SHORT COMMUNICATION

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The importance of sleep apnea index determination using 24 h ECG analysis in patients with heart rhythm disorders

Značaj određivanja indeksa apneje u snu analizom holter EKG-a kod bolesnika sa poremećajima srčanog ritma

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Abstract

Background/Aim. A possible cause of malignant heart rhythm disorders is the syndrome of sleep apnea (periodic cessation of breathing during sleep longer than 10 seconds). Recent 24h ECG software systems have the option of determination ECG apnea index (AI) based on the change in voltage of QRS complexes. The aim of the study was to determine the significance of AI evaluation in routine 24-hour Holter ECG on a group of 12 patients. **Methods.** We presented a total of 12 consecutive patients with previously documented arrhythmias and the history of breathing disorders during night. They were analyzed by 24 h ECG (Medilog AR 12 plus Darwin), that is able to determine AI. **Results.** We presented a case series of 12 patients, 8 men and 4 women, mean age 58.75 years and the average AI 5.78. In the whole group there was a trend of increasing prevalence of complex rhythm disorders with increasing of AI and increased frequency of arrhythmias in the night phase *vs* day phase. **Conclusion.** Determination of AI using routine long term (24 h) ECG analysis is important because sleep apnea can be successfully treated as an etiological or contributing factor of arrhythmias.

Key words:
sleep apnea syndromes; arrhythmias, cardiac; electrocardiography, ambulatory.

Apstrakt

Uvod/Cilj. Jedan od mogućih uzroka malignih poremećaja ritma srca na koji se ne obraća dovoljno pažnja je sindrom poremećaja disanja u toku spavanja poznat kao *sleep apnea* (periodični prekid disanja u toku spavanja duži od 10 sekundi). Noviji softverski sistemi holter EKG-a imaju mogućnost određivanja apneja indeksa (AI) na osnovu promene voltaže QRS kompleksa. Cilj ovog rada bio je utvrđivanje značaja određivanja AI u rutinskoj analizi holter EKG-a na uzorku od 12 bolesnika. **Metode.** Prikazana je grupa od 12 uzastopnih bolesnika sa prethodno dokazanim aritmijama i istorijom poremećaja disanja tokom noći. Svi su bili podvrgnuti 24 h holter EKG analizi (Medilog 12 plus Darwin) koja omogućava određivanje AI. **Rezultati.** Prikazali smo seriju od 12 bolesnika, 8 muškaraca i 4 žene, prosečne starosti 58,75 godina i prosečnog AI od 5,78. U celokupnoj grupi postojao je trend povećanja učestalosti kompleksnih poremećaja ritma sa povećanjem AI i učestalosti aritmije u noćnoj fazi u odnosu na dnevnu fazu. **Zaključak.** S obzirom na mogućnost lečenja apneje u snu kao etiološkog ili doprinosećeg faktora u nastanku i pogoršanju aritmija, određivanje AI rutinskom primenom holter EKG-a od velikog je značaja.

Ključne reči:
apneja, spavanje poremećaji, sindromi; aritmija; elektrokardiografija, ambulantna.

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Introduction

A possible cause of malignant arrhythmias that is often forgotten is a syndrome of breathing disorders during sleep, known as sleep apnea [1]. Besides, arrhythmias sleep apnea is a potential cause of many adverse cardiovascular events such as myocardial ischemia, and hypertension. Sleep apnea is defined as periodic interruption of breathing during sleep longer than 10 seconds. Hypopnea in adults is characterized by drop of nasal pressure at least 30% (compared to the basal state), of at least, 10 seconds associated with oxygen desaturation of ≥ 4%. Apnea index (AI) is the number of these episodes (apnea and hypopnea) *per* hour of sleep.

lation, although there is evidence that in the population of patients with atrial fibrillation the incidence of OSA is higher than in the general population [5]. In addition, a high incidence of recurrent atrial fibrillation was documented in the first year after cardioversion in patients with sleep apnea who were not treated with Continuous Positive Airway Pressure (CPAP) [6].

The newer software systems of long term ECG (12-channel ECG recording) have the option of determining the apnea index based on changes in QRS voltage that changes due to minimal changes in the axis of the heart that occur during respiration/breathing interruptions, known as ECG derived respiration signal (EDRF) (Figures 1 and 2).

