ISSN (Print) : 0974-6846
**Indian Journal of Science and Technology,** *Vol 8(27), DOI: 10.17485/ijst/2015/v8i27/81612, October 2015* ISSN (Online) : 0974-5645

# Usefulness of Video-Fluoroscopy in Assessment of Obstructive Sleep Apnea Syndrome

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## Abstract

The study tried to comparatively analyze surgical findings based on the examination results of polysomnography and video-fluoroscopy which are examinations useful in diagnosis of obstructive sleep apnea syndrome. The subjects were patients over the age of 18 who were admitted for snoring, observed apnea, or sleepiness. Received under polysomnography and video-fluoroscopy inspection of obstructive sleep apnea of doubt from March 2013 to February 2014, it was intended for patients who have undergone surgical treatment. In the analysis was obstructive sleep apnea severity, there were difference in all clauses excluding age and height ($P<0.05$). Crosstab due to the presence or absence of video-fluoroscopy and polysomnography and surgical treatment, there was a significant difference ($p<0.05$). There are many examinations for diagnosing obstructive sleep apnea but as an essential examination there are polysomnography and video-fluoroscopy examination that can observe the dynamic change of the obstruction which are clinically useful.

**Keywords:** Apnea-Hypopnea Index, Obstructive Sleep Apnea, Polysomnography, Video-Fluoroscopy

## 1. Introduction

This Sleep apnea refers to the symptom that is characterized by periodic cease of respiration during sleep. Obstructive sleep apnea syndrome is a disease that can show various symptoms such as sleep symptoms including excessive sleepiness, headaches, and snoring as well as severe cardiovascular complications. It is a syndrome that can have limitations on the patient's psychological, physical and social activities[1]. The most common form is where there is repetition of closing of the upper respiratory tract caused by sleep accompanied by the effort to breathe, and this is called obstructive sleep apnea[2,3]. Obstructive sleep apnea syndrome is a complex disease of the neuromuscular, respiratory and cardiovascular systems and it is a disease that can cause severe problems physiologically and socially. Before deciding on surgical treatment, first there needs to be detailed examination for diagnosis such as signs, symptoms, physical conditions, and habits as well as detailed investigation of things such as the social environment of the patient. Whether the surgery should be done or not must be decided upon considering influence of the airway obstruction in the daily life of the patient, physical and mental health as well as the accompanied discomfort and complications with surgery. The methods to treat snoring and Obstructive

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sleep apnea syndrome are largely divided into internal medicinal methods and surgical methods. For internal medicinal methods there are continued positive pressure therapy, intraoral devices, and drug therapy. For surgical treatment methods there are bronchotomy, uvulopalatopharyngoplasty, laser palatopharyngeal surgery, genioglossus advancement, maxillomandibular advancement and high-frequency thermal treatment[4]. The purpose of surgical treatment is to acquire the airway space without obstruction by soft-tissue and to maintain adequate airflow in normal air intake process by decreasing airway resistance[5]. Closure can occur in all parts of upper airway and there are a lot of them such as the nasal cavity, the soft palate, the root of the tongue, and the epiglottis[6–8]. There are variety of ways to check closure site such as Muller which uses the nasopharynx fiber, cephalometry that simply shoots side of the upper airway, manometry that decides the closure part by measuring the pressure of upper airway, computed tomography that observes the closure site solidly and magnetic resonance. There are a lot of controversy in undergoing clinical trial utility, patient compliance and economical burden[9,10]. Compared to this, video-fluoroscopy can check the dynamic change in upper airway when sleeping; It is non-invasive and can grasp the closure that happens in several parts[11]. Also in the polysomnography, it is a standardized test of sleep apnea so it can be over or under evaluated according to the sleep environment and measuring equipment, but until now it has been thought as reference standard, so it has been gone over without any doubt of reliability and technological accuracy[12].

Fortis the study tried to figure out the relevance in patients who are admitted for obstructive sleep apnea is the main symptom that received polysomnography and video-fluoroscopy examinations.

