9] and Neck circumference (NC)^[10] and were measured in centimeters and were recorded on the Performa sheet. Mallampati classification (MC)^[11] and Mandibular protrusion test (MPT)^[12] grading was also observed and recorded in the Performa sheet. While measuring the parameters inter-observer and intra-observer errors were taken into consideration along with taking aseptic precautions.

Measurement of IID ^[7]: Each volunteer was asked to sit on a chair with his mouth wide open up to a comfortable extend. A metallic ruler was placed between the edges of the upper and lower incisors and the readings were recorded in centimeters. Measurement of TMD ^[8]: Volunteer was asked to sit on a chair with their mouth closed and neck fully extended then a ruler was placed between the bony mentum and the thyroid notch and the distance measured was recorded on the Performa in centimeters. Measurement of SMD ^[9]: Volunteer was asked to sit on a chair with their mouth closed and neck fully extended then a ruler was placed between the bony mentum and the sternal notch and the distance measured was recorded on the Performa in centimeters.

Measurement of NC ^[10]: NC was measured by the help of flexible measuring tape with the volunteer standing straight and head in an erect position. Tape was wrapped around the circumference of the neck at the level of thyroid cartilage and the reading was recorded on the Performa in centimeters. MC ^[11]: It was observed with the volunteer in sitting position with mouth wide open and tongue protruded out and classification was done according to the pharyngeal structures visible. In Class 1 soft palate, fauces, uvula, anterior and posterior pillars are visible; In Class 2 soft palate, fauces and uvula is visible while anterior and posterior pillars were hidden by the tongue; In Class 3 only the soft palate and the base of the uvula is visible and In Class 4 only hard palate is visible.

MPT ^[12]: The volunteer was asked to sit on a chair and protrude his/her mandibular teeth beyond the maxillary teeth. If the volunteer was able to protrude his/her mandibular teeth beyond the maxillary teeth it was categorized under Grade A, if the volunteer able to protrude his/her mandibular teeth up to the edge of maxillary teeth then it was categorized under Grade B and if the volunteer was not able to protrude his/her mandibular teeth even up to the edge of maxillary teeth then it was categorized under Grade C. After measurement of the parameters the data was moved to Microsoft excel sheet. T-test was applied to compare the parameters in both male and female using SPSS V 25. If the is p-value <0.05 than the data was considered as statistically significant.

Result

In this study, a total of 500 volunteers were included wherein 238 were males and 262 were females. Comparative study of neck parameters along with MPT and MC between the two categories was done.

