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Original Research Article

Association of apnea-hypopnea index and lateral cephalometry pre- and post-surgery in obstructive sleep apnea patients

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ABSTRACT

Background: Snoring and obstructive sleep apnea are new emerging medical entity and require early diagnosis and treatment because of their increasing implication on physical, mental, social and emotional health. Aim of this study is to assess severity of OSHAS and co-relate efficacy of various post-surgical parameter on objective and subjective improvement in patients.
Methods: 43 patients having the symptoms were included in the study and followed over a period of three months and during their post operative visit their lateral cephalometric findings, ESS were recorded and compared to pre operative values to see if any association exists between them.
Results: it was seen that various surgical interventions did bring about subjective and objective improvement in patients and these were statistically significant.
Conclusions: OSHAS is a spectrum of disorders and has great impact on persons physical, mental and emotional well-being. Early diagnose and treatment eliminated the future risks. Surgical intervention helps improve symptoms of OSHAS and should be undertaken without delay wherever indicated.

Keywords: OSHAS, ESS, AHI, Cephalometry

INTRODUCTION

Obstructive sleep apnea has been observed since ancient times, with symptoms of heavy snoring recorded over for 2000 years. Tracheotomy, sole surgical procedure available during this period, was not well tolerated/accepted by most patients. In early 70's term used was hypersomnia with periodic apnea (HPA), later revised to obstructive sleep apnea syndrome (OSAS). In 1965 first polysomnography recorded apneas during sleep.[1] Snoring is one end of spectrum of sleep-related breathing disorders (SRBD'S) with extreme form, as obstructive sleep apnea syndrome. It is associated with medical conditions like hypertension, coronaryand cerebrovascular disease. 15-year mortality for adults with severe OSA is approximately 30% with adjusted mortality hazards ratios of 1.4, 1.7, and 3.8 for mild, moderate, and severe disease, respectively.[2]

Aim and objectives

Aim and objectives of current study were to study association of apnea and hypopnea index (AHI) and lateral cephalometric variables before and after surgery and to evaluate effectiveness of lateral cephalometry and Sleep study to diagnose severity of OSA as well to study postoperative effect of varied surgeries on AHI and symptoms of OSAS.

METHODS

It was prospective observational study conducted at KKR Hospital and Research Institute, Chennai, from March 2016 to March 2018. Sample size was calculated using the following formula;

$$n = \{[2(\alpha + \beta)\text{^}2\sigma\text{^}2]/[\mu1 - \mu2]\text{^}2\}$$

Where α=0.05=1.96; β=0.80= 0.84; μ1=5.6; μ2=7.4 and σ= 2.9 population variance, thus sample size n=41 was the calculated size and rounded off to 45.

Patients seen at outpatient department with complaints of snoring, apneic episodes or/and excessive daytime sleepiness and fulfilling inclusion and exclusion criteria were enrolled in study. All patients above 18 years, suffering from OSA and upper airway resistance syndrome that were willing to undergo surgery for OSA and were compliable for follow up for 3 months after surgery were included in study. While, patients with severe pulmonary disease, unstable cardiovascular disease, morbid obesity (BMI>35), alcohol or drug abuse or smoking, psychiatric instability, unwilling for surgery and age below 18 years of age were excluded from the study. A study performa was prepared which was filled for every patient. It included patient's details, chief complaints, their duration, pre-operative routine physical examination, lateral cephalometry, sleep endoscopy, level 3 sleep study, surgery performed and postoperative follow up at 3rd month (sleep study, lateral cephalometry, symptomatic improvement). All individuals reporting to OPD with signs and symptoms of OSAHS were assessed and informed about their disease, treatment options, nature of study, their role in study and consequences of study. Informed, written consent was taken from all. Detailed history and clinical examination (general and ENT) was done for all. Nose was examined for any pathological conditions. Oral cavity, oropharynx was examined and structures like soft palate, uvula, tonsils were documented. Malampatti grading and Friendman tongue position were used for oropharynx. Laryngeal structures were also seen. Lateral cephalometry (Figure 1) was done for each patient before surgery to assess site of obstruction and following variables were noted down: retropalatal space (RPS): soft palate length (SPL); posterior airway space (PAS); mandibulo-hyoid distance (MHD). All patients were subjected to an overnight level 3 sleep study (Figure 2). Based on symptoms, clinical features and polysomnographic recordings, patients were classified into following groups: mild obstructive sleep apnea (AHI=5-15); moderate obstructive sleep apnea (AHI=15-30); severe obstructive sleep apnea (AHI>30). Drug induced sleep endoscopy (DISE) was performed on all patients under effect of propofol with nasopharyngolaryngoscopy in supine position. Tongue base, lateral pharyngeal walls and vocal cords were assessed. Based on all above data patients underwent different kinds of snoring surgery under general anaesthesia. Patients were discharged on post-operative day 1 and were called for checkup on postoperative Day 7. Patients were then called for post-operative review on 1st month and 3rd month. During 3rd month review, postoperative Lateral cephalometry and level 3 sleep study, BMI and ESS score was done and documented. All Data were entered on excel spreadsheet. Association between lateral cephalometry and severity of OSA was assessed using Kruskal Wallis test and preoperative and postoperative improvement in AHI and lateral cephalometry variables were calculated using Wilcoxon signed rank test.