## 2. Materials and Methods

### 2.1 Materials

The subjects were patients over the age of 18 who were admitted for snoring, observed apnea or sleepiness. Received under polysomnography and video-fluoroscopy inspection of obstructive sleep apnea of doubt from March 2013 to February 2014, it was intended for patients who have undergone surgical treatment. From the people studied, 24(80%) of them were men, 6(20%) of them were women. The age distribution was from 18 to 62, average age was 43.5±13.4, average height was 170.1±9.6cm, weight of 76.1±12.7kg, and the average Body Mass Index (BMI) was 26.3±3.5kg/m$^2$.

### 2.2 Polysomnography

Five busy for the examination the administration of medicaments that influence sleep was ceased and help them arrive at the examination room two hours earlier than the average sleeping times and before polysomnography, explained to patients about physical measurement and polysomnography. In the record of polysomnography, we used medcare Embla N 7000 and A 10 recording system, and for the analysis program, we used Somnologica version 3.0. The review of the polysomnography record followed international review standards and apnea was defined as at least 10 seconds of continual 90% or more decrease of airflow, hypopnea was defined as at least 10 seconds of continual 50% or more decrease of airflow due to this arterial oxygen saturation decreased by more than 4%. It was called a minor case when apnea-hypopnea index was between 5 – 15, it was called a moderate case when it was between 15 – 30, and if it was over 30 was classified as a major case and when it was over five it was diagnosed as obstructive sleep apnea syndrome[13] in Figure 1.

**Figure 1.** Polysomnography.

### 2.3 Video-Fluoroscopy

The examination was conducted in supine position. In the imaging before anesthetic injection the patients were asked to open and close the mouth clearly checked the location of the soft palate and tongue root. For sleep induction Midazolam 3mg was intravenously injected and

if sleep induction failed 2mg was additionally injected. The imaging was ceased immediately after injection and then the patient was in full sleep the imaging started and it was conducted for about five minutes. Before the examination oxygen saturation equipment was attached to the fingers so that if the oxygen level rapidly decreased the prepared medical staff could conduct prompt emergency measures[14] in Figure 2.

**Figure 2.** Video-fluoroscopy.

### 2.4 Statistical Analysis

The difference of gender was tested by Mann-Whitney U test, analyzed the difference of obstructive sleep apnea severity by ANOVA and for the relationship between fluoroscopic findings and polysomnography and operative findings was analyzed by Pearson's chi-square test and Fisher's exact test. A one-way analysis of variance test (ANOVA) was used to evaluate the effects of the variables on severity. The Tukey test was applied as a post hoc test. If the assumption that the variances were equal was broken by the Levene test, the Welch variance weighted ANOVA test was used. The Tamhane test was applied as a post hoc test. Statistical analysis was performed using SPSS (version 21.0, Chicago, IL, USA). The measured values are marked as mean ± Standard Deviation (SD). A p value of less than 0.05 was considered to be statistically significant.

## 3. Results

From the analysis according to the gender, from all people, the average age of men were 40.6±13.4 and women were 55.2±3.9, the average height for men were 173.6±7.2cm and women were 156.2±3.3cm, the average weight for men were 78.8±12.2kg and women were 65.6±9.1kg($p<0.05$). Also, the average of BMI for men were 26.1±3.7kg/m$^2$ and women were 27.3±3.0kg/m$^2$, average oxygen saturation for men were 95.1±1.7% and women were 95.7±2.0%, minimum oxygen saturation for men were 82.6±8.0% and women were 86.3±5.7%, having not significant difference($p>0.05$). In the average Apnea-Hypopnea Index(AHI), men were 31.7±25.1 and women were 23.6±20.6, having not significant difference($p>0.05$). When assorted by severity, mild was 8, moderate 12, and severe was 10 in Table 1. In the analysis was obstructive sleep apnea severity, there were difference in all clauses excluding age and height($P<0.05$) in Table 2. There is a difference in the surgical therapy based on the diagnosis of the polysomnography obstructive sleep apnea ($x^2 = 5.000$, $p = 0.046$) in Table 3. In addition, there is a significant difference in polysomnography findings based on the video-fluoroscopy findings ($x^2 = 10.866$, $p = 0.002$) in Table 4. Finally, whether the operation in response to the video fluoroscopy findings also was a significant difference ($x^2 = 19.201$, $p = 0.001$) in Table 5.

