http://jmscr.igmpublication.org/home/
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v11i1.24

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

# Study of Electrocardiographic predictors of impending heart failure in proven Obstructive Sleep Apnea patients

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**Abstract**
*Obstructive sleep apnea (OSA) is the most common type of sleep apnea caused by a complete or partial obstruction of the upper airway.If the symptoms are also present in the daytime, it is referred to as obstructive sleep apnea syndrome. Multiple clinical reports have shown an association between OSA and heart failure. In patients with OSA, during the apneic events, substantial negative intrathoracic pressure develops due to continuous respiratory efforts against a partially or totally obstructed upper airway. This in turn causes a dramatic increase in after load resulting in decreased left ventricular stroke volume. In addition to these mechanical interactions, nocturnal myocardial ischemia may contribute to episodes of acute heart failure in patients with OSA. The aim of this study was to assess the changes in electrocardiographic parameters in proven obstructive sleep apnea patients to predict impending heart failure in a resource-scarce situation. A total of 30 proven OSA patients were included in the study and their electrocardiographic parameters were compared with the Apnea-Hyponea index derived from the polysomnography test results. In this study, the most common electrocardiographic markers seen were Prolonged PR interval(63.3%), Abnormal P wave (66.6%), Left ventricular hypertrophy(46.6%), Left axis deviation (30%), Prolonged QTc interval(46.6%). Studies have shown that prolonged QRS duration, left- axis deviation, prolonged QT interval, abnormal QRS- T axis, left ventricular hypertrophy, and left bundle- branch block, abnormal P- wave axis, are associated with Heart failure. Hence this study shows that the at risk OSA population can be risk stratified for impending heart failure using low- cost, noninvasive cardiac assessment tools like Electrocardiographs in rresource-scarce situations.*
**Keywords:** *Obstructive sleep apnea, Apnea hypopnea index, P-wave duration, QRS duration, QT prolongation.*

## Introduction

Obstructive sleep apnea (OSA) is the most common type of sleep apnea caused by a complete or partial obstruction of the upper airway. It is characterized by repetitive shallowness or pauses in breathing in spite of efforts to breathe normally. It is usually associated with de-saturation. If the symptoms are also present in the daytime, it is referred to as obstructive sleep apnea syndrome.

Typical clinical features of OSA include unrefreshing sleep, uncontrolled daytime somnolence, witnessed apneas or choking during sleep, loud snoring, morning headache, difficulty concentrating, and depressed mood or energy. Presumptive clinical diagnosis can be based on the presence of known or putative risk factors like old age, increased BMI, increased neck and waist circumference, crowded oropharynx, high Mallambati score, short mandibular length, and alcohol or sedative use.

Multiple clinical reports have shown an association between OSA and heart failure. In patients with OSA, during the apneic events, substantial negative intrathoracic pressure develops due to continuous respiratory efforts against a partially or totally obstructed upper airway. This in turn causes a dramatic increase in afterload resulting in decreased left ventricular stroke volume. In addition to these mechanical interactions, nocturnal myocardial ischemia may contribute to episodes of acute heart failure in patients with OSA. Acute CHF can also be caused by nocturnal cycles of apnea hypoxemia and arousal which induce arrhythmias

**Aims and Objectives**

1. To assess the changes in electrocardiographic parameters in proven obstructive sleep apnea patients to predict impending heart failure.

**Materials and Methods**

**Study Area and Study Design:** A cross-sectional study was conducted at the rural-based teaching tertiary care hospital in Puducherry from March 2021 to September 2021 for a period of 7 months. This study had been cleared by the Institutional Research and Ethics Committee.

**Study Participants:** Patients chosen for the study after getting informed consent were all patients who are diagnosed based on polysomnography between the age group of 20–70 years. Patients with previous or present atrial fibrillation, valvular heart disease, and lung diseases such as COPD, severe pulmonary hypertension, and thyroid disorder were excluded as these conditions can be confounding factors.

