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CASE REPORT

Severe OSA Leading to Long Pauses in 24-h Holter ECG Reversed with CPAP

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Abstract: ***Introduction*:** Sleep-related problems like sleep apnea are increasing tremendously mostly owing to the disordered lifestyle the present generation is leading which is added like a topping on the base of obesity and metabolic syndrome. The burden on the society is huge taking into consideration the work-time loss and health-related financial issues arising out of these sleep disorders with obstructive sleep apnea (OSA) leading the way. Early diagnosis can prevent several complications of OSA. Cardiovascular diseases, including various arrhythmias, arising due to OSA, are described previously.

***Case Presentation*:** Herein, an interesting case of OSA, whose pacemaker installation to rectify the long pause could be avoided by simple correction of his OSA using continuous positive airway pressure, is presented. This 49-year-old male patient was diagnosed with severe OSA by using polysomnography and all his significant sinus pauses (highest one with 7.8 sec) during holter ECG monitoring were found to be occurring at night and correcting his OSA with continuous positive airway pressure (CPAP) treatment reverted all those sinus pauses and the need for any further intervention with pacemaker was discarded.

***Discussion*:** OSA is caused by either partial or complete obstruction of the upper airway, and there is the simultaneously attenuated upper airway dilator muscle tone while the patient is sleeping. The gold standard test designed for the assessment of OSA is polysomnography, as approved by the American Academy of Sleep Medicine and CPAP has been found to be universally beneficial in treating OSA related complications. Physiologically, the ACC/AHA guidelines recommend pacing only in patients with prolonged asymptomatic pauses occurring during wakefulness. This case report proved the above mentioned claim of CPAP treatment.

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1. INTRODUCTION

Sleep-related disrupted breathing disturbs the normal temporal congruence of the human body and elicits numerous disturbances of hemodynamic milieu and autonomic and inflammatory pathways. Sleep apnea is usually accompanied by Cheyne–Stokes breathing (CSB), a common presentation in the cardiology clinics. Sleep apneas are of two types: obstructive sleep apnea (OSA) and central SA (CSA). OSA is caused by partial or complete obstruction of the upper airway, along with a simultaneously attenuated upper airway dilator muscle tone while the patient is sleeping.

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Conversely, CSA is characterized by the repeated starting and stopping of breathing during sleep. CSA is detected in approximately 25-40% of patients with congestive heart failure, and the incidence is higher than that of OSA [1].

OSA is defined as severe when the apnea-hypopnea index (AHI) is ≥30. Previous studies have shown that heart failure and atrial fibrillation can be expected if CSA occurs with CSB, which is also an indicator of poor prognosis. In such events, heart failure mostly results in mortality [2]. OSA is also known to be associated with clinical conditions, such as hypertension, coronary artery disease, cardiac arrhythmias, sudden cardiac death, and heart failure. In the event of OSA, the cardiovascular system of a patient suffers from intermittent hypoxia, oxidative stress, and elevated blood pressure. These manifestations impair myocardial contractility, which, in turn, contributes towards the

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progression of heart failure. Moreover, OSA is prevalent in patients with heart failure with a reduced rate of ejection fraction.

CSB is increasingly found in heart failure cases and is interlinked with CSA, indicating that it is a common condition in the CSA group of patients than in the general population [3]. However, some studies have established a correlation between moderate-to-severe OSA and increased risk of mortality in patients with heart failure. A Canadian study showed that CSA with heart failure and reduced ejection fraction does not benefit from continuous positive airway pressure (CPAP) treatment [4]. About 30 years ago, another study by Tilkian *et al.* linked OSA to arrhythmias. The study analyzed the effects of tracheostomy and atropine on cardiac arrhythmias in 15 patients with OSA in their awake and sleeping conditions. Additionally, continuous overnight Holter electrocardiogram (ECG) monitoring was employed along with respiratory and electroencephalographic recordings to detect changes in the patients [5]. Thus, although heart failure might be caused by several factors, including CSA, OSA might also be prevalent with respect to pathophysiological significance. The present study demonstrated that sleep is associated with the following arrhythmias:

- Severe sinus arrhythmia in 93% cases.
- Severe sinus bradycardia in 40% cases.
- Asystole seen in 33% cases.
- Complex premature ventricular beats in 66% cases.
- Second degree atrioventricular (A-V) block in 13% cases.
- Ventricular tachycardia in 13% cases.