All data are shown as mean±SD. Difference between means was assessed by Mann-Whitney U test ($p<0.05$). BMI: body mass index, SpO$^2$: O$^2$ saturation, AHI: apnea hypopnea index.

**Table 1.** Comparison between male and female by gender

| Variables | Total (n = 30) | Male (n = 24) | Female (n = 6) | t | p-value |
|---|---|---|---|---|---|
| **Age (yr)** | 43.5±13.4 | 40.6±13.4 | 55.2±3.9 | 0.026 | .026 |
| **Height (cm)** | 170.1±9.6 | 173.6±7.2 | 156.2±3.3 | 0.001 | .001 |
| **Weight (kg)** | 76.2±12.7 | 78.8±12.2 | 65.6±9.1 | 0.021 | .021 |
| **BMI (kg/m$^2$)** | 26.4±3.5 | 26.1±3.7 | 27.3±3.0 | 0.364 | .364 |
| **Mean $SpO_2$ (%)** | 95.2±1.74 | 95.1±1.7 | 95.7±2.0 | 0.299 | .299 |
| **Minimum $SpO_2$ (%)** | 83.4±7.6 | 82.6±8.0 | 86.3±5.7 | 0.350 | .350 |
| **AHI (event/h)** | 30.1±24.1 | 31.7±25.1 | 23.6±20.6 | 0.641 | .641 |

All data are shown as mean±SD. Difference between means was assessed by Mann-Whitney U test (p<0.05). BMI: body mass index, SpO2: O2 saturation, AHI: apnea hypopnea index.

**Table 2.** Polysomnographic data of the subjects according to the ahi dependency

| Variables | AHI Group | Mean | SD | F | *p*-value |
|---|---|---|---|---|---|
| **Age (yr)‡** | Mild | 43.5 | 12.2 | 0.361 | .702 |
| | Moderate | 45.8 | 15.5 | | |
| | Severe | 40.7 | 12.5 | | |
| **Height (cm)†** | Mild | 168.7 | 10.9 | 0.594 | .559 |
| | Moderate | 168.8 | 9.9 | | |
| | Severe | 172.9 | 8.8 | | |
| **Weight (kg)†** | Mild | 66.7[a] | 8.3 | 11.910 | .001 |
| | Moderate | 72.8[a] | 8.7 | | |
| | Severe | 87.8[b] | 11.4 | | |
| BMI (kg/m$^2$)‡ | Mild | 23.4[a] | 1.5 | 13.066 | .001 |
| | Moderate | 25.7[a] | 2.7 | | |
| | Severe | 29.5[b] | 3.3 | | |
| **Mean $SpO_2$ (%)‡** | Mild | 96.8[a] | 0.6 | 20.492 | .001 |
| | Moderate | 95.2[b] | 1.8 | | |
| | Severe | 93.9[b] | 1.3 | | |
| **Minimum $SpO_2$ (%)‡** | **Mild** | **92.5[a]** | **1.8** | **46.527** | **.001** |
| | **Moderate** | **82.4[b]** | **5.9** | | |
| | **Severe** | **77.2[b]** | **5.2** | | |
| **AHI (event/h)‡** | **Mild** | **8.3[a]** | **4.5** | **40.547** | **.001** |
| | **Moderate** | **22.4[b]** | **3.0** | | |
| | **Severe** | **56.8[c]** | **23.5** | | |

All data are shown as mean±SD. †One-way analysis of variance (ANOVA) was done. Multiple comparison test was done by Tukey test (p<0.05). ‡Welch variance weighted ANOVA was used. Multiple comparison test was done by Tamhane test (P<0.05). SD: standard deviation, BMI: body mass index, SpO2: O2 saturation, AHI: apnea hypopnea index.

