

# Evaluation of Chin EMG Activity at Sleep Onset and Termination in Obstructive Sleep Apnea Syndrome

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## Abstract

*Chin EMG is traditionally used for polysomnographic assessment of sleep stages. The aim of this study was to evaluate whether chin EMG shows significant differences between normal and OSA groups in wakefulness and sleep.*

*Chin EMG was collected as part of the polysomnographic data for eighteen normal and twenty severe OSA subjects. For each subject, four time windows at sleep onset and termination were selected and four parameters were computed: the mean power, the maximum power, the maximum-power frequency, and the median frequency. The mean power was significantly higher in the OSA group ( $7.5 \pm 3.9$ ) than the normal group ( $2.0 \pm 2.4$ ) in the S2 window ( $p < 0.00002$ ). It was also significantly higher in the OSA ( $19.8 \pm 10.5$ ) group than the normal group ( $8.8 \pm 6.3$ ) in the W2 window ( $p < 0.005$ ). Evaluation of Chin EMG power might be a quick and cheap method for OSA screening.*

## 1. Introduction

Chin EMG is one of the polysomnographic data collected in sleep labs. In standard polysomnogram, the recording of chin muscle activity is used as a criterion for staging rapid eye movement (REM) sleep [1]. During REM sleep, Chin EMG drops to its lowest level which reflects an inhibitory influence on motor activity and loss of muscle tone. Also, Chin EMG shows increase in its amplitude during arousals [2]. To record Chin EMG, an electrode placed over the mentalis is referenced to an electrode placed either directly below the chin (submentalis) or slightly off to the side. Chin muscles are close to the Geniohyoideus (GH) and Genioglossus (GG) muscles which are pharyngeal dilator muscles. These muscles play an important role in maintaining upper airway patency during the inspiration cycle.

It has been shown that obstructive sleep apnea (OSA) patients when compared with normal cases have augmented GG activity during wakefulness [3]. This activity is thought to represent a neuromuscular compensatory mechanism of compromised upper airway

patency. This augmented upper airway dilator muscle activity is lost at sleep onset and is associated with pharyngeal collapse [4], [5]. However, marked upper airway muscle activity was still present during sleep in some (especially severe) OSA patients [5].

The goal of this work is to evaluate whether chin EMG, considered as a noninvasive way for measuring upper airway EMG activities, shows significant differences between normal and OSA groups in wakefulness and sleep.

## 2. Methods

Chin EMG signals for eighteen normal (obstructive apnea hypopnea index, OAHl, = 0) and twenty severe OSA subjects (OAHl=  $58.0 \pm 12.9$ ) were available from The Sleep Heart Health Study (SHHS) [6]. The EMG signals were originally sampled at 125Hz. Four three-minute windows of the EMG were selected at sleep onset and termination. The first window, W1, contains the last three minutes of Chin EMG just before falling into sleep. The second window, S1, contains the first three minutes of EMG just after falling into sleep. The third window, S2, contains the EMG immediately before the final wakefulness, and the fourth window, W2, contains the EMG immediately after the final wakefulness of the night. For each of these windows, the periodogram of every 5 seconds was computed and the averages of four parameters were extracted from all the subjects. These parameters were: the mean power (Pmean), the maximum power (Pmax), the maximum-power frequency (Fmax), and the median frequency (Fmed).

## 3. Results

The mean  $\pm$  std of all the four parameter during the four time windows for the normal and the OSA groups are shown in Table 1. Using one-way ANOVA test, Pmean was significantly higher in the OSA group than the normal group during S2 and W2 windows with  $p < 0.00002$  and  $p < 0.005$  respectively. Both groups had their lowest Pmean at S2 while the OSA group had its highest Pmean at W2. The other three parameters did not

show significant differences between the two groups.

Figure 1 and Figure 2 show the average mean-EMG power of the 5-second segments in the last minute of S2 and the first minute of W2 windows for both the normal and the OSA groups. The average EMG power of the OSA group was greater than the normal group in every 5-second segment. Also, the EMG power for both groups was higher in W2 than S2.

The EMG power of the OSA patients jumped to high values at the last 10 seconds of S2 and continued to rise in the first 15 seconds of W2 before dropping to relatively lower values. The normal EMG power however, gradually increased in the last 15 seconds of S2 up to around middle of the first minute of W2 then, started to decrease.