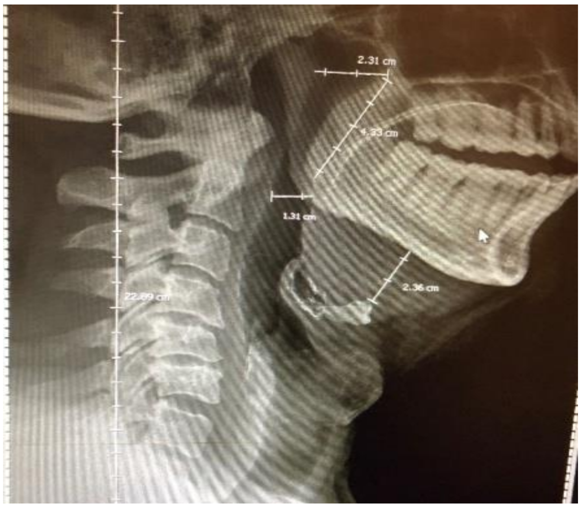

Figure 1: Lateral cephalometry.

Figure 2: Level 3 sleep study.

RESULTS

This was a prospective observational study which involved 45 patients, 43 patients were observed (2 lost to follow up) which included 41 males and 2 females. Patients were grouped within following age range: 20-29 yeares (16.3%); 30-39 (41.9%); 40-49 (27.9%); 50-59 (11.6%); 60-69 (2.3%) (Figure 3-4).

Table 1: Lateral cephalometric and ESS scores.

Parameters	Findings	N	%
Retropalatal space	>2 cm (increased)	14	32.6
	2 cm (normal)	4	9.3
	<2 cm (decreased)	25	58
Posterior airway space	>1 cm (increased)	13	30.2
	1 cm (normal)	9	20.9
	<1 cm (decreased)	21	48.8
	>4 cm (increased)	32	74.4
	4 cm (normal)	3	7
	<4 cm (decreased)	8	18.6
Mandibulohyoid distance	>2 cm (increased)	16	37.2
	2 cm (normal)	7	7
	<2 cm (decreased)	24	55.8
ESS	Normal (0-5)	23	53.5
	Mild (0-10)	5	11.6
	Moderate (11-15)	8	18.6
	Severe (16-24)	7	16.3

Table 2: Comparing lateral cephalometric findings pre and post-surgery.

Parameters	Mean pre-surgery	Mean post-surgery	P value/statistical significance (yes/no)
RPS	2.16	2.20	0.091/no
SPL	4.35	3.77	0.0001/yes
PAS	0.96	1.18	0.0001/yes
MHD	2.16	2.22	0.290/no

Table 3: Correlation of lateral cephalogram and severity of AHI before and after surgery.

