Section: Respiratory Medicine

Original Research Article

STUDY OF USG IN ANATOMIC UPPER AIR WAY CHANGES WITH OBSTRUCTIVE SLEEP APNEA

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ABSTRACT

Background: The upper airway is a more complex anatomical region. It excludes Pulmonary air passage. Hence, obstructive sleep apnea is assessed by use of USG. **Materials and Methods:** 50 adult OSA patients were compared with the same number of healthy people. Epworth sleepiness score ECG, echocardiogram, and complete overnight polysomnography were performed. EEG, EOG, EMG, and USG to rule out OSA. **Result:** Polysomnography and USG data were compared with the controlled group and have significant p-value results ($p < 0.001$). **Conclusion:** USG is more ideal and convenient than questionnaires for OSA and more relevant than pulse oximetry for examining the pharyngeal airspace.

INTRODUCTION

The upper airway is an extraordinarily complex anatomical region. Anticipating and preparing for difficulty in airway management is crucial to avoid airway catastrophes.[1] Examination usually includes an assessment of mouth opening and dentition, Mallampati classification, thyromental distance measurement, and evaluation of neck mobility. These methods are quickly and easily performed at bedside, but unfortunately, their sensitivity for accurate prediction of difficulty with airway management is low.[2] The ultrasound (USG) has been in clinical use since the early 1990s and is capable of providing detailed anatomic information that has numerous potential clinical applications.[3] It can be used to identify airway pathology and may assist other methods in predicting difficulty with airway management.

The term "airway" refers to or is defined as an extrapulmonary air passage consisting of the nasal cavity, pharynx (including the nasopharynx, oropharynx, and laryngopharynx), (hypopharynx), larynx, trachea, and large bronchi.[4] Hence, obstructive sleep apnea patients were evaluated with the usage of USG by comparing them with a normal (healthy) group of adults.

MATERIALS AND METHODS

50 (fifty) adult patients admitted at MGS Super Speciality Hospital, Rohtak Road West Punjabi Bagh, New Delhi-110026, were studied.

Inclusion Criteria

OSA-diagnosed patients aged between 18 to 50 years. The patients who gave their consent in writing were selected for study.

Exclusion Criteria

The patients who had undergone tracheostomy, alcoholic patients, patients having endocrine disorders such as hypothyroidism or acromegaly, patients with abnormalities in the soft palate or upper airway, and patients with cardiac diseases (e.g., organic valvular, pericardial effusion, dysarrhythmias, or cardiac temponade) were excluded from the study.

Method: Apart from 50 OSA patients, 50 healthy (controlled) groups were also selected for study. Every patient underwent detailed clinical evaluation, including history taking, clinical examination, Epworth sleepiness score, electrocardiogram, and echocardiography. Complete overnight polysomnography was performed over the whole night (8 hours of sleep). The study started at 10 pm and lasted until 6 am, using "SOMNOscreen" plus polysomnography with digital IR videometry (made in Germany). The obtained data was

- Apnea: complete cessation of airflow breathing at the nostrils and mouth for at least 10 seconds or longer.
- Hypopnea: decrease in rate and depth of breathing by 50% for 10 seconds or longer.
- Apnea hypopnea index (AHI): Average number of apneas and hypopnea per hour of sleep. Persons with AHI < 5 are not considered to have OSA. In contrast, AHI ≥ 5 and < 15, AHI ≥15 and

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<30, and AHI ≥30 are classified as mild, moderate, and severe, respectively (5).

- Other measured variables are total sleep time, sleep efficiency, sleep stage percentage, sleep stage latency, arousals, respiratory disturbance index (RDI), snoring, body position, oxyhemoglobin saturation, limb movements, and arrhythmias.
- The system records sleep stages by electroencephalography (EEG), electrooculography (EOG), and electromyography (EMG). EEG was used to monitor sleep stages and identify sleep latency and arousal. EOG was applied to monitor both horizontal and vertical eye movements to document the onset of REM and slow rolling movements accompanying the onset of sleep. EMG records atonia during REM or lack of atonia in REM-related parasomnia.

Neck ultrasonography was done using a Hitachi EUB-7000 in the ultrasound unit. All cases were examined by B-mode and Doppler scan with a curvilinear transducer (2-5 MHz). Ultrasound examination was done on the day after overnight polysomnography.

