Review article

Use of primary screening tools as a pre-surgical evaluation protocol for obstructive sleep apnea in maxillofacial surgery patients

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ABSTRACT

Obstructive Sleep Apnea (OSA) is implicated in the etiology of numerous serious health problems. The aim of this study is to screen suspected cases of OSA, create awareness amongst patients at risk and propose a cost effective and easy screening protocol for OSA. An observational study which included screening of patients posted for surgery, at department of Oral and Maxillofacial Surgery using detailed history and clinical examination, STOP BANG questionnaire, lateral cephalogram and overnight pulse oximetry in a step wise manner. The data obtained was analysed to determine the relationship of each test parameter to the final risk scoring and overnight Oxygen Desaturation Index (ODI). In this study, over a period of one year, out of 124 cases, 40 cases (32.3%) were categorized as intermediate or high-risk cases for presence OSA, according to the STOP-BANG questionnaire. 11 cases (26.2%) were screened as high-risk based on ODI value. There was a strong correlation between risk factors such as snoring, obesity, male gender, excessive daytime sleepiness, hypertension and OSA. We can categorize the patients as low, intermediate and high-risk cases and accordingly advise them for further polysomnography studies, lifestyle modifications or oral appliances and take the necessary peri-operative precautions for intermediate or high-risk cases where surgery is mandatory.

INTRODUCTION

Obstructive sleep apnea (OSA) is a potentially life-threatening disorder characterized by repeated collapse of the upper airway during sleep, with periodic cessation of breathing (for more than 10 seconds) [1]. OSA is implicated in the etiology of numerous serious health problems, including systemic hypertension, coronary heart disease, heart attack, pulmonary hypertension, stroke, psychiatric problems, cognitive dysfunction, and death. Other consequences of untreated OSA syndrome can include obesity, decreased libido, social withdrawal, poor job performance, automobile accidents, and family problems. The importance and prevalence of this disorder have only recently been identified, and thus many physicians are not aware of the symptoms or implications of OSA.

Presently, large numbers of patients with sleep apnea and partial upper airway obstruction remain undiagnosed and untreated. Unidentified OSA in preoperative patients can lead to unplanned postoperative admissions, increased length of stays in the post anaesthesia care unit (PACU) and more serious outcomes if OSA patients are discharged to a non-monitored unit or home. Preoperative screening of all patients for OSA is recommended to avoid respiratory events [2].

The performance of an overnight polysomnographic (PSG) test at specialized sleep clinics remains the gold standard for diagnosing obstructive sleep apnea disorder. OSA represents a major public health burden and currently available resources allow only a minority of affected patients to be assessed and treated. At present, international sleep and respiratory scientific societies are addressing the problem in a systematic way, and the future direction is likely to involve an increasing proportion of limited sleep studies outside the sleep laboratory environment. The aim of the current study is to propose a cost-effective and easy to perform screening protocol, using only primary tools such as a standard validated questionnaire and finger pulse oximeter to evaluate pre-surgical maxillofacial cases. The objective of the study is to Screen suspected cases of Obstructive Sleep Apnea, to identify patients at risk for OSA who need further evaluation, taking necessary peri-operative precautions in suspected cases of obstructive sleep apnea and creating awareness amongst patients at risk and educating them for advised appropriate treatment.

MATERIALS & METHODOLOGY

A Cross-sectional study was conducted in the Department of Oral and Maxillofacial Surgery, College of Dental Sciences, Davangere which included 124 participants. Consent for performing

the study was obtained from the institutional ethical committee (CODS/IEC/1813/2016-2017). A written consent form was obtained from each volunteer after the nature of the study had been fully explained. The procedure began with screening of patients by STOP BANG questionnaire. Out of these 124, 40 patients underwent further evaluation with nocturnal sleep study using CMS50D+ Pulse Oximeter and Lateral Cephalogram radiography. There were 88(71.0 %) males and 36(29.0%) females in the study with mean age of 39.41yrs (Range=17yrs to 79yrs).

Inclusion criteria
1.   Patients with retrognathic mandible.
2.   Patients with Class 2 malocclusion.
3.   Patients with temporomandibular joint ankylosis.
4.   Patients with obesity problem.