The results indicated potentially life-threatening arrhythmias, tachycardia, and bradyarrhythmia associated with OSA. Prolonged apnea and hypoxemia in OSA probably cause bradyarrhythmias and elicit a vagal activation reflex from cardiac tissue. This leads to sympathetic activation of the peripheral blood vessels, muscles, and renal and splanchnic bed but not the cerebral vasculature [6-8]. A series of the population- and cohort-based studies and observational studies in hypertensive patients attending hypertension and sleep clinics have shown a close association between the two diseases [9, 10]. Some studies also linked OSA with the loss of natural nocturnal dip and increased variability in the blood pressure [11]. The appropriate amount of sleep in a patient with OSA is vital. Engleman *et al.* conducted a randomized cross-over study and showed that only a 4-h CPAP treatment per night improves the condition of daytime tiredness [12].

Hoffstein *et al.* conducted a prospective study of 458 patients [13] and showed that patients with AHI > 40 were more likely to develop arrhythmias than those with AHI < 40. The AHI is the sum of apneas and hypopneas occurring per hour of sleep, with apnea defined as an absence of airflow for ≥10 s and hypopnea defined as a reduction in respiratory effort due to the presence of ≥4% oxygen.

2. CASE PRESENTATION

A 49-year-old male visited our outpatient department (OPD) with chief complaints of fatigue, light-headedness, nocturnal chest pain, and palpitations. He was diabetic, dyslipidemic, and hypertensive for 5 years. Medical history did not reveal any syncope, effort angina, orthopnea, paroxysmal nocturnal dyspnea, or pedal swelling. His daily medications included Metformin (1000 mg twice) and Glimepiride (2 mg once), Aspirin (75 mg once), Atorvastatin (20 mg once), and Telmisartan (40 mg once). The blood glucose was well-controlled, as indicated by a blood HbA1c level of 6.8%. He smoked 30 cigarettes daily and consumed alcohol occasionally. Physical examination revealed stable vitals. He was obese with a body mass index (BMI) of 30. In addition, bibasal fine rales with occasional ronchi were detected, and resting pulse oximetry oxygen saturation (SpO_2) was 96%.

Recent investigations revealed normal urine albumin–creatinine ratio, blood creatinine, normal lipid profile, and euthyroid status. His coronary angiography (performed 6 months ago) showed minor plaque burden (30%–40% disease) in the mid-left anterior descending artery. The patient underwent a 24-h Holter ECG monitoring due to light-headedness and palpitations; frequent short and long sinus pauses were detected with the highest record of 7.8 s (Table **1**). Thus, he was advised urgent pacemaker implantation. Surprisingly, the Holter monitoring report revealed that all sinus pauses occurred only during the sleep at night (Fig. **1**). Further questioning confirmed recurrent nocturnal awakening and daytime sleepiness. His partner confirmed loud snoring at night. Considering his clinical presentation, he was provisionally diagnosed with OSA and advised polysomnography for confirmation, which revealed AHI = 68 and oxygen desaturation index = 65 (Table **2**). Thus, he was diagnosed with severe OSA with significant desaturation. He underwent a CPAP trial and was advised weight reduction and cessation of smoking. Further, the CPAP trial AHI was drastically decreased to 5.6 (Table **3** and Fig. **2**), the quality of sleep improved dramatically, and daytime sleepiness subsided. Subsequently, Holter ECG monitoring repeated during CPAP (Table **4**) did not show any more significant sinus pauses as reflected by the longest sinus pause of 1.3 s (Fig. **3**).

Therefore, he was advised to use CPAP for at least 4 h/night. Consequently, the plan of implantation of the pacing device was canceled, and he was followed up after 4 weeks.

3. DISCUSSION

Untreated OSA exhibits multiple complications, such as somnolence, fatigue, headaches, decreased quality of life, cardiovascular disorders (including hypertension), and the most fatal being increased risk for motor vehicle accidents. The gold standard test designed for the assessment of OSA is polysomnography, as approved by the American Academy of Sleep Medicine. The test measures the neurological and cardiorespiratory parameters together during the sleep period. In this test, the frequency of the obstructive event for OSA is represented by AHI [14]. Severe OSA is also associated with the rising incidence of comorbidities, obesity, diabetes mellitus type 2, hypercholesterolemia, and hypertension. Obesity narrows the upper respiratory muscles owing to the accumulation of fatty tissues, thereby triggering apnea and hypoxia and, consequently, heart failure.

Table 1. Summary report of 24-h Holter ECG monitoring: Pre-CPAP installation.