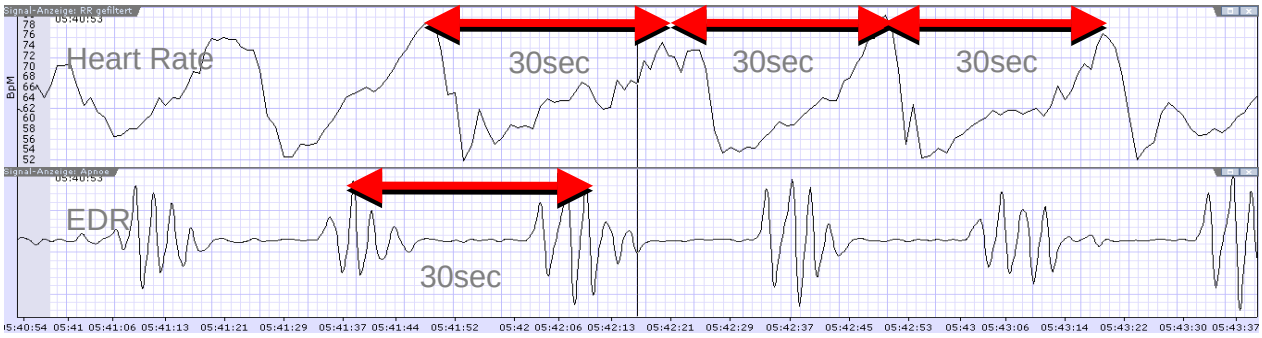

Fig. 1 – Episodes of apnea occur periodically leading to significant fluctuations of the heart rate. The length of these oscillations correlates with the period of time from one to the next apnea on the presented electrocardiogram (ECG) derived respiration (EDR) signal.

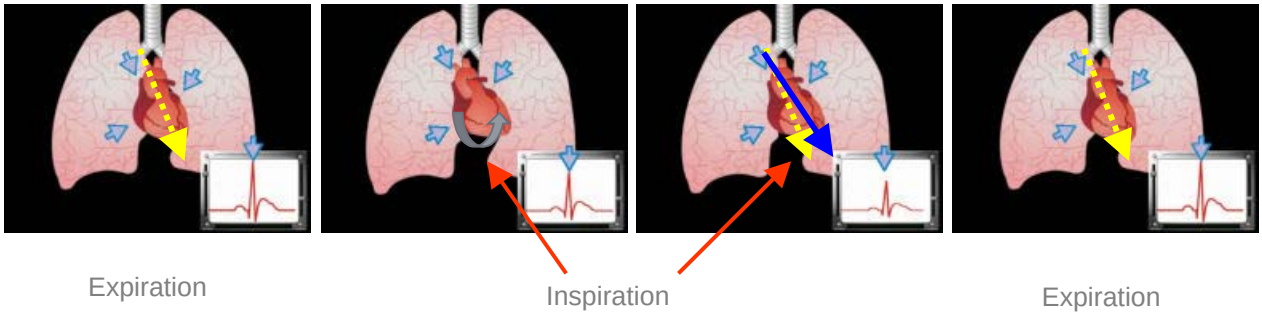

Fig. 2 – The heart is slightly raised and moves during inspiration and expiration flow related to a fixed position of the electrodes.

There are two main types of sleep apnea: obstructive sleep apnea (OSA), which occurs when the throat muscles collapse, due to different functional disorders of nose, use of sedatives, short neck, obesity; and central sleep apnea (CSA) the brain does not send proper signals to the muscles that control breathing.

Polysomnography is the gold standard in the diagnosis of sleep apnea in specialized laboratories. It is expensive and requires training staff and in our country is rarely used, only in scientific purposes.

The percentage of rhythm disorders caused by apnea is significant [2]. Guilleminault at al. [2] in the long term ECG analysis found that 3% of the 400 patients with OSA had atrial fibrillation [3, 4], which is significantly higher comparing the prevalence of atrial fibrillation in the general popu-

During episodes of interrupted breathing, heart rate compensatory increases and that period of heart rate oscillation correlates with the period of time from one episode to the next episode of apnea of EDRF signal (Figure 3).

Small changes of the vector result in very small changes in ECG amplitudes of a few μV which is possible to be recorded by the high resolute 24h ECG devices.