Exclusion criteria
1.   Patients who have undergone previous nasal and oropharyngeal surgery.
2.   Patients with diagnosed upper aerodigestive malignancies.
3.   Patients who are pregnant.
4.   Patients with chronic intake of sedative medications.
5.   Patients with debilitating diseases.
6.   Patients with airway and upper digestive tract disorders and infections.

The STOP-BANG Questionnaire has been validated in medical and surgical patients and in different ethnic groups [3]. A STOP-Bang score of 0 to 2 indicates a low risk of OSA; a STOP-Bang score of 3 to 4 indicates an intermediate risk of OSA; and a STOP-Bang score of 5 to 8 indicates a high risk of OSA.

Stop (yes/no)
The questions are as follows:

•   Do you SNORE loudly (louder than talking or loud enough to be heard through closed doors)?

•   Do you often feel TIRED, fatigued, or sleepy during Daytime?

•   Has anyone OBSERVED you stop breathing during your sleep?

•   Do you have or are you being treated for high blood PRESSURE?

Bang (yes/no)
•   BMI more than 35kg/m2?

•   AGE over 50 years old?

•   NECK circumference > 16 inches (40cm)?

•   GENDER: Male?

Lateral Cephalogram
Upper Airway Space Analysis was done using Mc Namara 's cephalo metric Analysis in a lateral cephalogram. According to the analysis, the upper pharyngeal width is measured from a point on the posterior outline of the soft palate to the closest point on the posterior pharyngeal wall. This measurement is taken on the anterior half of the soft palate outline because the area immediately adjacent to the

posterior opening of the nose is critical in determining upper respiratory patency. In the Ann Arbor sample, the average upper airway measurement for adults of both sexes is 17.4 mm [4].

Sample size estimation
The sample size was decided using the following formula:

$x = z^2 pq/e^2$

x = sample size

z = critical value of z statistic at 5% significance = 1.96

p = prevalence rate of Inclusion criteria

q = non-prevalence

e = error in judging the sample units based on questionnaire

By the above formula, sample size comes to approximately is 124.

Statistical analysis
Data collected over a period of one year, including questionnaires, nocturnal oximetry records, lateral cephalogram measurements were analysed to determine whether there were any significant differences in the cases and controls. The calculation of mean, standard deviation was carried out for all the patients in the study. The relationship of each test parameter to the final risk scoring and overnight oxygen desaturation index was determined.

Results were tabulated and subjected to appropriate statistical analysis using descriptive statistics, logistic regression analysis and Independent sample t test.

RESULTS
Total of 124 patients participated in this study. Out of these 42 patients underwent further evaluation with sleep study and radiography. There were 88(71.0 %) males and 36(29.0%) females in the study with mean age of 39.41 yrs. (Range=17yrs to 79yrs). Questionnaire was responded by 25%(n=31) of participants which were above the 50 years old whereas 75%(n=93) were under the age of 50. 124 participants were administered the STOP-BANG questionnaire which consisted of 8 questions. The participants in the study have attended all the questions and has responded according to their criteria. 46% responded that they snore loudly and only 13.7% responded that they often feel fatigued, TIRED or sleepy throughout daytime. A total of 97.6% participants denied that some other person had observed them stop breathing during sleep and only 26.6%(n=33) participants admitted that they were being treated for hypertension. When the patients were enquired about the BMI of the participants, 9 (7.3%) had BMI >35kg/m2 and 115(92.7%) had BMI <35kg/m2. 9,7%(n=12) participants had neck circumference >16 inches (>40cm) while 90.3% had a neck circumference <16 inches.

Figure 1. Each of the 124 patients were stratified based on their scores into low, intermediate and high risk for OSA.

Cumulative odds ordinal logistic regression with proportional odds was run to measure the effect of Age and Sex on the risk of having OSA as determined by STOP-BANG

questionnaire. Both Age and Sex significantly predicted the chances of having higher risk.