Heart Rate Date	
Total Beats	107314
Min HR	40 BPM at 04:25:09 AM
Avg HR	75 BPM
Max HR	98 BPM at 04:12:16 PM
Heart Rate Variability	
ASDNN 5	48.5 ms
SDANN 5	56.9 ms
SDNN	94.2 ms
ST Episode Analysis	
-	Ch1 Ch2 Ch3
Min ST Level	- - -
Max ST Level	- - -
ST Episodes	- - -
Pacer Analysis	
Single Paced Beats	0 (0.0%)
Dual Paced Beats	0 (0.0%)
Fusion Beats	0 (0.0%)
Atrial Fibrillation	
AFib Beats	0 (0.0%)
Duration	0.0 min Events: 0
Ventricular Ectopy	
Total VE Beats	19 (0.0%)
Vent Runs	0
Beats	0
Longest	0
Fastest	0 BPM
Triplets	0 Events
Couplets	0 Events
Single/Interp PVC	0/19
R on T	0
Single/Late VE's	0/0
Bi/Trigeminy	0/0 Beats
Supraventricular Ectopy	
Total SVE Beats	221 (0.2%)
Atrial Runs	0
Beats	0
Longest	0
Fastest	0 BPM
Atrial Pairs	7 Events
Drop/Late	39/20
longest N-N	*7.8 s at 04:31:52 PM*
Single PAC's	180
Bi/Trigeminy	7/0 Beats

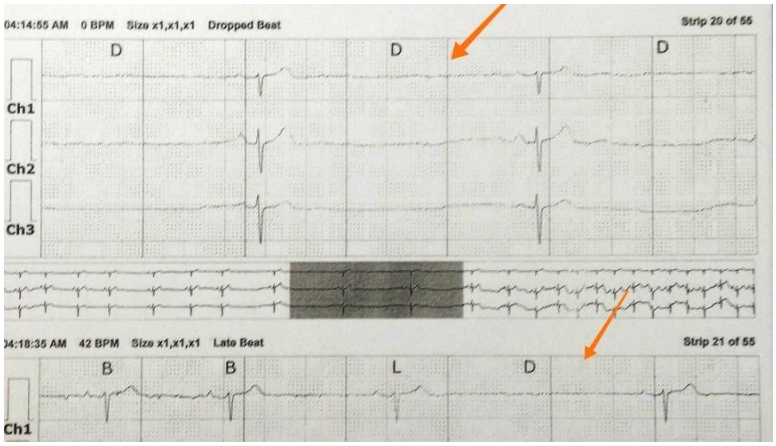

Fig. (1). Sinus pause of significant duration occurring during sleep time: pre-CPAP installation. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

Table 2. Polysomnography report demonstrating a severe degree of OSA: pre-CPAP installation.

Detected events (excluding time in ramp)		
-	**Index (evts/h)**	**Number**
Apneas + Hypopneas	5.6	141
OBS AH	3.3	82
CNT AH	2.4	59
OBS Apneas	2.6	64
OBS Hypopneas	0.7	18
CNT Apneas	0.7	17
CNT Hypopneas	1.7	42
Snoring	52.0	1301
FL Runs	16.5	412
Leaks	-	-
-	I/min	I/s
Min.	17	0.28
Max.	79	1.32
Aver.	43	0.72
% of time above the limit leak	0.1%	-

Latest settings for the period	
Mode	A-PAP + FL
Max. Pressure	20.0 cmH2O
Command on Flow Limitation Run	Enabled
Ramp	I.Ramp (45 min)
Patient Circuit	⌀22mm
Min, Pressure	4.0 cmH2O
Pressure Decrease	Slow
Max, Pressure for Command on Apnea	10.0 cmH2O
Comfort Pressure	4.0 cmH2O
Comfort Calibration CC+	Enabled During Ramp

Table 3. CPAP polysomnography demonstrating reversal of AHI score to normal levels.

Analysis (Flow evaluation period: 7 h 45 min/SpO_2 evaluation period: 7 h 37 min)		
Indices	**-**	**Normal**
AHI*	68.8	<5/h
RI*	72.4	<5
Apnea Index	66.3	<5/h
UAI	0	-
OAI	66.1	-
CAI	0.1	-
MAI	0.1	-
Hypopnea Index	2.5	<5/h
% Flow lim. Br. without Sn (FL)	25	<Approx. 60
% Flow lim. Br. with Sn (FS)	14	<Approx. 40
ODI Oxygen Desaturation Index*	65	<5/h
Average Saturation	88	94-98%
Lowest Desaturation	67	-
Lowest Saturation	67	90-98%
Baseline Saturation	92	%
Minimum Pulse	40	> 40 bpm
Maximum Pulse	94	< 90 bpm
Average Pulse	64	bpm
Proportion of Probable CS Epochs	0	0%
Result	-	-
Average Breaths Per Minute [bpm]	9.01	
Breaths	4190	
Apneas	-	514
Unclassified Apneas	0 (0%)	
Obstructive Apneas	512 (100%)	
Central Apneas	1 (0%)	
Mixed Apneas	1 (0%)	
Hypopneas	-	19
Flow lim. Br. Without Sn (Fl)	1051	
Flow lim. Br. With Sn (FS)	572	
Snoring Events	4204	
No. of Desaturation	495	
Saturation ≤ 90%	311 min (68%)	
Saturation ≤ 85%	132 min (29%)	
Saturation ≤ 80%	46 min (10%)	