All sonographic studies were carried out with the study subjects lying supine on the examination couch. The neck of the patient was slightly extended with the infraorbital meatal baseline (the line joining the infraorbital margin and the ear tragus) perpendicular to the scanning table. Measurements as mentioned below:

- Retropharyngeal pharynx transverse diameter (RPD) USG scanning from the hyoid bone to the external auditory meatus at the level of the oral pharynx, then the probe is tilted downwards to locate the retropalatal pharynx, which is defined as the air column at the highest plane near the uvula. RPD is determined by the outer margin of the air column (RPD) [Figure A1].
- Distance between lingual arteries (DLA) In the same previous USG scanning position, the lingual arteries were observed by power Doppler scan on both sides of the lower lateral border of the tongue base. The distance between lingual arteries (DLA) was measured [Figure B1].
- Coronal mid tongue base thickness (TBT) [Figure C1]
- Sagittal mid tongue base thickness (STBT) [Figure D1]
- Lateral para-pharyngeal wall thickness (LPWT) [Figure E1]

The duration of study was May 2024 to June 2025.

Statistical Analysis: Various parameters of polysomnography and USG in the OSA and controlled groups were compared with tests, and significant p-values ($p < 0.001$) were noted. The statistical analysis was carried out using SPSS software. The ratio of male and female was 2:1.

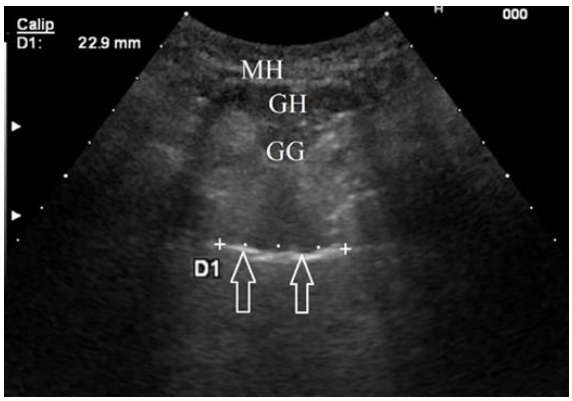

Figure A1: Retropalatal pharynx transverse diameter, geniohyoid muscle (GH), mylohyoid muscle (MH), genoidglossus muscle (GG). Retropalatal pharynx is represented by the hyperechogenic line (hollow arrows).

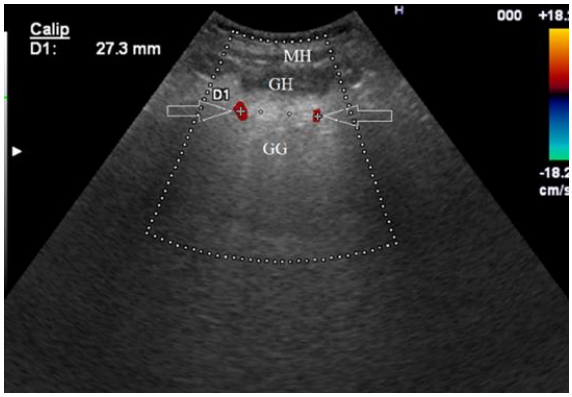

Figure B1: Distance between lingual arteries, geniohyoid muscle (GH), mylohyoid muscle (MH), genoidglossus muscle (GG). Lingual arteries (hollow arrows).

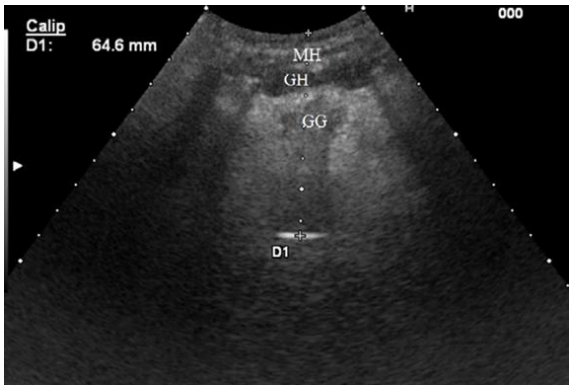

Figure C1: Coronal mid-tongue base thickness, geniohyoid muscle (GH), mylohyoid muscle (MH), genoidglossus muscle (GG)