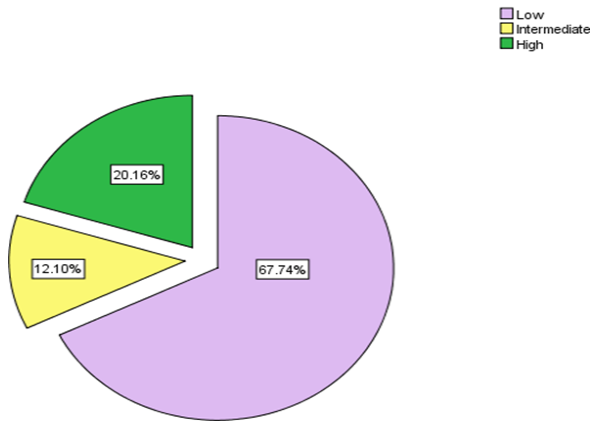**Figure 1:** Total Estimation of Risk Stratifications of 124 sample

Table 1: Estimation of risk factor with respect to Age group of the study participants

Risk * Age Group						
Count						
		Age Group				**Total**
		17-30	**30-45**	**45-60**	**>60**	
Risk	**Low**	41	31	9	3	84
	Intermediate	4	1	9	1	15
	High	1	7	11	6	25
Total		46	39	29	10	124

Table 1. An increase in age (expressed in years) was associated with increased odds of having higher risk of OSA with odds ratio of 1.120 (95% CI, 1.076 to 1.165) with p<0.001 (This means 1-year increase in age increases the risk of OSA by 1.120 times as assessed by the questionnaire) Figure 2. Similarly, male gender was significantly associated with higher risk category of OSA as compared females (p<0.001) with ail OR 43.064 (95% CI, 6.572 to

282.168).

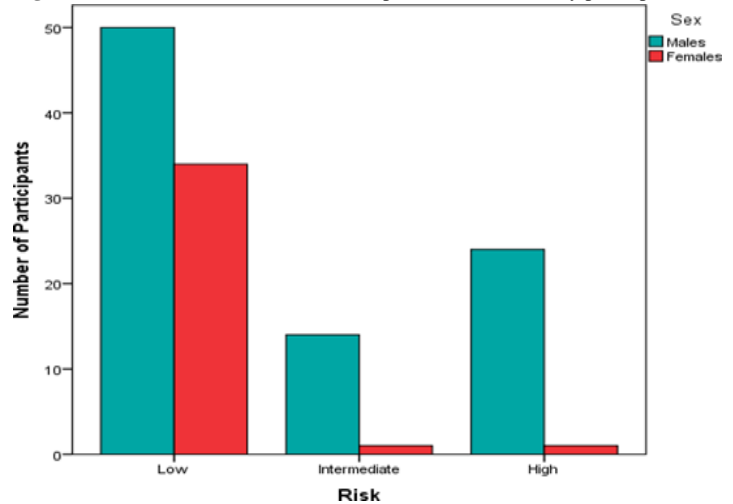**Figure 2:** Estimation of risk factor with respect to sex of the study participants

Table 2, shows Snoring and neck circumference showed a strong relationship with *decreased* LCUAS. A moderate relationship was seen in relation to Q2, Q4, Q5 and Q6. However, the relationship of decreased LCUAS was weak with Q3 and Q8 and was not significant. Based on their risk Stratification low risk patients (n=29) had an average of 0.3 events<88% with ODI of 0.95±1.6 Intermediate risk patients (n=2) had an average of 63 events<88% with an ODI of 10, l±0.63. High risk patients (n=ll) had an average of 23 events<88% and an ODI of 15.6±10.71. (Table 3).

Snoring and neck circumference showed a strong relationship with decreased LCUAS. A moderate relationship was seen in relation to Q2, Q4, Q5 and Q6. However, the relationship of decreased LCUAS was weak with Q3 and Q8 and was not significant. (Table 4)

Table 2: final score vs risk

Score v/s Risk								
	Q1Snore	**Q2Tired**	**Q3Observed**	**Q4HBP**	**Q5BMI**	**Q6AGE50**	**Q7Neck16**	**Q8Male**
Correlation Coefficient (r$_{pb}$)	-.565**	-.492**	-.218*	-.529**	-.434**	-.563**	-.535**	-.379**
p-value	.000	.000	.015	.000	.000	.000	.000	.000
**Correlation is highly significant								
*Correlation is significant								