That is why a simple and inexpensive examination by 24 h ECG (comparing to the specialized respiratory laboratories) may be used as screening test for patients with breathing disorders during sleeping. This may improve etiologic treatment of arrhythmias, without unnecessary or improper use of antiarrhythmic drugs even implantation of pace-maker devices.

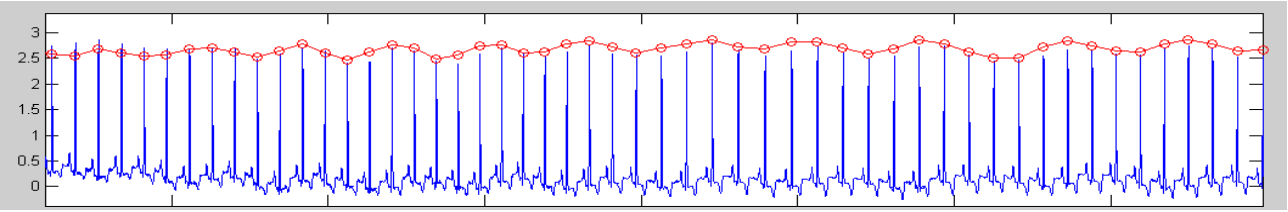

Fig. 3 – Heart rate compensatory increases during the episodes of interrupted breathing.

Methods

We presented a total of 12 consecutive patients with previously documented arrhythmias and history of breathing disorders during night. They were analyzed by 24 h ECG, (Medilog AR 12 plus Darwin), that is able to determine AI. The study group consisted of 8 men and 4 women aged from 42 to 65 years, average 58,75 years. The average AI was 5,78 (min AI = 0 , max AI = 18).

There was an increase in the incidence of complex rhythm disorders with an increase of AI (except for the patient ID 12, who had 78 episodes of pauses), and increase in the incidence of all kinds of arrhythmia during the night comparing with the the day phase. Concerning the previous data in the literature [6] that symptomatic patients with AI >5 are candidates for treatment with CPAP, and patients with AI > 20 have the absolute indication for administration of CPAP, we divided our patients into two groups, the group I = AI < 5 and the group II = AI > 5. In the group II (with breathing disorders during sleeping) all the patients (100%) were men, with hypertension and smoking habit, data that "they stop breath during the sleep", and 60% were obese according to body mass index (BMI). Also, 80% in this group met criteria for metabolic syndrome (Table 1).

Concerning complex rhythm disorders in the group I we found 42% of the patients with this arrhythmia (Lawn III, IV or V class) *vs* 80% patients in the group II. All the patients in the group II had more than 50% episodes of arrhythmia during the night phase. In the patients with AI > 15 we detected pauses of more than 2 s and their number was in correlation with AI (Table 2).

We selected and presented the patient ID 7 from the group I, with AI = 2.29, and arrhythmias by the Lawn classification IV, 2,700 premature ventricular complex (PVC). The

Table 1

Apnea index (AI), rhythm disorders and heart rate variability in the study population

ID	AI	Pause	Tachycardia	VES	Night arrh %	CI	SDNNi	SDANNi	Qtcdisp
1	0	0	0	L3	0	1.21	87.0	172.1	511
2	0.29	0	0	0	0	0.95	32.2	90.2	303
3	0.29	4	1	L1	0	1.30	62.7	136.7	284
4	0.71	3	3	L4	0	1.36	40.5	124.2	344
5	1,57	0	0	0	0	0.93	27.3	85.7	434
6	2.0	7	6	0	0	1.11	119.6	211.6	601
7	2.29	0	0	L4	80	1.35	67.5	137.2	458
8	5.29	0	0	L3	62	0.88	42.6	84.4	383
9	8.0	0	0	L4	52	1.23	106.9	75.2	717
10	15	5	0	L5	68	1.19	60.0	84.0	413
11	16	27	0	L4	73	1.09	56.1	98.6	416
12	18	78	2	0	89.7	1.24	88.6	47.1	787

ID – patient's identification number; CI – circardial index; VES – ventricular extrasystoles; Qtcdisp – Qtc disperzion; SDNNi – average value of all standard deviation PR interval; SDANNi – standard deviation of all the average values.