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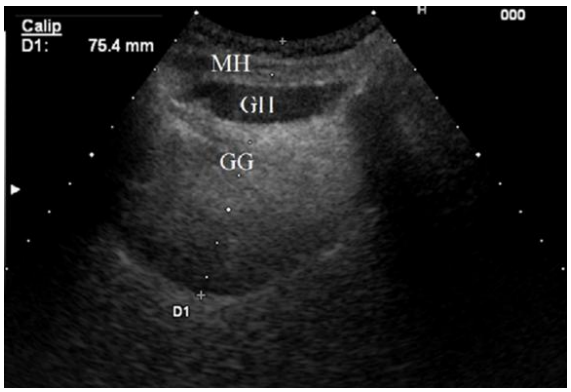

Figure D1: Sagittal mid-tongue base thickness, geniohyoid muscle (GH), mylohyoid muscle (MH), genoidglossus muscle (GG)

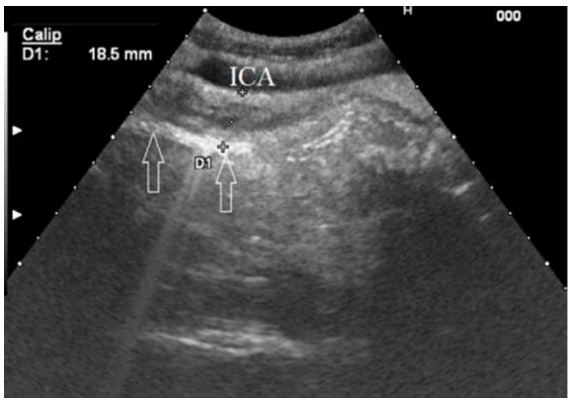

Figure E1: Lateral parapharyngeal wall thickness, internal carotid artery (ICA). The hyper echogenic line represents the air in the pharynx (hollow arrows)

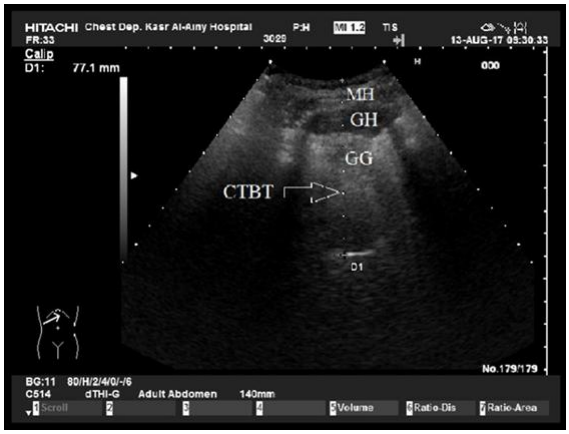

Figure A2: Coronal tongue base thickness (CTBT).

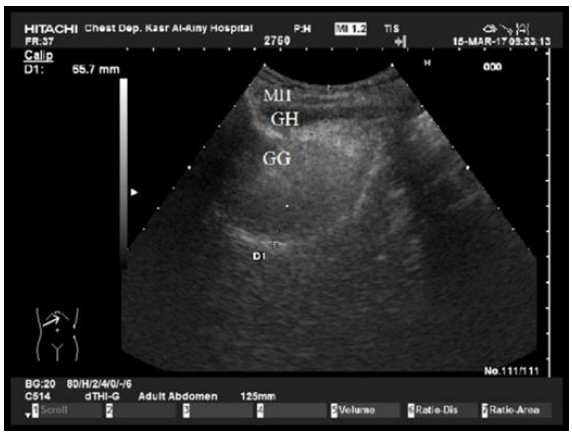

Figure B2: Sagittal tongue base thickness (STBT).

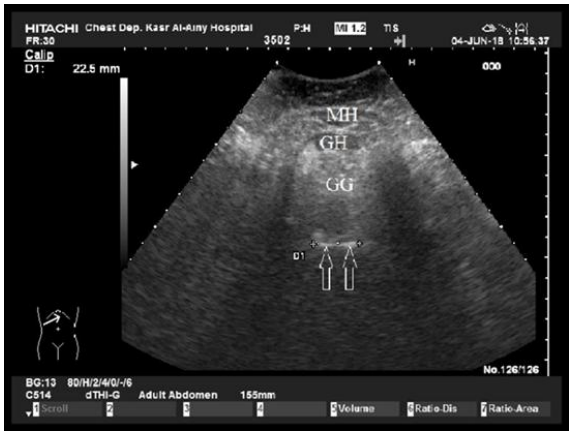

Figure C2: Retropalatal pharynx diameter (RPD)