**Table 3.** Comparison between polysomnography findings and surgical treatments

| Polysomnography Findings | Surgical treatments | | Total | $X^2$(P) |
|---|---|---|---|---|
| | Non-operative | Operative | | |
| **Sonring** | 7 | 2 | 9(100%) | 5.000 |
| **Sonring_OSA** | 7 | 14 | 21(100%) | (.046)* |

*Comparison between polysomnography findings and surgical treatments assessed by Fisher's exact test (p<0.05). OSA: obstructive sleep apnea.

**Table 4.** Comparison between polysomnography findings and video-fluoroscopy findings

| Polysomnography Findings | Video-fluoroscopy findings | | Total | $X^2$(P) |
|---|---|---|---|---|
| | Sonring | Snoring_OSA | | |
| **Sonring** | 8 | 1 | 9(100%) | 10.866 |
| **Sonring_OSA** | 5 | 16 | 21(100%) | (.002)* |

*Comparison between polysomnography findings and video-fluoroscopy findings assessed by Fisher's exact test (p<0.05). OSA: obstructive sleep apnea.

**Table 5.** Comparison between video-fluoroscopy findings and surgical treatments

| Video-Fluoroscopy Findings | Surgical treatments | | Total | $X^2$(P) |
|---|---|---|---|---|
| | Non-operation | Operation | | |
| **Sonring** | 8 | 1 | 9(100%) | 19.201 |
| **Sonring_OSA** | 5 | 16 | 21(100%) | (.001)* |

*Comparison between video-fluoroscopy findings and surgical treatments assessed by Pearson's chi-square test (p<0.05). OSA: obstructive sleep apnea.

## 4. Discussion

Obstructive Sleep Apnea (OSA) can be caused by gender, age, obesity degree interaction and in this research, the people were above BMI 25, and by looking at the fact that bigger the Apnea-Hypopnea Index (AHI) is, the BMI was bigger. We can see from this that obesity and sleep apnea has close relation[15]. Browman[16] says that obesity is a important factor to cause or aggravate sleep apnea, for a mild case, by just losing weight, they can improve snoring and sleep apnea. Video-fluoroscopy can check the dynamic change in the upper airway when sleeping, and it is non-invasive. Especially, it can find the closure site that happens at the same time easily[17]. Like this, because it shows structural correlation well, it is useful when deciding surgical treatment. Tongue rear part space has relationship with sleep apnea moderate and the hyoid bone's position is the way of distinguishing the patient of sleep apnea and normal person[18]. From the video-fluoroscopy research, Suratt[19] ,the upper airway closure is usually in the part of the epiglottis, so when doing test while sleeping, the soft palate touches the wall of posterior pharynx and tongue, which is connected to closure. Walsh[20] said that closure starts from the soft palate and goes to under part of the hypopharynx. Pepin[21] also had the similar result. From those patients who were diagnosed as snoring or closure sleep apnea syndrome needs treatment and there are still a lot of dispute about what kind of treatment to use. Normally, when there is no clinical sign or no complications of cardiovascular, it can be fixed by behavioral therapy and drug therapy. However, if there is complication of cardiovascular, or clinical sign of daytime sleepiness by the apnea, or of those patients whose condition is bad, they need to start treatment immediately[22]. Before the treatment, the clinical test, radiological test and polysomnography test is important and see where the obstruction site is. By the diagnosis, we can plan the treatment and stage approach of surgical

therapy can refer to Stanford University method[23]. By this, in this research, we tried to analyze the relationship between those patients who got treated and closure site, video-fluoroscopy and polysomnography, as a result, there were positive correlation between them. Especially for video-fluoroscopy, it has strong positive correlation, so we could learn that it is useful for clinical index. For last, induced sleep can be different from the real sleep[24]. Normally, we inject sleeping pill such as Midazolam, the 3 step sleep and REM sleep doesn't emerge, so the real closure site might not be found[25]. In this research, we also injected Midazolam, so there can be difference from the real sleep and there is limit of sampling number.

## 5. Conclusion

For diagnosis of snoring and obstructive sleep apnea syndrome, various examination findings of polysomnography and radiological findings of videofluoroscopy examination is clinically useful in diagnosing the level of obstruction and location of obstruction in the upper respiratory tract and it could be seen that as a surgical index it had close relevance with surgical treatment planning.

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