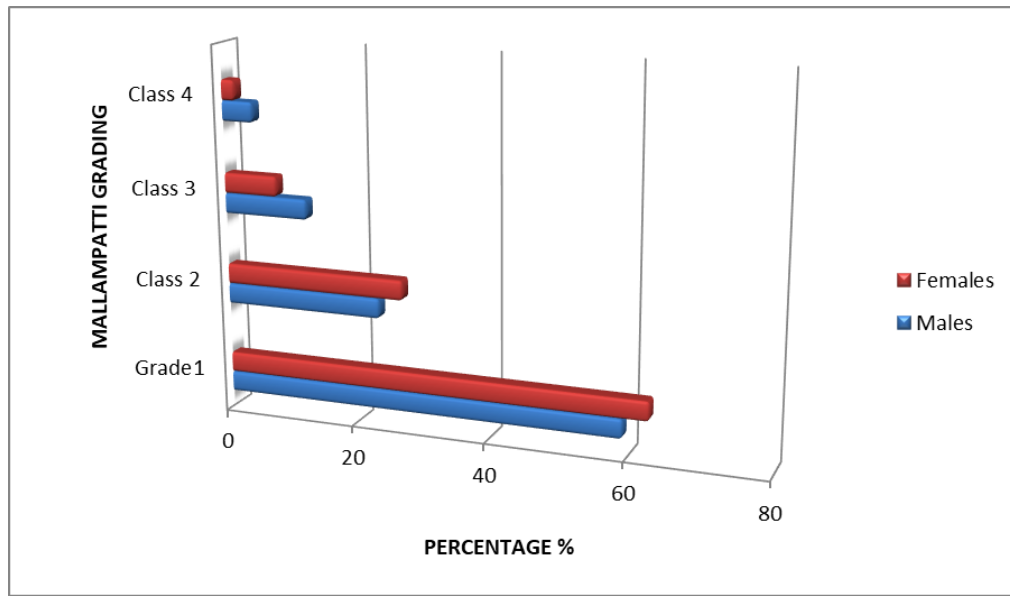


Figure 1. Sexual dimorphism in Mallampati classification in Indian population

Figure 1 depicts sexual dimorphism in different classes of Mallampati grading. Class 1 was found in 141 male and 165 female making a percentage of 59.25% and 62.98 % respectively. Class 2 was observed in 56 male and 71 female making a percentage of 23.53 % and 27.1 % respectively. Class 3 was observed in 30 males and 21 in females with 12.6% and 8.02% respectively. Class 4 was observed in 11 male and 5 female with 4.62% and 1.9% respectively.

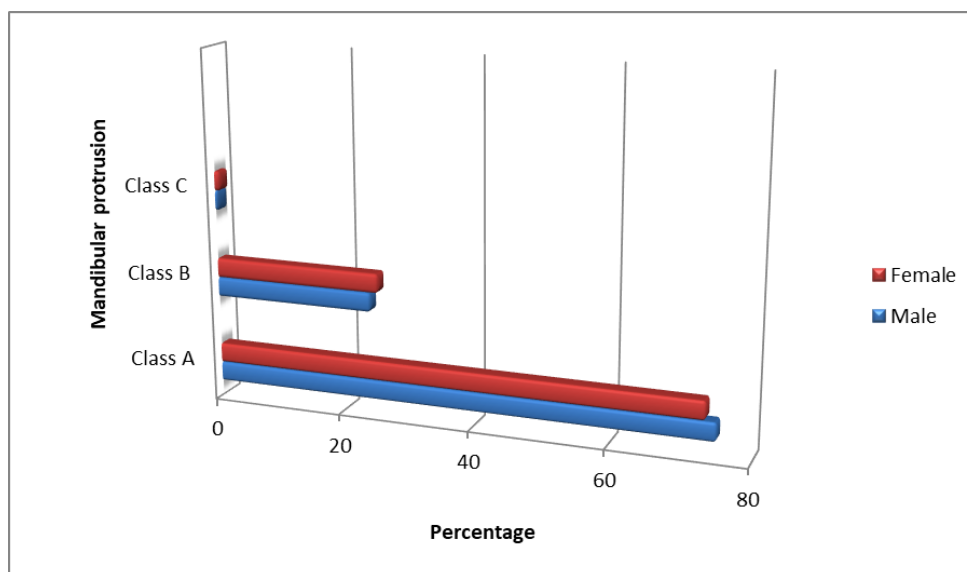


Figure 2. Sexual dimorphism in mandibular protrusion in Indian population

Figure 2 showed the percentage of each grade in male and female population. Class A was observed in 179 male and 193 female making a percentage of 75.22% and 73.66 % respectively. Class B was observed in 58 male and 67 female making a percentage of 24.36 % and 25.57 % respectively. Class C was observed in 1 male and 2 female with 0.42% and 0.77% respectively.

Table 1
Sexual dimorphism in Inter-incisal distance in Indian population (cm)

| | n | Mean \pm S.D. | t-value | p-value |
|--------|-----|-------------------|---------|---------|
| Male | 238 | 4.310 \pm 0.622 | 2.406 | <0.05 |
| Female | 262 | 4.179 \pm 0.600 | | |

Table 1 showed mean value of IID in males was 4.310 \pm 0.622 and female was 4.179 \pm 0.6004, t-value for both genders was 2.406. The result showed that p-value of IID in both genders was statistically significant (<0.05).

Table 2
Sexual dimorphism in neck circumference in Indian population (cm)

| | n | Mean \pm S.D. | t-value | p-value |
|--------|-----|--------------------|---------|---------|
| Male | 238 | 35.892 \pm 3.041 | 4.952 | <0.05 |
| Female | 262 | 34.479 \pm 3.057 | | |

Table 2 showed the comparison of NC in Indian population between males and females the mean value for males was 35.892 \pm 3.0419 and females was 34.479 \pm 3.057. There was statistically significant difference ($p < 0.05$) in NC between males and females in Indian population.

Table 3
Sexual dimorphism in thyro-mental distance in Indian population (cm)

| | n | Mean \pm S.D. | t-value | p-value |
|--------|-----|--------------------|---------|---------|
| Male | 238 | 10.081 \pm 1.692 | 2.922 | <0.05 |
| Female | 262 | 9.767 \pm 1.396 | | |

Table 3 showed the comparison of TMD in Indian population between males and females. The mean value for males was 10.081 \pm 1.692 and for females was 9.767 \pm 1.396. There was statistically significant difference ($p < 0.05$) in TMD between males and females in Indian population.