Table 3: Score v/s ODI

Score v/s ODI								
	Q1Snore	**Q2Tired**	**Q3Observed**	**Q4HBP**	**Q5BMI**	**Q6AGE50**	**Q7Neck16**	**Q8Male**
Correlation Coefficient (r$_{pb}$)	-.647**	-.454*	-.056	-.447*	-.457*	-.816**	-.296	-.343*
p-value	.000	.003	.724	.003	.002	.000	.057	.026
**Correlation is highly significant								
*Correlation is significant								

Table 4: Score v/s LCUAS

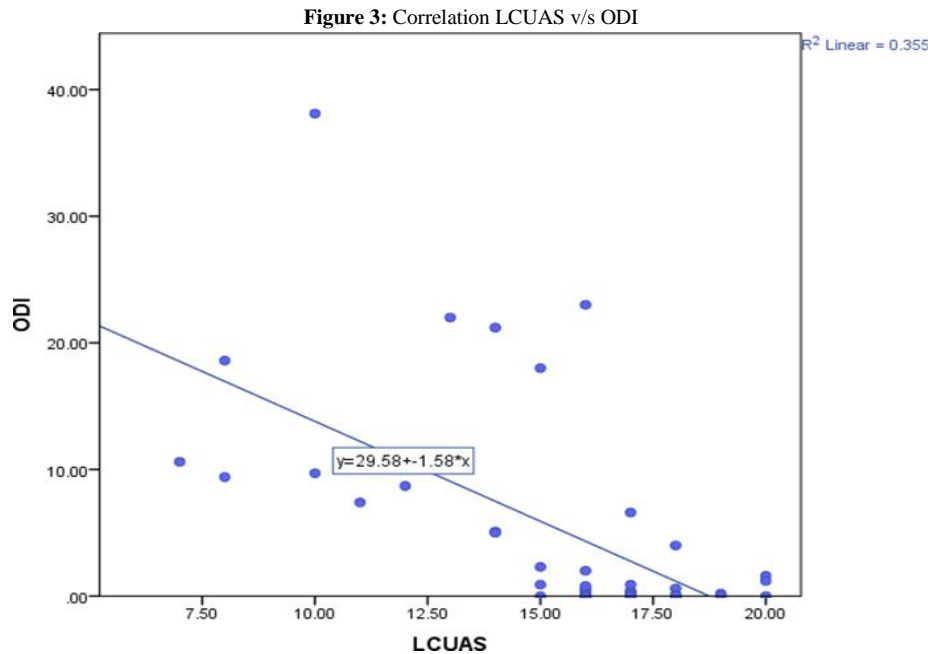| Score v/s LCUAS								
	Q1Snore	**Q2Tired**	**Q3Observed**	**Q4HBP**	**Q5BMI**	**Q6AGE50**	**Q7Neck16**	**Q8Male**
Correlation Coefficient (r$_{pb}$)	.613**	.341*	.241	.471*	.451*	.349*	.534**	.141
p-value	.000	.027	.125	.002	.003	.023	.000	.374
**Correlation is highly significant								
*Correlation is significant								

Figure 3: Correlation LCUAS v/s ODI

Figure 3. represents a Chart showing Correlation line of LCUAS v/s ODI. A Point-b is serial correlation was run to check the correlation between each of the 8 Questions and the Upper airway space.

There is a strong association (-.565) between snoring and risk of OSA. It was seen that a very significant relationship was present between Snoring and Age >50 yrs. Snoring and neck circumference showed a strong co-relation (.613) with *decreased* upper airway space as seen in the Lateral cephalogram.

DISCUSSION

The clinical manifestations of sleep apnea syndrome have been described as early as in the fat boy Joe in Charles Dickens Pickwick Papers, it was Gas taut in 1965 who provided the first detailed polygraphic description of the manifestations of this sleep related breathing disorder [5].

The pathophysiology of OSA is multi-factorial and not well-understood. The potential mechanism is related to reduced oxygenation caused by the repeated apneas and hypopneas events. Therefore, surges of the sympathetic activation, including rises of catecholamine levels, leads to endothelial dysfunction.[3] Moreover, there is evidence showing increased inflammatory markers such as C-reactive protein in patients diagnosed with OSA. The upper airway anatomy in patients diagnosed with OSA is usually smaller and narrower than patients without this condition. This presentation of the soft tissue structures surrounding the upper airway promotes its collapse [6].