The sample size was calculated to be 30 based on previous studies using the formula 4pq/d2 where-p-prevalence, q- 100-p, d-relative precision of 20% with a 10% non-response rate.

**Sampling Procedure**

Samples for the study are derived from collecting medical records of already proven obstructive sleep apnea patients and excluding based on the exclusion criteria, the electrocardiograph and polysomnography findings are collected for the study.

The ECG of the 30 proven OSA patients were analyzed for parameters such as P-wave duration (normal is <100 ms), QRS duration (80–120 ms), Deep S wave, LVH using Sokolov-Lyon criteria (S wave depth in V1 + tallest R wave height in V5-V6 > 35 mm), RBBB. Any deviation from the normal duration is recorded and compared with the severity of OSA by apnea-hypopnea index (AHI) to estimate the risk of impending heart failure

**Statistical Analysis**

Data were entered into the Microsoft Excel data sheet and were analyzed using the SPSS 22 version software (IBM, Armonk, New York, USA). Categorical data were represented in the form of frequencies and proportions. The Chi-square test was used as the test of significance for the qualitative data. Continuous data were represented as mean and standard deviation. An Independent t-test was used as the test of significance to identify the mean difference between two quantitative variables. MS Excel and MS Word were used to obtain the various types of graphs such as bar diagrams.

**Results**

**Table 1:** Demographics based on the age of the patient:

| Age | N | % |
|---|---|---|
| 40-45 years | 12 | 40.0 % |
| 46-50 years | 2 | 6.7 % |
| 51-55 years | 7 | 23.3 % |
| 56-60 years | 4 | 13.3 % |

The above table shows that the majority of patients were between 40-45 years of age.

**Table 2:** showing common presenting symptoms in the patient population.

| S.No. | Symptoms | n (%) |
|---|---|---|
| 1 | Easy fatiguability | 3 (10%) |
| 2 | Insomnia | 4 (13.3%) |
| 3 | Morning headache | 6 (20%) |
| 4 | Snoring | 17 (56.7%) |
| 5 | Day time sleepiness | 16 (53.3%) |

This table shows that the majority of patients presented with snoring and daytime sleepiness.

**Table 3:** showing associated comorbidities of the patients.

| S.No. | Co-morbidities | n (%) |
|---|---|---|
| 1 | Type 2 DM | 16 (53.3%) |
| 2 | Hypertension | 11 (36.7%) |
| 3 | Dyslipidemia | 8 (26.7%) |
| 4 | Obesity | 15 (50%) |
| 5 | ASCVD | 29 (96.7%) |
| 6 | Smoking | 14 (46.7%) |
| 7 | Alcoholism | 10 (33.3%) |

| BMI | n | % |
|---|---|---|
| Normal (18.5-24.9) | 3 | 10% |
| Overweight (25-29.9) | 12 | 40% |
| Obese (30-34.9) | 12 | 40% |
| Extremely Obese (>35) | 3 | 10% |

**Table 4:** showing severity of OSA patients based on the Apnea-Hypopnea index:

| Apnea-Hypopnea Index | n | % |
|---|---|---|
| **Mild (5-14/hour)** | 4 | 13.3% |
| **Moderate (15-29/hour)** | 6 | 20% |
| **Severe (>30/hour)** | 20 | 66.7% |

