Sighs During Sleep in Future Victims of Sudden Infant Deaths

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The study was designed to evaluate the presence of sighs during sleep in 15 infants who became victims of SIDS. There were 11 boys and 4 girls, born at term, and with a median age of 12 weeks at the time of polysomnographic recording. They were 34 week old at the time of death. The recordings of the SIDS victims were age- and sex-matched with those of healthy control subjects. Sighs were defined as a brisk and isolated increase in thoracoabdominal excursion with an amplitude at least twice superior to that measured during the 10 seconds that preceded the event. Sighs were classified in four categories depending on their association with apneas: isolated, pre-apneic, post-apneic, and intra-apneic. No significant difference was found between the two groups of infants for total sleep time, types, number or duration of apneas. A total of 218 sighs were scored during sleep (135 in the future SIDS victims, 83 in the control infants). In the two groups, the types of sighs were seen with decreased order of frequency as: pre-apneic, isolated, post-apneic, and intra-apneic. Sighs were found in all sleep states, but were more frequently found in NREM sleep. The distribution of the sighs in the various sleep stages was not different between the two groups. Pre-apneic sighs were significantly more common in the future SIDS victims (p= .035). No significant difference was found between the two groups of infants for the frequency of the other types of sighs. Transient increases in EEG frequencies following the sighs were observed significantly more frequently in the future SIDS victims. Oxygen blood saturation preceding the sighs was lower in the SIDS victims. The mechanisms responsible for a greater frequency of sighs preceding central apneas in future SIDS infants remain unclear. **(Sleep and Hypnosis 2003;5(2):83-88)**

Key words: *apnea, infants, sighs, sleep, sudden infant death*

INTRODUCTION

A sigh is defined as an isolated breath with an increased tidal volume that is seen during sleep or wakefulness. Sighs may occur spontaneously or be induced by lung inflation or airway occlusion (1,2). Sighs then result from a vagally-induced inspiration-augmented reflex and rapidly adapting pulmonary mechano receptors. Sighs are associated with increases in pulmonary compliance and functional residual capacity, and the opening of collapsed alveoli (3). In sleeping infants, sighs are associated with sleep apneas (4-7), and fluctuations in heart rates or blood oxygenation (8). Sighs have also been linked to arousals from sleep (9). The frequency of isolated sighs was reported to be lower in future victims of the

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sudden infant death syndrome (SIDS) than in control infants (10). The finding was however not confirmed by further investigations (11). The present study was designed to evaluate the presence of various forms of sighs during sleep in infants who became victims of SIDS and to compare their frequency and characteristics with those from healthy matched control subjects.

METHODS

Infants

Among the infants admitted to several sleep laboratories in Belgium to take part to various research programmes on sleep between 1992 and 1999, 15 infants eventually died of SIDS. There were 11 boys and 4 girls, all born at term. At the time of recording, their median age was 12 weeks (range: 8 to 16 weeks). At the time of death, the infants had a mean age of 34 weeks (range: 22 to 49 weeks). No infant was monitored at the time of death. Among the infants studied in the same sleep laboratories and who survived the first year of life with no history of apnea, 15 were selected to form a matched control group. They were healthy, and had no personal or family history of sleep apnea or SIDS. The future SIDS and the control infants were matched for sex and age at the time of study.

Sleep recordings and scoring

The infants were admitted to the sleep laboratories for an 9-hour nighttime monitoring session performed in a quiet and darkened room, at ambient temperature ranging between 20°C and 23° C. All infants slept supine, without restraints. Recording started around 21.00 h. The infants were observed continuously during recording. They were fed on demand; their behaviour and any nursing intervention were charted. The data were recorded on a computerised polygraph system (Alice 4, Medatec, USA). The following variables were recorded: two EEG, two electrooculograms, ECG (DII), thoracic and abdominal respiratory movements by inductive plethysmography and airflow by means of thermistors taped under each nostril and on the side of the mouth. Oxygen saturation was recorded from a transcutaneous sensor (Ohmeda Box, USA). Each 30-second period of the recordings were scored as NREM sleep, REM sleep, indeterminate sleep, or wakefulness according to conventional criteria (12). Indeterminate sleep was scored together with REM sleep.

The scoring of gross body movements was based on actigrams. Sleep apneas were scored if they lasted 3 seconds or more. A central apnea was scored when flat tracings were obtained simultaneously from the strain gauges and the thermistors. An obstructive apnea was scored when continuous deflections were obtained from the strain gauges while a flat tracing was recorded from the thermistors. Mixed apneas were defined as central apneas followed directly by obstructive episodes. A sigh was defined as a brisk and isolated increase in thoracoabdominal excursion with an amplitude at least twice superior to that measured during the 10 seconds that preceded the event (Figure 1). Nonspecific body movements were distinguished from sighs by the presence of movement artifacts on the thermistors and EEG tracings (3,13). When more than one sharp increase in respiratory and cardiac amplitude occurred in a row, the event was also scored as a movement.