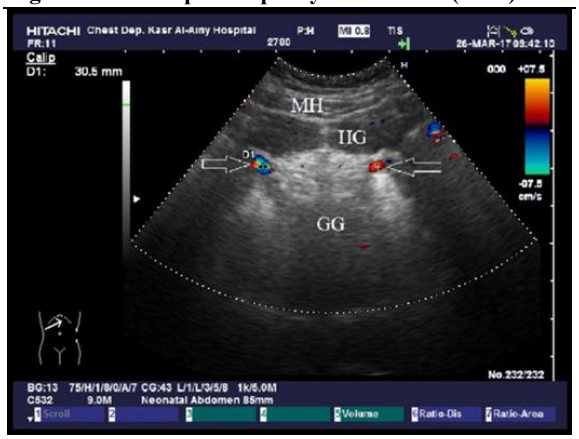

Figure D2: Distance between lingual arteries (DLA)

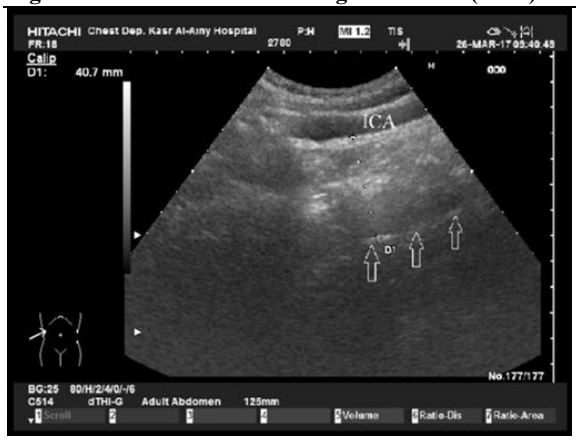

Figure E2: Lateral parapharyngeal wall thickness (LPWT)

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RESULTS

[Table 1] Polysomnographic and USG study in anatomic upper airway changes with obstructive sleep apnea (OSA)

- Total sleeping time: 293.82 (± 60.4) in OSA patients, 346.68 (± 48.05) in controlled group, t test was 4.59 and p<0.001.
- Total sleeping period: 338.22 (± 68.2) in OSA patients, 378.30 (± 30.21) in controlled group, t test was 3.60 and p<0.001.
- Sleep efficiency: 86.53 (± 4.10) in OSA patients, 84.50 (± 5.20) in controlled group, t test was 2.05 and p<0.001.
- Wake Index: 4.98 (± 2.32) in OSA patients, 8.05 (± 3.45) in controlled group, t test was 5.00 and p<0.001.
- Flow limitation index % tal: 3.03 (± 1.23) in OSA patients, 13.65 (± 6.30) in controlled group, t test was 11.09 and p<0.001.
- % of sleep in supine position: 76.25 (± 10.45) in OSA patients, 82.45 (± 12.7) in controlled group, t test was 2.52 and p<0.001.
- A+ H/h in supine position: 29.00 (± 9.82) in OSA patients, 1.48 (± 0.52) in controlled group, t test was 18.7 and p<0.001.
- Isolated LMS Index: 17.14 (± 1.5) in OSA patients, 18.30 (± 2.3) in controlled group, t test was 2.81 and p<0.001.
- Resp. LMS index: 28.82 (± 5.2) in OSA patients, 0.42 (± 0.2) in controlled group, t test was 36.6 and p<0.001.
- Minimal oxygen saturation %: 69.07 (± 7.60) in OSA patients, 83.38 (± 9.30) in controlled group, t test was 7.99 and p<0.001.
- Base line oxygen satutation %: 90.55 (± 4.44) in OSA patients, 92.82 (± 3.25) in controlled group, t test was 2.76 and p<0.001.
- Average oxygen satutation: 88.21 (± 5.90) in OSA patients, 92.48 (± 4.30) in controlled group, t test was 3.92 and p<0.001.
- SPO2 time <90 (%): 49.60 (± 8.21) in OSA patients, 20.52 (± 4.28) in controlled group, t test was 21.06 and p<0.001.
- O2 de saturation index: 45.25 (± 5.30) in OSA patients, 5.24 (± 2.20) in controlled group, t test was 46.7 and p<0.001.
- Apnea index: 14.60 (± 3.80) in OSA patients, 5.24 (± 2.18) in controlled group, t test was 14.3 and p<0.001.
- Hypopnea index: 18.335 (± 4.80) in OSA patients, 1.38 (± 0.30) in controlled group, t test was 23.6 and p<0.001.
- AHI (/h): 33.02 (± 5.15) in OSA patients, 1.62 (± 0.6) in controlled group, t test was 4.05 and p<0.001.
- Arrhythmia index: 67.10 (± 5.02) in OSA patients, 0.42 (± 0.3) in controlled group, t test was 88.9 and p<0.001.
- (B) Neck ultra sonography RPD (cm): 1.62 (± 0.80) in OSA patients, 2.33 (± 0.25) in controlled group, t test was 5.68 and p<0.001.
- DLA (cm): 2.65 (± 0.45) in OSA patients, 2.08 (± 0.3) in controlled group, t test was 7.07 and p<0.001.
- CTBT (cm): 6.58 (± 0.02) in OSA patients, 6.75 (±0.5) in controlled group, t test was 2.2 and p<0.001.
- STBT (cm): 8.24 (± 0.02) in OSA patients, 7.12 (± 0.70) in controlled group, t test was 12.6 and p<0.001.
- LPWT (cm): 4.62 (± 1.02) in OSA patients, 3.42 (± 0.68) in controlled group, t test was 6.5 and p<0.001.