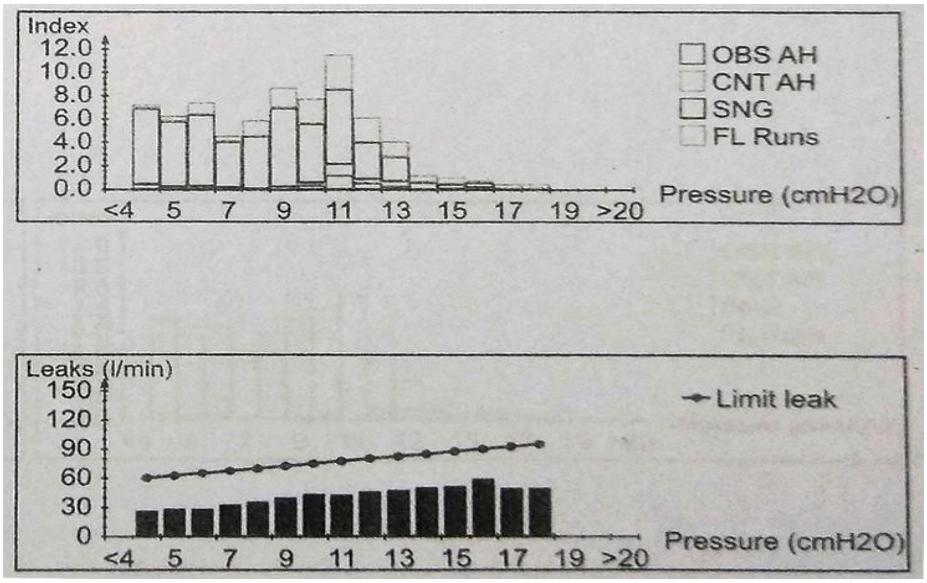

Fig. (2). CPAP polysomnography demonstrating reversal of AHI score to normal levels. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

Table 4. A 24-h Holter ECG after treatment with CPAP shows marked improvement in terms of correction of cardiac arrhythmias.

Heart Rate Date			
Total Beats	123593		
Min HR	53 BPM at 01:21:06 AM		
Avg HR	86 BPM		
Max HR	120 BPM at 01:27:03 PM		
Heart Rate Variability			
ASDNN 5	37.1 ms		
SDANN 5	76.2 ms		
SDNN	85.0 ms		
ST Episode Analysis			
-	Ch1	Ch2	Ch3
Min ST Level	-	-	-
Max ST Level	-	-	-
ST Episodes	-	-	-
Pacer Analysis			
Single Paced Beats	0 (0.0%)		
Dual Paced Beats	0 (0.0%)		
Fusion Beats	0 (0.0%)		
Atrial Fibrillation			
AFib Beats	0 (0.0%)		
Duration	0.0 min Events: 0		

(Table 4) Contd…

Ventricular Ectopy	
Total VE Beats	0 (0.0%)
Vent Runs	0
Beats	0
Longest	0
Fastest	0 BPM
Triplets	0 Events
Couplets	0 Events
Single/Interp PVC	0/0
R on T	0
Single/Late VE's	0/0
Bi/Trigeminy	0/0 Beats
Supraventricular Ectopy	
Total SVE Beats	6 (0.0%)
Atrial Runs	0
Beats	0
Longest	0
Fastest	0 BPM
Atrial Pairs	0 Events
Drop/Late	0/4
longest N-N	*1.3 s at 03:29:30 PM*
Single PAC's	2
Bi/Trigeminy	0/0 Beats