Table 1. Chin EMG power parameters at sleep onset and termination for the normal and the OSA groups

Normal Subjects				
Window	Pmean (µW)	Pmax (µW)	Fmed (Hz)	Fmax (Hz)
W1	13.6± 14.8	185.1± 188.0	32.6± 1.9	26.3± 13.0
S1	12.5± 14.2	169.6± 185.6	32.1± 1.9	24.1± 14.0
S2	2.0± 2.4*	85.8± 180.0	29.1± 2.5	19.5± 13.2
W2	8.8± 6.3†	382.9± 1131.5	32.3± 1.6	29.6± 12.6
OSA Patients				
Window	Pmean (µW)	Pmax (µW)	Fmed (Hz)	Fmax (Hz)
W1	13.6± 12.0	224.7± 375.5	31.3± 3.8	26.9± 12.8
S1	16.4± 11.7	249.8± 364.6	31.8± 4.3	30.0± 11.5
S2	7.5± 3.9*	190.0± 391.0	29.5± 3.5	20.1± 12.7
W2	19.8± 10.5†	351.7± 440.0	31.5± 3.0	22.2± 12.8

\* Significantly different,  $p < 0.00002$ .

† Significantly different,  $p < 0.005$ .

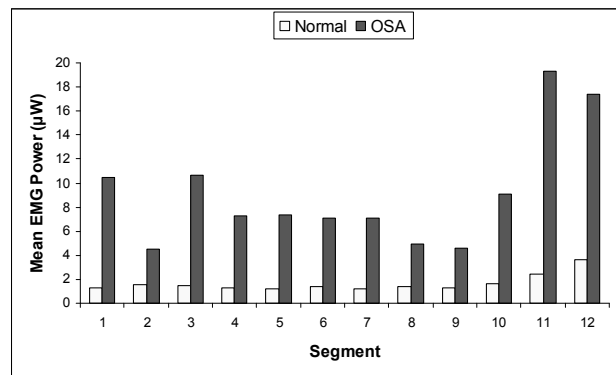


Figure 1. Mean EMG power of the 5-second segments in the last minute of S2.

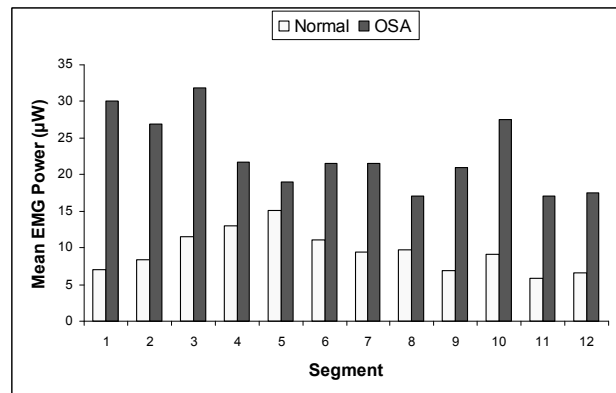


Figure 2. Mean EMG power of the 5-second segments in the first minute of W2.

#### 4. Discussion and conclusions

Chin EMG was significantly higher in sleep apnea patients than normal subject at sleep termination. Furthermore, to eliminate the effect of REM sleep on Chin EMG power, subjects with REM sleep in S2 were removed from both groups. The mean EMG power of the OSA patients ( $2.6 \pm 2.7$ ) was still significantly higher than the normal group ( $7.7 \pm 3.7$ ) with  $p < 0.001$ . This finding is consistent with the previous results that showed OSA patients having higher upper airway muscle activities than normal subjects in wakefulness [3]. Evaluation of Chin EMG power might be a quick and cheap method for OSA screening. Further analysis of Chin EMG activity between the two groups is required.

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## References

- [1] Castronovo VE, Butkov N. Sleep stages and sleep architecture. In: Butkov N, Lee-Chiong T, editors. *Fundamentals of sleep technology*, Philadelphia: Lippincott Williams & Wilkins, 2007;280-99.
- [2] Smurra MV et al. Sleep fragmentation: comparison of two definitions of short arousals during sleep in OSAS patients. *Eur Respir J* 2001;17:723-7
- [3] Mezzanotte WS, Tangel DJ, White DP. Waking genioglossal EMG in sleep apnea patients vs. normal controls (a neuromuscular compensatory mechanism). *J Clin Invest* 1992;89:1571-9
- [4] Mezzanotte WS, Tangel DJ, White DP. Influence of sleep onset on upper-airway muscle activity in apnea patients versus normal controls. *Am J Resp Crit Care Med* 1996;153:1880-7.
- [5] Katz ES, White DP. Genioglossus activity in children with obstructive sleep apnea during wakefulness and sleep onset. *Am J Respir Crit Care Med* 2003;168:664-70.
- [6] [www.jhucct.com/shhs](http://www.jhucct.com/shhs).

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