Parameters	Pre operative				Post operative			
	Mild OSA	Moderate OSA	Severe OSA	P value	Mild OSA	Moderate OSA	Severe OSA	P value
RPS	2.46±0.66	2.11±0.27	2.12±0.16	0.825	2.22±0.14	2.23±0.23	2.11±0.09	0.541
SPL	3.21±0.21	3.89±0.14	4.58±0.10	0.0001	3.68±0.06	3.82±0.13	4.04±0.13	0.040
PAS	1.09±0.09	1.15±0.12	0.84±0.07	0.062	1.27±0.05	0.98±0.07	1.11±0.09	0.008
MHD	1.95±0.16	1.74±0.16	2.43±0.16	0.033	2.02±0.13	2.46±0.23	2.58±0.42	0.043

Table 4: Different surgeries and effect on AHI and ESS.

Surgery performed	Percentage of study population	Pre-op AHI	Post-op AHI	Pre-op ESS	Post-op ESS
Nasal surgery with barbed stitch palatoplasty (BSP)	39.5	37.2	18.2	9.29	1.0
Nasal surgery with expansion sphincter palatoplasty	11.9	41.52	9.76	11	1.8
Multilevel surgery	23.2	52.01	26.15	13.9	2.3
Hyoid suspension with BSP	0.02	53	20	12	0
Maxillo mandibular advancement with adenoidectomy	0.02	35.8	26.1	2	0
Tongue base channeling	0.02	17.6	11.5	10	0
Nasal surgery with anterior palatoplasty	0.04	18.5	6.3	9	1.5
Nasal surgery with adenoidectomy with BSP	0.02	21.7	7.2	16	3
Tongue base excision with BSP	0.02	11.1	8.1	15	3
Nasal surgery with tonsillectomy with zetaplasty	0.02	64.3	15.3	17	3
Nasal surgery with transpalatal advancement palatoplsty	0.04	37.05	15.8	7	1.5
Nasal surgery with tongue base channeling	0.02	87.7	53.3	14	0

Out of 43 patients, all patients (100%) presented with snoring. Of which 33 patients additionally had nose block, 29 patients' apneic episodes at night, 21 patient excessive day time sleepiness.

Body mass index is categorized into 4 Grades. In our study, of 43 patients, 14.0% belonged to Grade 1 (20-25 kg/m^2), 37.2% to Grade 2 (25-30 kg/m^2), 48.8% to Grade 3 (30-40 kg/m^2). None belonged to Grade 0 (<20 kg/m^2) or Grade 4 (>40 kg/m^2). Severity of OSAHS classified based on the preoperative apnea-hypopnea index into mild (AHI 5-15) 25 patients), moderate (AHI=15-30), severe (AHI>30) (Figure 5). Lateral cephalogram and Epworth Sleepiness Score findings were done and documented.

DISE showed 93% had collapse at the level of velopharynx, 48.8% at Oropharynx while 39.53% showed tongue base collapse and 9.3% had epiglottic collapse. An objective and subjective assessment of improvement after multilevel pharyngeal surgery was done by overnight sleep study, lateral cephalogram and ESS score at 3rd post-operative month. AHI value observed from sleep study was taken into consideration to calculate mean. Mean AHI of patients before surgery was 41.84±3.49 and after was 19.56±2.28 which gave p value of 0.0001, which was statistically significant. Mean ESS calculated before surgery was 10.4±0.86 and after was 1.40±0.29 and p value calculated was 0001, which was again statistically significant. On comparing pre and post lateral cephalometric variables it was seen that improvement in a few parameters was statistically significant (Table 2).

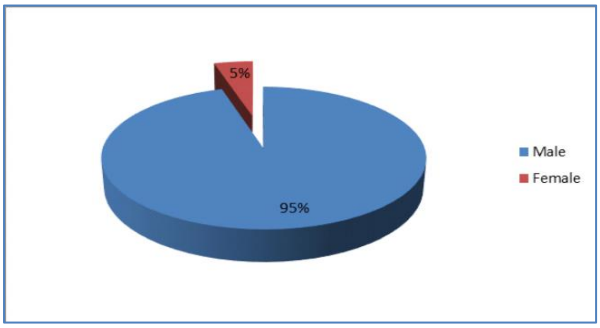

Figure 3: Gender distribution in the study.