OSA is associated with various comorbidities such as myocardial ischemia, heart failure, hypertension, arrhythmias, metabolic syndrome, cerebrovascular disease, insulin resistance, gastroesophageal reflux, and obesity [7].

Due to the complex symptomatology and fast changing

insights in the different aspects of OSAS, diagnosis and treatment require expert attention of different clinical specialities. Various questionnaires for the evaluation of daytime sleepiness and other OSAS related symptoms and comorbidity have been developed. Computerised Tomography, Magnetic Resonance Imaging, and other techniques to define upper airway anatomy and collapsibility have been described. These techniques have been used mainly for research purposes and their clinical value needs further elucidation. OSAS cannot be diagnosed without recording of breathing pattern during sleep. The gold standard for a definitive diagnosis of OSAS is polysomnography (PSG) [8]. The use of portable recording devices has rapidly increased. Following the American Sleep Disorders Association, the minimal requirement for a portable device are: recording of ventilation, ECG or heart rate and oxygen saturation [9].

Unfortunately, > 80% of patients with OSA are unrecognized before surgery, putting them at increased risk of complications during the perioperative period. The performance of an overnight polysomnographic (PSG) test at specialized sleep clinics remains the gold standard for diagnosing obstructive sleep apnea disorder.

In this study, we have attempted to prepare a pre-surgical screening protocol for OSA, in the maxillofacial surgery set up. Keeping in mind, the limitations of individual screening parameters, we tried to prepare a screening protocol by combining three validated methods of OSA screening which includes STOP-BANG Questionnaire, Lateral cephalogram, Nocturnal Pulse Oximetry. In 2006, a population-based survey from north India had estimated the prevalence of OSAS at 3.6 per cent (males and females being 4.9 and 2.1% respectively) the prevalence of OSA in the same study was 13.7 per cent [10].

124 patients participated in this study. There were 88(71.0

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%) males and 36(29.0%) females in the study with mean age of 39.41yrs. 37.1% were in the 17-30 age group, 31.5% in the 30-45 age group, 23.4% in the 45 to 60 age group and 8.1% in the above 60 years age group of the 42 patients, 29(69.0%) were classified as low risk, 2(4.8%) were intermediate risk and 11(26.2%) were high risk for OSA as assessed by the STOP-BANG Questionnaire.13 patients classified as intermediate and high risk by the questionnaire had high ODI values (>5) and corresponding reduced airway space.

The STOP-Bang questionnaire has been validated in medical and surgical patients and in different ethnic groups. A STOP-Bang score of 0 to 2 indicates a low risk of OSA; a STOP-Bang score of 3 to 4 indicates an intermediate risk of OSA; and a STOP-Bang score of 5 to 8 indicates a high risk of OSA [11]. For the 42 cases who were subjected to nocturnal pulse oximetry, it was seen that there was a highly significant correlation between high oxygen desaturation index and cases who had answered _yes 'for Snoring. Obstructive sleep apnea (OSA) is highly relevant to patients with hypertension (HTN): These two conditions frequently co-exist (an estimated 50% of patients with HTN suffer from concomitant OSA), and recent evidence supports the notion that OSA represents the most prevalent secondary contributor to elevated blood pressure (BP) in patients with resistant HTN [12,13].

In a study by Pedrosa et al, among 125 patients, OSA was the most common condition associated with resistant hypertension (64.0%) and they concluded that obstructive sleep apnea appears to be the most common condition associated with resistant hypertension. Age >50 years, large neck circumference measurement, and snoring are good predictors of obstructive sleep apnea in this population [13]. In this study, out of 124 cases, 26.6% (33) participants were hypertensive and showed a significant relation between hypertension and OSA risk, decreased upper airway space as well as Oxygen Desaturation Index. Obesity is a potent risk factor for the development and progression of sleep apnea. These effects may be mediated by circulating adipokines, which influence body fat distribution and CNS activity [14]. In this study, 7.26% cases had a Body Mass Index of >35 kg/m^2 and there was a significant relationship (-0.43) between BMI >35kg/m2 and the risk for OSA, ODI and upper airway space.

One intriguing aspect of OSA is the difference in the prevalence of the disease between Genders. Although this complex topic is still poorly understood, it is believed that there are inherent differences in fat distribution, length and collapsibility of the upper airway [15].

