AN EXAMINATION OF THE CHANGE IN DISTRIBUTION AND INTENSITY OF SNORING SIGNALS ACCORDING TO SLEEP STAGES IN APNEA PATIENTS

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Abstract: **In this study, the distribution and intensity of snoring episodes due to sleep stages were examined. For this goal, sound records of apnea patients were taken synchronously with polysomnography. These sound records were taken during a whole night in Gülhane Military Medical Hospital Sleep Studies Laboratory. It is found that, the distribution of snoring episodes increases in stage 3 whereas there is not a remarkable change in the intensity of snoring episodes.**

I. INTRODUCTION

Physiological definitions

Sleep is defined as the temporary partial loss of interaction of the organism with environment for a period.

Snoring is the respiration sound generated from vibration of upper breathing pathway during sleep. It is determined that snoring is a risk factor in appearance of systemic arterial hipertension, sleep disorders and several diseases [1].

According to the snoring, some people face with pauses of respiration in their sleep. This serious situation emerges from slack tissues in throat which close the air pathway. Apnea is defined as the pausing of respiration in sleep more than 10 seconds[2]. As a result of cancellation of respiration, organism's oxygen amount reduces and the one carbondioxide increases. These changes force person to wake up and generally air pathway is tried to open with a loud snoring.

Obstructive sleep apnea is known as absence of air flow in mouth and nose while there is a breathing effort[2]. Patients who have sleep apnea, cancellation of respiration may vary from 5 to 30 in an hour. The studies to detect the reasons of occurence of apnea is ongoing. Recently, there are lots of researches done to understand the relationship between snoring and obstructive sleep apnea syndrome(OSAS)[3]. Therefore, analysis of snoring sounds is an effective method to determine the other respiration disorders which are related with pathologies such as obstructive sleep apnea or upper breathing pathway resistance syndrome. For this purpose, snoring sounds' intensity and distribution analysis, their spectral and waveform investigations are having been studied [4,5].

Sleep Stages

Sleep consists of two parts and five stages. The two parts are REM and NREM. Also NREM is divided into 4 parts which are stage1, stage2, stage3 and stage4. These substages refer to the deepness of the sleep. For instance; in sleep stage4, the deepest sleep is observed whereas in stage1, it is said that sleep is more sensitive.
REM stage forms % 20 of the night sleep. The most important function of the REM sleep is that during this stage membrane stabilization occurs in neurons. In REM stage, it is easy to wake the person up. Dreams are also mostly seen in REM sleep.

Polisomnography

Polisomnography (PSG) is the general name given for the techniques and recordings which are used in sleep laboratories to detect sleep disorders. During sleep, patient's nearly all biomedical signals are recorded which are neurophysiological , respiratory, cardiovascular and other physiological parameters. For every 30 seconds polisomnpgraphy gives a sleep stage information.

Motivation

As mentioned above, sleep has has a definite structure and some stages. The distribution of these stages to a whole night sleep and their time durations are the basic factors effecting sleep disorders. On the other hand, snoring is not independent from sleep stages. So, how snoring effects sleep structure, how the distribution of snoring episodes is and snoring intensities due to the sleep stages should be investigated.
In this study, the distribution and intensity of snoring spisodes according to the sleep stages are taken as a purpose to explain how snoring effects sleep structure. All sound and PSG recordings are taken from apnea

patients in Gülhane Military Medical Academy Sleep Laboratory.

II.METHOD

For this study, the sound recording are taken by a sensitive intensifier microphone which is Sennheiser ME 64. This microphone has a frequency response of 40-20000 Hz ± 2.5 dB. In order to prevent the echos from the environment, the microphone has a cardioid pattern. Microphone is placed 15 cm above the patient's head. Signal is transferred to Edirol UA-1000 model data acquisition system by BNC cables. Then, data is saved to a personal computer. In order to reduce the noise ratio in recordings, the computer is placed out of the recording room. The sampling frequency of the signal is 16 KHz and it is coded by 16 bits.

In Figure-1, a snoring signal taken from an OSAS patient which has a duration of 20 seconds is shown.

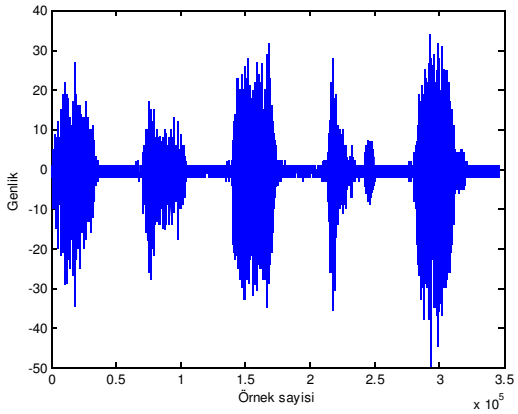

Figure 1 20 seconds duration snoring signal

Detection Of Snoring Episodes

In order to detect each snoring episode, Principal Component Analysis method based acoustic system desing is performed[6,7]. During a night sleep, system detects the snoring episodes from the recorded sound signal and rejects the unwanted waveforms.
In this study, 10 OSAS patients are examined, but for a more sensitive study this number will be increased.