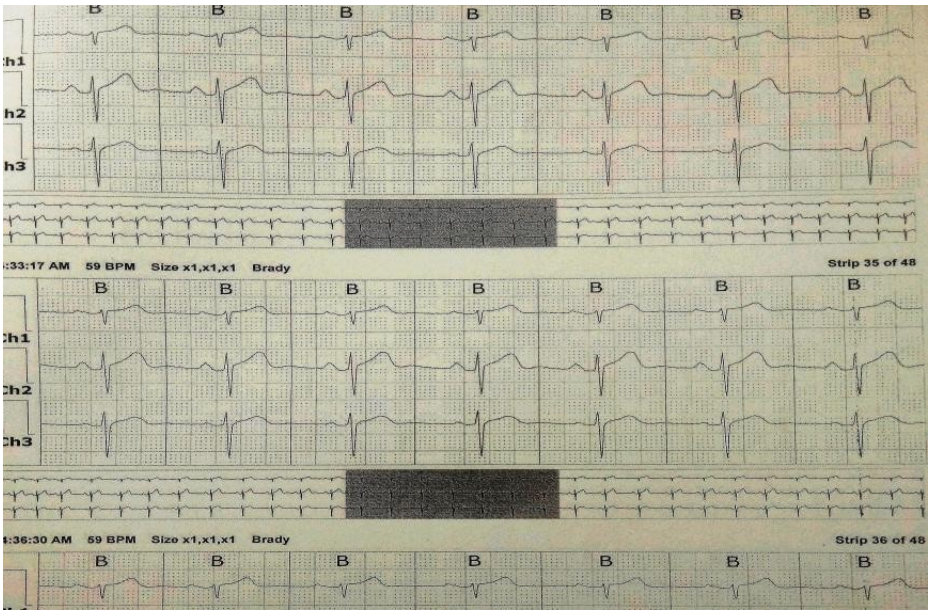

Fig. (3). Holter ECG showing absence of sinus pauses while the patient is on CPAP. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

The air is constantly flowing inside the airways so that continuous pressure is maintained to keep the airways open *via* CPAP [15]. All the breaths of a patient in CPAP are self-initiated, and no additional pressure is provided above the set level. CPAP is delivered through several methods, such as nasal CPAP, nasopharyngeal CPAP, and face mask [16]. A combination treatment of CPAP and surgery has been applied to lose weight as a part of the treatment of severe OSA.

Polysomnography is a conglomerate of various items, such as electroencephalography, electromyography (submental), electrocardiography, electrooculography, pulse oximetry, respiratory movement or respiratory effort, and electromyography of limb movement used to calculate the AHI [17, 18]. In Holter ECG monitoring, a patient is connected to 3–5 ECG electrodes, which gives 2 ECG vectors and a third derived ECG. The patient has to maintain a diary to note down the exact time and description of symptoms occurring during this period to correlate with the Holter findings. A Holter machine detects the average heart rate, atrial fibrillation, different ectopic heartbeats and their exact duration, the longest pause, and the exact time [19]. A previous study of 23 patients with OSA used CPAP and showed a marked improvement in severe nocturnal cardiac abnormalities. It also revealed that loop-recorders pick up these disturbances much more effectively than Holter ECG monitoring [20].

According to the guidelines set by the American College of Cardiology/American Heart Association Task Force on Practice Guidelines 2008 for device-based therapy, the pacing is indicated for symptomatic bradycardia or frequent sinus pauses. Additionally, a class-1 indication for pacing in asymptomatic and awake individuals-those with sinus pauses extending over 3 s or >5 s in the case of atrial fibrillation was observed. Nocturnal arrhythmias are detected in 50% of patients with OSA. It is often speculated that bradycardias and sinus pauses induced by OSA are a part of the "diving reflex," during which the lack of oxygen stimulates a cardiac parasympathetic response and simultaneously causes peripheral vasoconstriction, which is induced sympathetically. Physiologically, the ACC/AHA guidelines recommend pacing only in patients with prolonged asymptomatic pauses occurring during wakefulness. Interestingly, in another case study, a similar scenario occurred where the need for pacing was terminated after discovering that the long asymptomatic pauses occurred only while sleeping. A majority of patients with severe OSA exhibit cardiac arrhythmias that are markedly reduced by CPAP. Holter ECG monitoring could not describe these bradyarrhythmias [21].

This clinical case proves that the recent guidelines are critical, and it also avoided the implantation of pacemaker in the event of asymptomatic pauses, thereby prompting further investigation. Therefore, the patient obtained maximum benefit from the CPAP therapy, which terminated the long pauses noted in ECG, postponing the need for a pacemaker.

LIST OF ABBREVIATIONS

ACC	=	American College of Cardiology
AHA	=	American Heart Association
AHI	=	Apnea-Hypopnea Index
BMI	=	Body Mass Index
CPAP	=	Continuous Positive Airway Pressure
ECG	=	Electrocardiogram
HbA1c	=	Glycosylated Hemoglobin
OSA	=	Obstructive Sleep Apnea
SpO_2	=	Capillary Oxygen Saturation

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

STANDARD OF REPORTING

CARE guidelines and methodology were followed in this study.

CONSENT FOR PUBLICATION

Written informed consent of the patient was taken prior to submission.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

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