Table 2

Main characteristics of the study group

ID	Gender	Age (year)	BMI	Msy	Smoking	HTA	SAH	DN
1	F	64	1	0	0	0	0	0
2	F	51	0	1	0	1	0	0
3	M	42	0	0	0	0	0	0
4	F	53	1	1	1	1	0	0
5	F	55	0	1	1	1	1	1
6	M	69	1	0	1	1	1	1
7	M	42	0	1	0	1	1	0
8	M	54	1	0	1	1	1	0
9	M	66	0	1	1	1	1	1
10	M	73	0	1	1	1	1	1
11	M	58	1	1	1	1	1	1
12	M	78	1	1	1	1	1	1

ID – patient's identification number; BMI – body mass index, 1 > 0.25 kg/m^2;
Msy – metabolic syndrome; SAH – history of cessation of breathing at night;
DN – information on the deviation of the nose; F – female; M –male.

patient had 80% of complex arrhythmia episodes recorded in the night phase in the periods of breathing cessation (Table 2). The patient had the history of viral myocarditis a year ago when 24 h ECG was also performed using standard 24 h ECG (it was recorded PVC 5100, Lawn 4, but without the possibility of determining the AI). All the signs of myocarditis on this control check up were negative (clinical, laboratory and echocardiography findings), and VES might be induced not only by viral myocarditis. This patient also gave information about deviation nose which may be a predisposing factor for the development OSA. He was overweight, not a smoker, blood pressure values were slightly higher in the morning hours to a maximum of 150/90 mmHg without treatment. He was referred to additional throat examination and operative correction.

We also presented the patient ID 12 from the group II, with 78 episodes of OSA type block longer than 2.0 seconds and Mobitz type I and II [70 (89.7%) episodes in the night phase] (Figure 4). This patient was obese, excessive smoker with a large-scale neck, unregulated hypertension, morning headaches, disorientation and fatigue. Echocardiography showed slightly impaired global systolic function, diastolic dysfunction grade II. Hypertension was treated using angiotensin-converting enzyme (ACE) inhibitors and calcium antagonists.

The patients with AI > 5 were advised to perform polysomnography, but we have not been able to perform it.

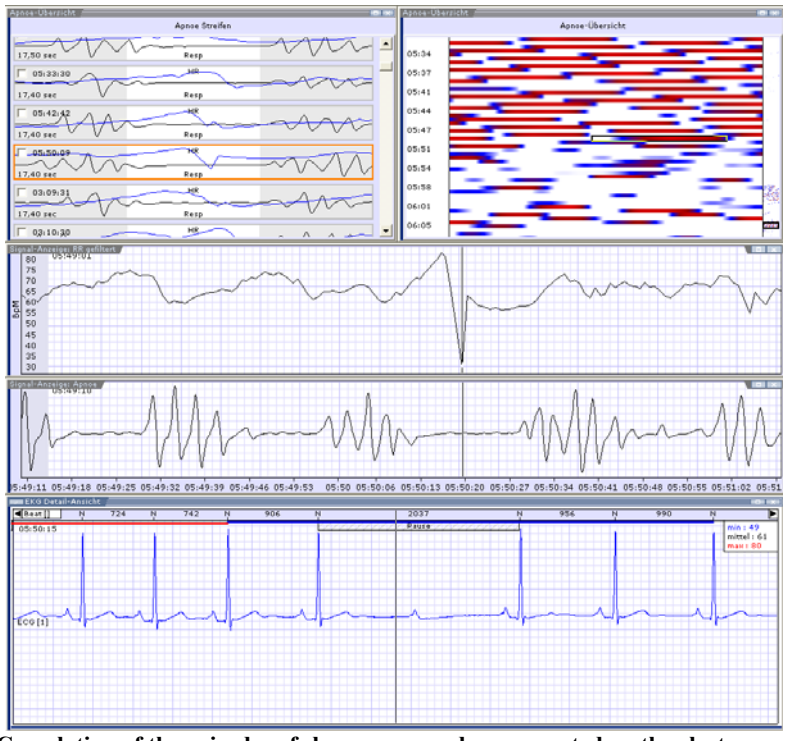

Fig. 4 – Correlation of the episodes of sleep apnea and pauses noted on the electrocardiogram.

Discussion

Sleep apnea is a disorder that in many ways diminishes the quality of life of patients and increases cardiovascular morbidity and mortality [7]. The literature rather analyzes the phenomena of cardiovascular events in patients with breathing disorders. The obstructive sleep apnea is associated with several heart diseases, most notably hypertension, ischemic heart disease, heart failure, stroke, rhythm disorders and pulmonary hypertension [2]. Our study included patients with both history of breathing disorders during night and rhythm disorders. We tried to determine if abnormal breathing during sleep was a contributing factor for arrhythmias.