In Figure-2 the interface of the designed system is shown.

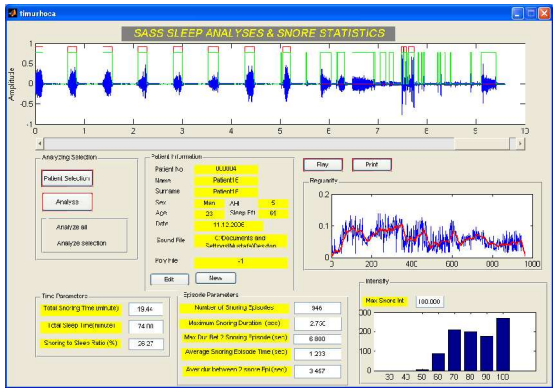

Figure 2 The Interface of the Designed System

III.RESULT

In order to examine the distribution and intensity of snoring episodes according to the sleep stages, synchronous sound recordings are taken with polisomnography and for each stage, 10 patients' average snoring episodes and intensities are plotted. In Figure-3 and Figure-4, these plots are shown. Also, in Figure-5 normalized distribution of snoring episodes are shown.

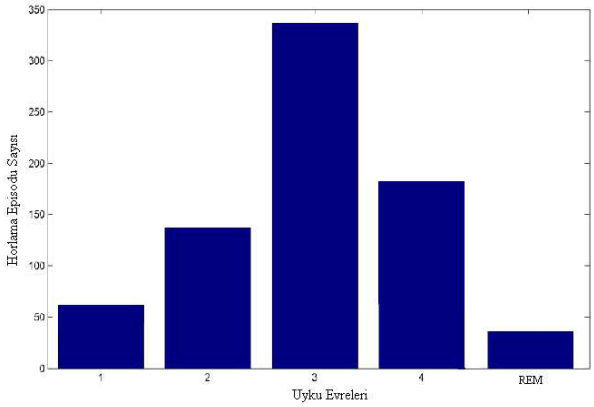

Figure 3 The distribution of snoring episodes according to the sleep stages

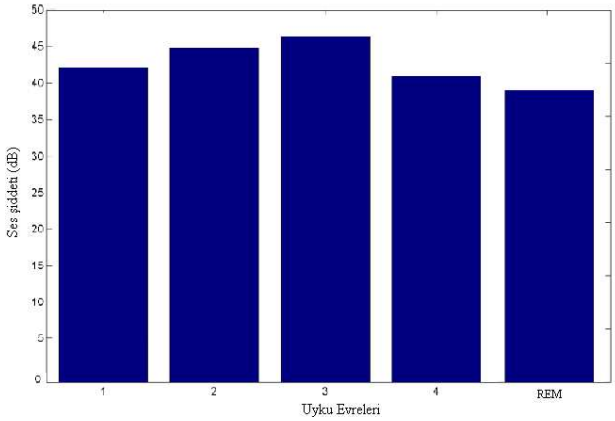

Figure 4 The distribution of snoring episodes' intensities according to the sleep stages

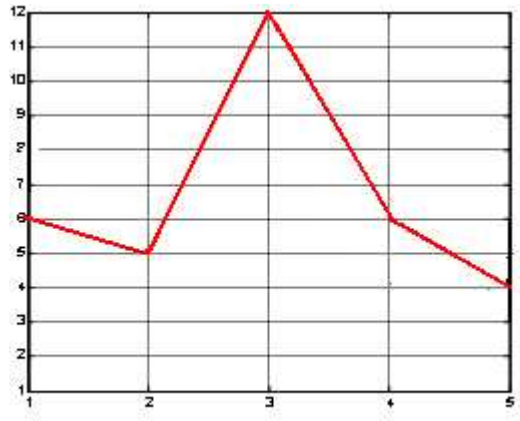

Figure 5 The normalization distribution of snoring episodes with the duration of sleep stages

IV.DISCUSSION

When snoring episodes' distributions according to the sleep stages are examined, it is seen that snoring episodes increase with deep sleep. Deep sleep beginning called NREM stage 3 has more snoring episodes than the stages NREM 1-2-4 and the stage REM. After normalization of the distribution of snoring episodes with the duration of sleep stages, it is seen that again in sleep stage NREM-3 there is a concentration of snoring episodes. This can be interpreted that by passing to the deep sleep, the decrease in muscle tone reaches its maximum and the slackness of the tissues that cause snore increases.

This situation also resembles to an increase in apnea/hipopnea index (AHI) in stage-3. The incresing slackness of the tissues results in a cancellation of air pathway and also apnea. Snoring sounds' intensities do not change dramatically in each sleep stage. This situation shows that, the basic factor which determines the intensity of the snore is not caused by slackness of tissues. It is thought that the reason is upper respiration pathway pressure.

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