Table 1: Polysomnographic and ultra sonographic study in anatomic upper air way changes with obstructive sleep apnea (OSA)

USG data	OSA patients (50) (mean ±SD)	Controlled group (50) (mean ±SD)	t test	p value
Total sleep time (TST)	293.82 (±60.4)	346.68 (±48.05)	4.59	P<0.001
Total sleep period (TSP)	338.22 (±68.2)	378.30 (±30.21)	3.60	P<0.001
Sleep Efficiency	86.53 (± 4.10)	84.50 (± 5.20)	2.05	P<0.001
Wake Index	4.98 (± 2.32)	8.05 (± 3.45)	5.00	P<0.001
Flow limitation Index % total	3.03 (±1.23)	13.65 (± 6.30)	11.09	P<0.001
% of sleep in supine position	76.25 (± 10.45)	82.45 (± 12.7)	2.52	P<0.001
A+H/h in supine position	29.00 (± 9.82)	1.48 (± 0.52)	18.7	P<0.001
Isolated LMS Index	17.14 (± 1.5)	18.30 (± 2.3)	2.81	P<0.001
Resp-LMS Index	28.82 (± 5.2)	0.42 (±0.2)	36.6	P<0.001
Minimal oxygen saturation %	69.07 (± 7.60)	83.38 (± 9.30)	7.99	P<0.001
Baseline oxygen saturation %	90.55 (± 4.44)	92.82 (± 3.25)	2.76	P<0.001
Average Oxygen saturation %	88.21 (±5.90)	92.48 (±4.30)	3.92	P<0.001
SPO2 time <90 (%)	49.60 (± 8.20)	20.52 (± 4.28	21.06	P<0.001
O2 de saturation Index	45.25 (± 5.30)	5.24 (± 2.20)	46.7	P<0.001
Apnea Index	14.60 (± 3.60)	5.24 (±2.18)	14.3	P<0.001
Hypopnoea Index	18.33 (± 4.80)	1.38 (±0.30)	23.6	P<0.001
AHI (lh)	33.02 (±5.15)	1.65 (±0.6)	40.5	P<0.001
Snore Index	159.25 (± 10.40)	128.22 (± 4.20)	18.5	P<0.001
Arrhythmia Index	67.10 (±5.02)	0.42 (±0.3)	88.9	P<0.001

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Table 2: Neck Ultra sonography

RPD (cm)	1.62 (± 0.80)	2.33 (± 0.25)	5.68	P<0.001
OLA (cm)	2.65 (± 0.45)	2.08 (± 0.30)	7.07	P<0.001
CTBT (cm)	6.58 (± 0.02)	6.75 (±0.5)	2.2	P<0.001
STBT (cm)	8.24 (± 0.02)	7.12 (± 0.70)	12.6	P<0.001
LPWT (cm)	4.62 (± 1.02)	3.42 (± 0.68)	6.5	P<0.001

CTBT = Coronal mid tongue Based thickness DLA = Distance between lingual arties
LPWT = Lateral para-pharyngeal wall thickness
N = Number Resp LMS = Respiratory related leg movements
RPD = Retro-palatal pharynx trans verse diameter
STBT = Sagital mid-tongue base thickness