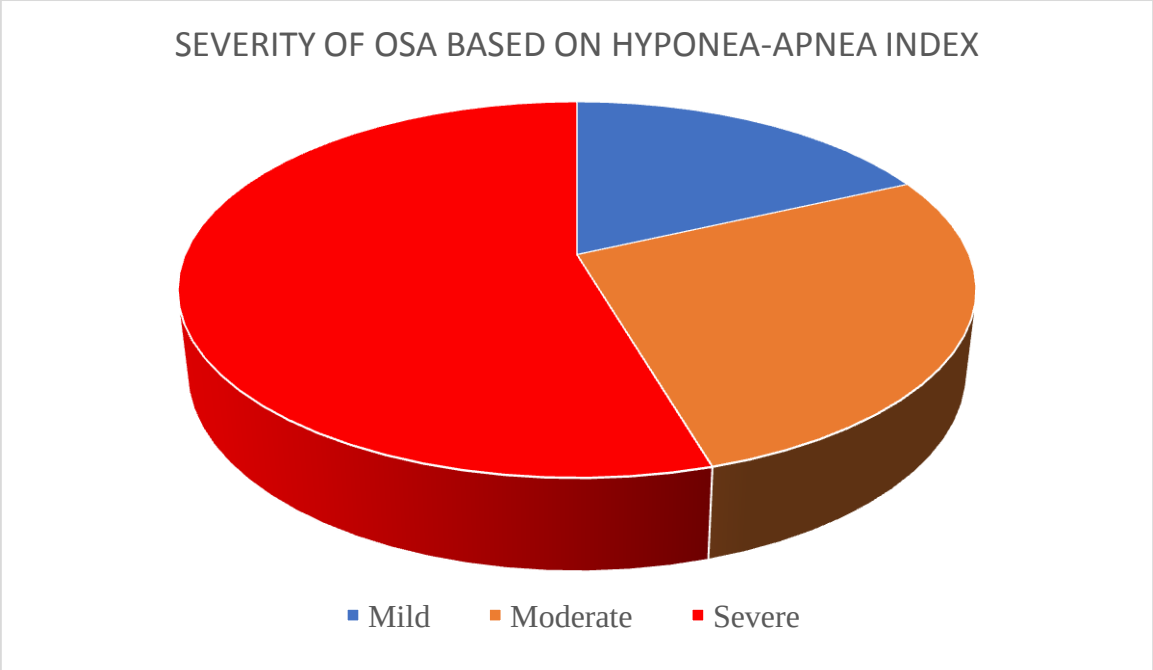
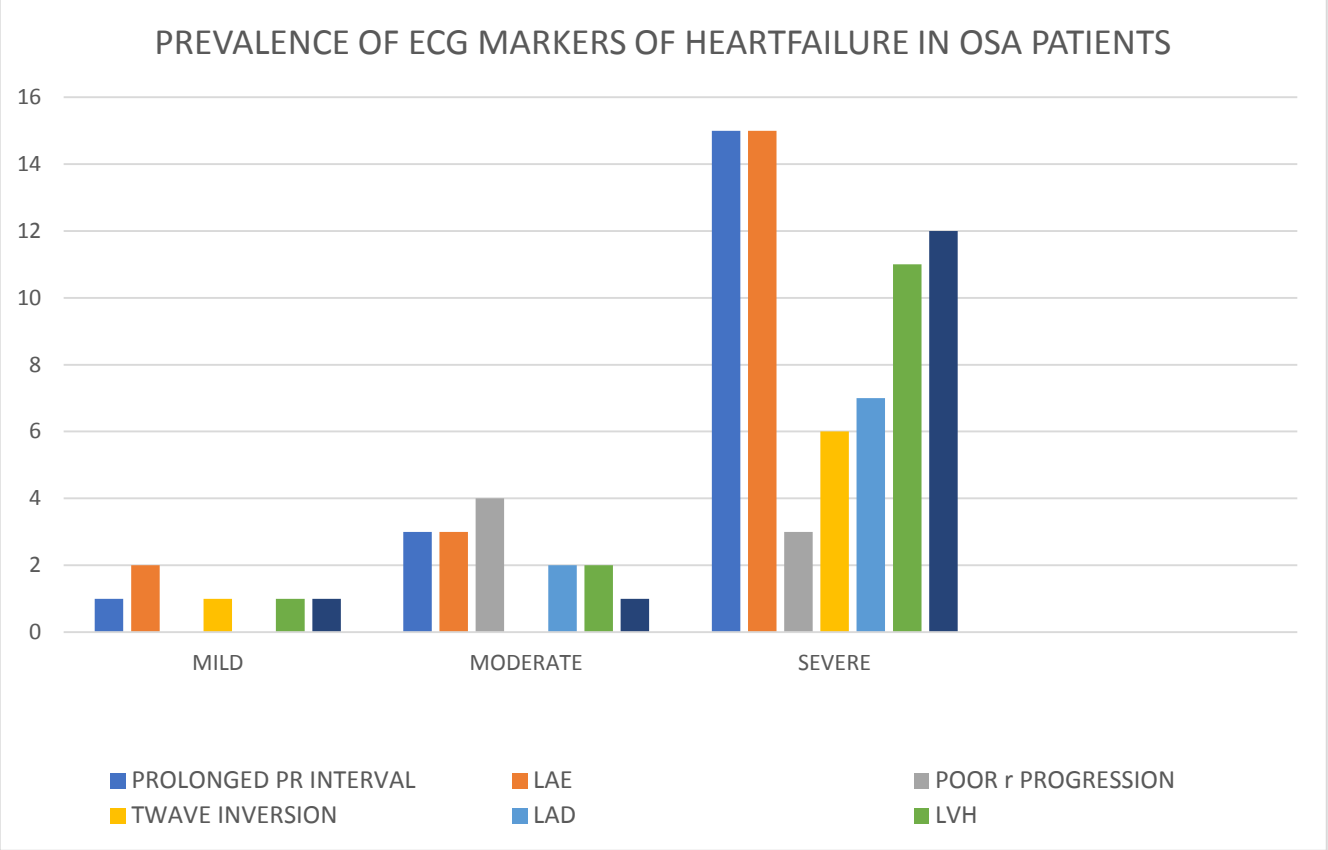