In the present study, 88(71.0 %) males and 36(29.0%) females participated with mean age of 39.41yrs. Male gender was significantly associated with higher risk category of OSA as compared females (p<0.001) with an OR 43.064 (95% CI, 6.572 to 282.168) which depicts that males are 43 times more likely to be classified as higher risk for OSA than females. A moderately strong (-.379) relationship was seen between Male gender and OSA risk, moderate correlation (-.343) with ODI.

We found that patients above 50 years age had a statistically significant and a very strong correlation with risk of obstructive sleep apnea as well as high ODI and moderately strong relationship with decreased upper airway space. In the present study, an increase in age (expressed in years) was associated with increased odds of having higher risk of OSA with an odds ratio of 1.120 (95% CI, 1.076 to 1.165) with p<0.001. Thus, we can positively correlate with the available literature which says that anatomic and physiologic factors probably contribute to increased upper airway collapsibility with aging.

Neck circumference (NC) is a newly identified clinical feature that may be associated with OSAS. Higher NC value was determined to be associated with severity of OSAS, and is an independent risk factor for severe OSAS [16].

In the current study, there was a statistically significant and strong relationship (.534) between snoring, increased neck circumference and decreased upper airway space measured by lateral cephalogram. The Lateral Cephalogram Upper Airway Space (LCUAS) was measured in 42 individuals who had already given the questionnaire. The mean values of lateral Cephalogram of low risk patients was 17.0±1.54mm, intermediate risk 12.5±3.04mm and for high risk was 8.5± 2.12mm. An increase in LCUAS was associated with decreased odds of having risk of OSA with an odds ratio of 0.880 (95% CI, 0.560 to 1.384). A less than 1 value of OR indicates that as LCUAS increases the risk of OSA. Desaturation episodes are one of the main reasons for the development of complications associated with OSAS. The average number of desaturation episodes per hour can be measured and is called the oxygen desaturation index (ODI). Desaturation episodes are generally described as a decrease in the mean oxygen saturation of ≥4% (over the last 120 seconds) that lasts for at least 10 seconds. An ODI>5 is a good predictor for AHI>5 with an accuracy of 87%, an ODI>15 for AHI>15 with an accuracy of 84%, and an ODI>30 for AHI>30 with an accuracy of 93.7%. A cut-off value of the ODI>10 has high sensitivity (93.3%) to detect moderate and severe OSA. ODI has a prognostic value because the complications and mortality of OSA are related to nocturnal hypoxia [17].

In the present study, for the 42 cases, Events>88% were measured for each patient and Oxygen Desaturation Index (ODI) was calculated for each patient. Based on their risk stratification low risk patients (n=29) had an average of 0.3 events<88% with ODI of

0.95±1.6. Intermediate risk patients (n=2) had an average of 63 events<88% with an ODI of 10.1±0.63. High risk patients (n=11) had an average of 23 events<88% and an ODI of 15.6±10.71, Because of the low frequency (2), the average events<88% appears to be more for intermediate than high risk group. This is one of the drawbacks of this study due to small sample size with unequal distribution of patients. We found that of the 42 cases that underwent overnight pulse oximetry, 23 cases who had moderate or high risk based on stop bang questionnaire or those who were suspected of having OSA based on inclusion criterion, it was observed that there was a strong significant correlation between ODI values, risk based on questionnaire and symptoms of the cases. The other cases who had a score of zero in the questionnaire, no symptoms of OSA and no comorbidities, had very low or zero desaturation episodes in the nocturnal oximetry study.

CONCLUSIONS

Thus, we observe that there is quite a significant number of undiagnosed cases of OSA in the pre-surgical population of a maxillofacial surgery unit. Based on this study results, we can conclude that there is a strong and significant correlation between risk factors such as snoring, obesity, male gender, excessive daytime sleepiness, hypertension and OSA.

Looking at the number of undiagnosed cases of OSA in the pre-surgical population, and the associated peri-operative risks and complications of OSA due to the interactions of sedatives and opioid analgesics used during general anaesthesia, we need an easy, cost-effective and universally reproducible screening protocol for OSA screening.

AUTHORS CONTRIBUTION & CONFLICT OF INTEREST

All author made best contribution for the concept, assessment and evaluation, data acquisition and analysis and interpretation of the data. The author disclosed no conflict of interest.

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