Table 4
Sexual dimorphism in sterno-mental distance in Indian population (cm)

| | n | M \pm S.D. | t-value | p-value |
|--------|-----|--------------------|---------|---------|
| Male | 238 | 19.328 \pm 1.969 | 2.279 | <0.05 |
| Female | 262 | 18.844 \pm 1.691 | | |

Table 4 showed the comparison of SMD in Indian population between males and females the mean values for males was 19.328 \pm 1.969 and for females was 18.844 \pm 1.691. There was statistically significant difference ($p < 0.05$) in SMD between males and females in Indian population.

Discussion

This study was conducted among 500 healthy individuals (262 females and 238 males) having age above 18 years. Purpose of this study was to give the baseline value of parameters predicting difficult intubation in apparently normal subjects of Indian population. This study presents normative data, comparative statistics and tries to give information regarding the values of IID, NC, TMD and SMD, MC and MPT grading in Indian population. In our study, the frequency of MC grade 1 in males was 141 (59.25%) and in females was 165 (62.98%). Frequency of grade 2 in males was 56 (23.53%) and in females were 71(27.1%). Frequency of grade 3 in males was 30(12.6%) and in females were 21 (8.02%). Frequency of grade 4 in males was 11 (4.62%) and in females were 5 (1.9%). In research done by Hailegebriel K frequency of MC grade 1 was 261 (93.5%), grade 2 was 10 (3.6%), grade 3 was 7 (2.9%) while no patient was found with grade 4 MC.^[13] In another study by Cattano D frequency of MC 1 and 2 was found in 444 patients while grade 3 and 4 was found in 113 patients^[14]. Earlier studies suggested that MC 3 and 4 was highly related to difficult intubation^[14, 15].

In our study, the frequency of MPT Class A in males was 179 (75.22%) and in females was 193 (73.66%). Frequency of MPT Class B in males was 58 (24.36%) and in females was 67 (25.57%). Frequency of MPT Class C in males was 1 (0.425) and in females was 2 (0.77%). In research done by Hailegebriel K et al frequency of MPT Class A was 270 (97.1%), Class B was 5 (1.8%) and Class C was 3 (1.1%) which was not coinciding with our study^[13]. In another research work done by Tamire T. et al MPT Class A was found in 175 (72.3%) and Class B and C collectively found in 67 (27.7%). The result of our study was similar to this

study^[16]. In our study on comparison of IID, NC, TMD and SMD between two genders, mean values for males was found to be 4.310 ± 0.622 , 35.892 ± 3.0419 , 10.081 ± 1.692 and 19.32 ± 1.96 respectively while for female these values were found to be 4.179 ± 0.6004 , 34.479 ± 3.057 , 9.767 ± 1.396 and 18.84 ± 1.69 respectively. The differences between these values were statistically significant. In research done by Aktas S. et al, comparison of values was done between easy and difficult intubated patients and the mean of IID was found to be 3.8 ± 1.1 and 3.5 ± 1.3 respectively, which was statistically insignificant ($p > 0.05$)^[7]. A study done by Chara L. et al on Greek population, the mean value of NC, TMD and SMD in male were 41 cm, 9 cm and 18 cm respectively while in females were 36 cm, 8cm and 17 cm respectively. The difference between the values was statistically significant ($p < 0.05$)^[17]. The differences in baseline values between two studies is due to racial variation in anthropometry.

Conclusion

The purpose of the study is to find out the baseline values of parameters involved in assessing methods for difficult intubation in healthy Indian population. Neck parameters are useful in predicting various clinical conditions and difficulties that can arise during mask ventilation, endotracheal intubation, laryngoscopy etc. Studies are done on different populations but literature on baseline values in Indian population is lacking. Besides this, the uniqueness of the study is that it gives separate values in both the genders which will help in better prediction. This study will also prove to be helpful in better designing of the equipment utilized in the management of airway since racial variation is seen.

Author contribution

Jain SK conceived the review idea. Rai A conducted the literature search. Varshney R prepared the first draft of manuscript. Sharma N and Bhatnagar S reviewed, edited and revised the manuscript substantially on the key intellectual content. Jain SK finalized and approved the content.

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