**Chart 1:** showing the distribution of OSA patients based on their severity.




The above chart shows that the incidence of electrocardiographic parameters predicting impending heart failure is significantly increased in Severe OSA patients.

**Discussion**

There are different theories explaining the role of OSA in the development of Heart Failure. Due to the generation of a negative intrathoracic pressure, which increases both cardiac preload and after load. Intermittent hypoxic periods increase oxidative stress and inflammation markers, damaging the endothelial walls. Increased sympathetic nervous activity, leads to an increase in blood pressure and heart rate.

In this study the most common electrocardiographic markers seen were

- Prolonged PR interval – 19 (63.3%)
- Abnormal P wave (left atrial enlargement) – 20 (66.6%)
- Left ventricular hypertrophy – 14 (46.6%)
- Left axis deviation – 9 (30%)
- Prolonged QTc interval – 14 (46.6%)

Studies have shown that prolonged QRS duration, left- axis deviation, prolonged QT interval, abnormal QRS- T axis, left ventricular hypertrophy, left bundle- branch block, abnormal P- wave axis, and abnormal QRS- T axis is associated with Heart failure. OSA is independently associated with an increased risk of HF-related symptom progression, hospitalization, and mortality.

By 2030, the prevalence of heart failure is expected to raise by 23%, with medical costs increasing to nearly $53.1 billion. Hence the identification of at- risk individuals by low- cost, non-invasive cardiac assessment is of paramount importance due to the large burden that heart failure will place on the healthcare system. This fact is especially important in the OSA population since studies have shown that patients without HF diagnosed with OSA have an increased subsequent risk of incident HF.

**Conclusion**

This study shows that the at-risk OSA population can be risk stratified for impending heart failure using low- cost, non-invasive cardiac assessment

tools like Electrocardiographs in resource-scarce situations.

**Limitations**

The relatively small number of participants (sample size = 30) since the feasibility of getting proven OSA patients without the factors mentioned in the above exclusion criteria is very difficult.

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