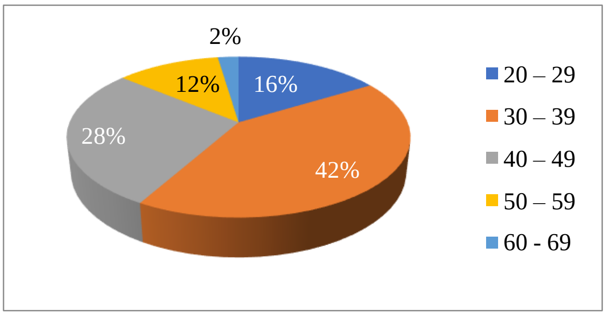

Figure 4: Patient distribution as age.

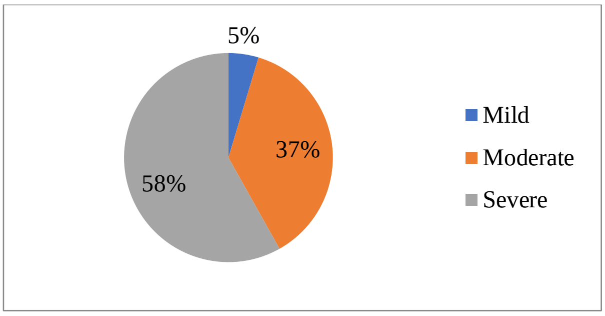

Figure 5: Patient distribution as per severity of OSHAS.

From Table 3, it is concluded that when compared pre operatively it was seen that SPL and MHD are statistically significant in assessing the severity of OSAHS. When seen postoperatively, major and statistically significant change in severity was for patients having an improved PAS and none other parameters showed any significant difference. Different kinds of surgery were performed and their effect on pre and post AHI and ESS were documented as shown in Table 4.