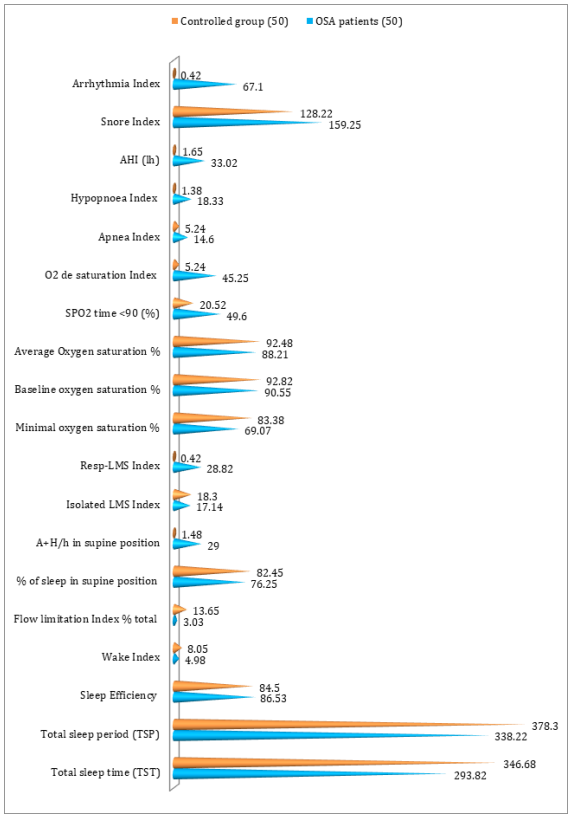

Chart 1: Polysomnographic and ultra sonographic study in anatomic upper air way changes with obstructive sleep apnea (OSA)

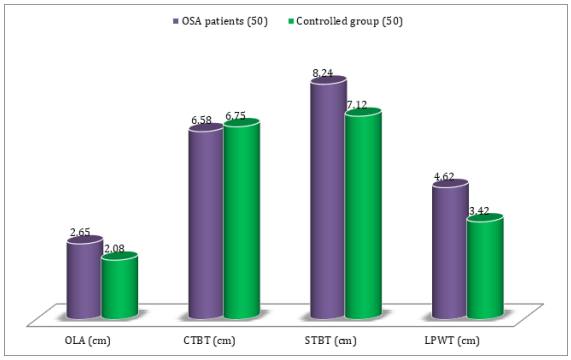

Chart 2: Neck Ultra sonography

DISCUSSION

Present study of USG in anatomic upper airway changes with OSA in adult population. The polysomnographic and USG parameters related to OSA and the controlled group were compared, and significant p-value results were noted [Table 1]. These findings and figures A1, B1, C1, D1, and A2, B2, C2, D2, E2 are more or less in agreement with previous studies.[6-8]

USG can be used to obtain certain airway measurements preoperatively to predict difficult intubation. Several sonographic parameters are useful as predictors of difficult laryngoscopy and intubation.[9] An oblique transverse US view of the airway in the preoperative holding area can help to obtain measurements like the distance from the epiglottis to the midpoint of the distance between the vocal folds and the depth of the pre-epiglottic space. Both of these measurements were found to have a strong correlation with the Cormack-Lehane grading for airway assessment, thus suggesting that noninvasive USG can be used to supplement presently available modalities of pre-anesthesia airway assessment, including.[10] Hyomental space measurements using USG can be useful in predicting difficult intubation. USG can be useful in the evaluation of soft tissue masses before intubation. Pharyngeal or laryngeal pathology, such as tumors, abscesses, or epiglottitis, which may have a significant effect during airway management, is detected by the use of USG scans.[11]

OSA is often a contributor to difficulties in managing the upper airways. In patients with a history of sleep apnea, upper airway USG has been used to visualize approximation of the tongue base posteriorly and inferiorly towards the hypopharynx to cause airway obstruction.[12] USG measurements of the width of the tongue have been found to correlate with the severity of sleep-related breathing disorders.

It is also reported that severity of OSA is observed in depressive illness patients,[6] hence, it can be hypothesized that OSA is an expression of neurosis or psychosomatic disorder. Hence, apart from bronchodilators, antidepressants, and mood stabilizers, therapy could be useful.

CONCLUSION

The study of USG in the assessment of anatomic upper airway changes in patients with OSA is quite useful. USG is an inexpensive, readily available tool that is non-invasive and more relevant than pulse oximetry for examining pharyngeal air space. Unfortunately, OSA disorder remains undiagnosed in a substantial proportion of the population. Hence, the

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present study demands further nutritional, genetic, and environmental studies to rule out the pathophysiology of OSA.

Limitation of study: Owing to the small hospital, small number of patients and lack of latest techniques we have limited findings and results.

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