Ventricular arrhythmias show circadian rhythm with the highest incidence of occurrence of midnight (0 h) to 6 h in the morning. This could be one of the reasons for the increased incidence of ventricular arrhythmias in patients with OSA, although increased oxygen desaturation during OSA is certainly a contributing factor [8].

The predisposing factors for sleep apnea are: obesity, hypertension, broad neck (short, thick neck), narrow airways, smoking [9]. People with this disorder often snore at night and have elevated blood pressure during the night and early morning, morning headaches, depression, memory problems. Data from the literature suggest that these noncardiac manifestations can lead to sudden cardiac death, because patients with sleep apnea are sleepy during the day phase, have loss of concentration and, therefore, have an increased incidence of traffic accidents [10]. All the presented patients in this study had all of the above predisposing factors (smoking, obesity, metabolic syndrome and hypertension). The consequences in terms of daily loss of concentration and sleepiness had only patient ID 11 and ID 12 in which the AI > 15, which is consistent with literature data.

Sleep apnea is associated with prolonged episodes of hypoxemia which triggers the reflex similar during drowning. This reflex has a duty to preserve oxygen to the vital or-

gans, the brain and the heart, reducing blood flow to the periphery which consists of sympathetic vasoconstriction (reflected in the periphery) and the vagal response that affects the heart. Effects on the heart are various conduction disorders that occur in patients with OSA [8, 10] such as sinoatrial block, sinus arrest, AV conduction disorders, even asystole. It has been shown that these patients have no structural and anatomical changes in the conduction system and rhythm disorders were the result of increased parasympathetic tone due to hypoxemia. These conduction abnormalities are reversible and disappear after the use of CPAP [8]. These bradyarrhythmias, SA and AV conduction abnormalities and ventricular premature beats and complex type of atrial fibrillation may predispose and lead to sudden cardiac death. This risk is increased in patients with associated risk factors for cardiovascular events, so detection of breathing disorders in these patients could be the obligatory diagnostic procedure, if technically possible. Since the presented group was a random sample of patients who came to perform 24 h ECG due to arrhythmias, complex ventricular arrhythmias were more common than pauses (higher incidence in the literature), but the patients ID 11 and ID 12 with AI > 15 had recorded a significant number of pauses which occurred during periods of apnea consistent with previous research [11–13].

In the previous studies the heart rate variability (HRV) showed that HRV was expressed in the severe cases of OSA. On the contrary, in patients with milder degrees of OSA, in patients who take amiodarone, sotalol, propafenon, nebivolol, bisoprolol and very elderly people with "rigid heart rhythm", HRV was not pronounced [14, 15]. In our study, there were no statistically significant difference in parameters of HRV, also.

This pilot study showed the significance of determining AI in patients with rhythm disorders in order to establish cause and determine further diagnosis and treatment. In fact people with AI > 5 are referred for further diagnostic of sleep apnea. Also, we advise them to correct habits of living, reduce and/or eliminate use of medications that predispose manifestation of respiratory distress (sedatives), and to visit the throat specialist to correct existing anomalies. If sleep apnea is confirmed in the specialized laboratory, than the application of CPAP will be the best form of treatment for arrhythmia and apnea.

Standard cardiorespiratory monitoring is complex including: nasal airflow, measurement of saturation (pulse oxygen meter), determination of HRV and determination of "respiratory movements". Laboratories for cardiorespiratory monitoring and polysomnography in our country are not available in routine clinical practice due to methods complexity, the need for special equipment and high costs of treatment.

Unfortunately, there are no studies on a large number of patients that compared the results of classical polysomnography 24 h ECG with respiratory monitoring. But the available literature data suggest that the sensitivity and specificity of this method in determining of sleep apnea are satisfactory [16, 17].

Conclusion

The conclusion of this pilot study is that respiratory analysis of apnea index by appropriate 24 h ECG is precious in patients with arrhythmias, as well as in the group of patients with suspected breathing disorders during sleep, as primary screening of patients with sleep apnea and dynamic screening of patients who are treated with CPAP. Further investigations by the cardiologists in our country in this field are necessary.

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