DISCUSSION

Obstructive sleep apnea hypopnea syndrome is characterized by repeated airway collapse during sleep. Often cause is decreased airway space due to relaxation of pharyngeal musculature during sleep. This becomes evident in patients with predisposing factors like morbid obesity, specific craniofacial anatomy like retrognathism, macroglossia, increased mandibulo-hyoid distance, maxillary and mandibular hypoplasia. Medical consequence of OSA is decrease in length and quality of patient's life due to development of pulmonary and arterial hypertension, cardiac rhythm disorders, metabolic syndrome and type 2 diabetes. These alarming medical consequences of OSAHS make it an important entity requiring an early diagnosis and treatment. Other important indications which emphasize on treatment are decreased work productivity, disturbed social and personnel life. This study aimed at establishing correlation between lateral cephalometry finding and severity of AHI both preoperatively and postoperatively. Study included 45 patients but only 43 were observed (2 patients lost to follow up). In this study symptomatic patients were subjected to preoperative evaluation consisting of level 3 sleep study and lateral cephalometry to assess severity of OSAHS. Various surgical procedures were done based on their cephalometric findings and DISE. Post operatively patients were assessed for improvement in their symptoms by postoperative sleep study and lateral cephalometry. In this study 41 patients were male and 2 females. Likewise, was study of Borges et al. where there were 58.1% male and 41.9% female.[3] Possible explanations include effects of hormonal influences affecting muscles of the upper airway and its ability to collapse, sex differences in body fat distribution, and differences in pharyngeal anatomy and function. In our study, youngest age was 23 years and oldest 63 years. Mean age was 39.04 years. Study conducted by Borges et al, documented mean age of 46.70 years.[3] Hence, OSAHS is more common in 3rd to 5th decade. In present study, all 43 patients presented with chief complaint as snoring. In addition, 76.7% had nasal block, 67.4% apnoeic spells during sleep while 48.4% excessive day time sleepiness. In study by Schlosshan et al 70-95% presented with snoring, 30-50% had excessive daytime sleepiness, while few presented with apneic spells and the remaining presented to other specialities for complaints like hypertension, ischaemic heart disease, depression, stroke, nocturia, endocrine disorders, gastro oesophageal reflux disorder, etc.[4] Most important predisposing factor documented in literature for OSAHS is morbid obesity. Ideal way of analyzing it is by measurement of the body mass index. In present study 14.0% had Grade I, 37.2% had Grade II, 48.8% had Grade III BMI, while none of the patient fell in Grade IV BMI. Mean BMI here was 29.36. This is similar to study by Borges et al where mean BMI for female was 27.41 and for male was 27.88.[3] Various studies published in literature emphasize on higher BMI to be causing more severe OSAHS. In study, severity of OSAHS was graded as per AHI as mild, moderate and severe. Of 43,4.7% had mild, 37.2% moderate while 58.1% patients had severe OSAHS. Similar findings were seen in study conducted by Zarycka et al where 17% had mild OSAHS, 39% moderate and 44% had severe OSAHS.[5-7] Severity of symptoms of all patients in present study was also analyzed by measuring ESS which yielded mean value of 10.14±0.86. Likewise, result was obtained in a study by Li et al where mean ESS was 10.2±1.8. After detailed analysis of all preoperative data attempt was made to find correlation between AHI and cephalometric values. It was found that severity of AHI correlated positively with SPL and MHD of lateral cephalometry, p value for SPL correlation was 0.0001 and that of MHD was 0.033. While remaining two values, RPS and PAS did not have any positive correlation (p value for RPS is 0.825, for PAS is 0.062). In literature various studies document a correlation between the AHI and lateral cephalometry. Like, a study by Davies et al showed positive correlation between SPL and MHD with severity of AHI which is in accordance with present study.[8] As per this study, mandibulo hyoid distance positively correlated with severity of OSA. This could be attributed to the reason that an inferiorly located hyoid may pull the tongue backwards further narrowing the pharyngeal airway. Hence, more distance between mandible and hyoid, greater is AHI. Likewise, increased soft palate length caused higher AHI because greater soft palate length narrows velopharyngeal space. Both above factors tend to worsen with increasing BMI.

In addition to sleep study and lateral cephalometry all patients were subjected to DISE and findings were classified as per site of collapse and following observation was made: 93% had collapse at the level of velopharynx, 48.8% had at level of Oropharynx, 39.53% at tongue base and 9.3% had an evident epiglottic collapse. Based on above findings, patient underwent surgical procedure as single/multilevel staged surgeries. Various surgical procedures performed were septoplasty, turbinoplasty, anterior palatoplasty, transpalatal advancement palatoplasty, barbed stitch palatoplasty, expansion sphincter pharyngoplasty, tongue base excision, epiglottoplasty and hyoid suspension. Patients were called on 3rd postoperative month. During this follow up, recorded values showed following results: postoperative AHI mean was 19.56±2.28, when compared to preoperative AHI, it was found that surgical intervention had positive impact on reduction of AHI, thus proving it to be statistically significant (p value is 0.0001). Same as present study, a study by Li et al also showed statistically significant difference between pre (39.8) and postoperative AHI (15.1) after barbed stitch palatoplasty as a surgical intervention.[9] Piccin et al reported similar results after Hyoid suspension in OSAHS patients (pre op mean AHI was 431.1 and post op 10.9).[10] In light of present study and other published literature, it could be concluded that surgical intervention does have impactful outcome on postoperative AHI, thus justifying the need for these procedures in OSAHS patients. Patients also had lateral cephalometry at postoperative 3rd month. Mean postoperative RPS was 2.20±0.10, SPL was 3.7±0.06, for Both MHD and PAS was 2.22±0.10 and 1.18±0.04 respectively. On comparing post- and pre-operative values, it was found that parametric measurements of SPL and PAS changed statistically significantly after surgical intervention. However, RPS and MHD values did not. Above result can be attributed to fact that in present study majority of patients had soft palate obstruction as predominating etiological factor for OSAHS. As a result, surgical intervention mainly aimed at altering palatal anatomy more than other factors. There are various studies in literature documenting changes in lateral cephalometric variables after surgical intervention like a study conducted by Mike which showed the mean of 0.9±0.04 for PAS, 2.67±0.08 for mandibulo-hyoid distance and 0.6±0.02 for retropalatal space.[11] P values for above mentioned variables are 0.09, 0.06 and 0.04 respectively. It shows that there is no statistically significant change is observed in PAS and MHD, which is contradictory to present study. Study showing similar result to present study was by Li et al where there was increase in PAS was statistically significant.[9] After analyzing postoperative AHI and Lateral cephalometric values a correlation was obtained between them. In present study, there is positive correlation between AHI and lateral cephalometric variables namely; SPL, PAS and MHD. RPS although was increased postoperatively, correlation was not found to be statistically significant. Similar to present study, study conducted by Li et al and Boris et al.[9-11] Stuck et al showed a positive correlation between PAS and AHI.[12] But study by Bowden et al documented a positive correlation of SPL and MHD with AHI only in severe cases. The literature does not mention anything statistically significant regarding correlation between

AHI and RPS similar to present study.[13] As surgery objectifies symptomatic outcome of surgery so postoperative ESS was also calculated for all patients which had mean of 1.40±0.29 and was found to be statistically significant (p=0.0001). This is in accordance with study of Bowden et al where mean postoperative ESS came down to 10.9 from preoperative of 13.8.[13] It also stated that all patients who were heavy snorers before surgery had significant symptomatic improvement. Li et al study also found statistically significant improvement in ESS with preoperative mean of 10.2 and 4.9 postoperatively.[9] At end of discussion supported with various published literature it can be postulated that both sleep study and lateral cephalometry play an important role to measure severity of OSAHS. Surgical intervention to be made can also be deduced with the help of above two and DISE. On studying correlation it was seen that AHI and Lateral cephalometry reflected a positive correlation both preoperatively and postoperatively. Patients who underwent surgery also had noteworthy symptomatic improvement as can be seen with decreasing ESS post operatively. Patients here underwent various surgical procedures and had change in pre and post operative ESS (Table 4). Likewise, Yao et al did a study on multilevel (UPPP, genioglossus advancement and hyoid myotomy with advancement) surgery for patients with OSAHS.[11] They found that post surgery; patients were categorized into responders and non-responders with Responders having the RDI decreased from 47.5 pre-operatively to 17.5 post-operatively. Non-responders presented with increased post-operative AHI of 52 while pre-operative for was 51.3. They also saw that ESS scores improved from mean preoperative score of 11.4 to 11.3 post-operatively.

Limitations

This study has been carried in a particular region with a limited population of 45 patients only. Hence, though the study provides substantial data on the improvement of patients AHI and ESS post-surgery, it cannot be used as a generalized principle. Follow-up duration is of shorter duration. A minimum follow-up of at least 5 years should be done in order to really appreciate the success of surgery and the impact patients' lifestyle on the post-surgical effects.

CONCLUSION

At present, snoring and OSA are emerging as a major medical entity and burden of medical sequel of OSAHS and its effect on social and personnel life has provoked the medical practitioners to diagnose and manage it as early as possible. Majority of patients have day time sleepiness and apnoeic spells and most of them are obese with BMI>25 (average 29.6 in present study), making obesity as important predisposing factor for OSAHS. Males are commonly affected. Sleep study, DISE, lateral cephalogram form vital diagnostic tools for OSHAS, all of which have been used here to grade severity pre surgery and also decide upon operative intervention needed. Co-relation between sleep study and cephalometric findings suggested that severity of AHI had positive correlation with SPL and MHD. Patients underwent various customised surgeries in single/multilevel and were followed in 3rd post operative month and were subjected to Level 3 sleep study and lateral cephalometry. Symptomatic improvement was calculated using ESS, which showed statistically significant reduction postoperatively. To conclude, this study showed that both AHI and lateral cephalometry are effective tools to diagnose and decide upon the management of OSAHS. There is a positive correlation between AHI and lateral cephalometry both before and after surgical intervention.

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