Sighs were classified in four categories depending on their association with apneas. Isolated sighs were scored when they were not preceded and not followed by an apnea; pre-apneic sighs were immediately followed by an apnea; post-apneic sighs were immediately preceded by an apnea; intra-apneic sighs were immediately preceded and followed by an apnea. Mean values of blood oxygen saturation, heart rate and respiratory rates were calculated

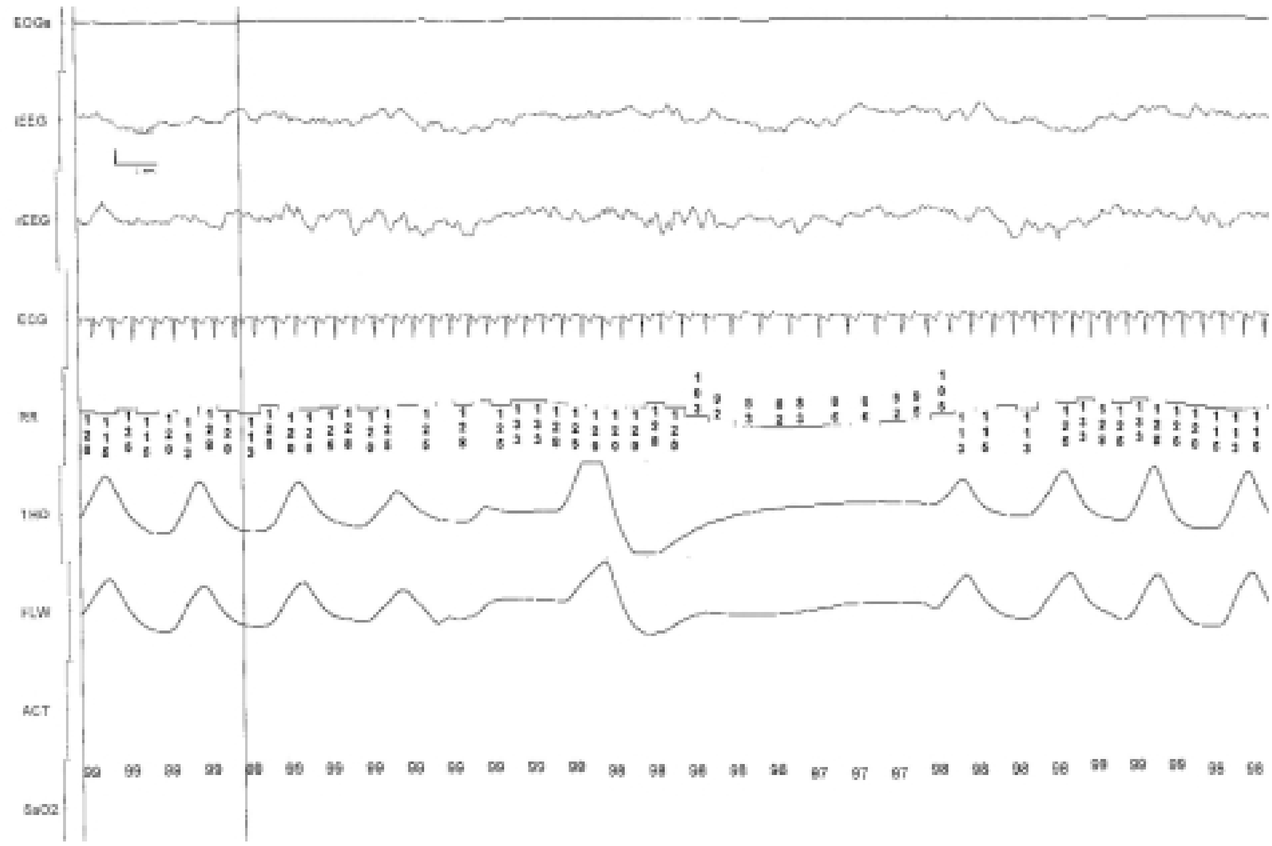

Figure 1. Polysomnographic picture of a pre-apnea sigh

for 10 seconds periods preceding and following each sigh. Mean respiratory rates preceding a sigh were not calculated for post- and intra-apneic sighs. The changes in EEG activities that were scored in association with a sigh included modifications of sleep states, increases in EEG frequency (10 Hz or more), suppressions of spindle activity, appearance of high amplitude delta wave or of muscular artifacts. Each record was allocated a random code number. The code was disclosed after completion of the analysis. The scorer had not taken part in the collection of the data and analyzed the coded recordings without knowledge of the patient's identity and study hypothesis.

Statistical analysis

SPSS for Windows statistical package (release 6.1) was used in data analysis. Mann-Whitney U test for continuous and chi-square test with Yates correction for category variables were used for the comparisons between SIDS and control groups. Statistical significance was set at $p<.05$.

RESULTS

No statistically significant difference was found between the two groups of infants for the following variables: total sleep time (395 minutes in the future SIDS victims, 440 minutes in the control infants; range values: 326 to 543 minutes); number of central apneas per hour of sleep (48 apneas in the future SIDS victims, 42 in the control infants; range values: 3 to 319 apneas); number of obstructive apneas per hour of sleep (8 in the future SIDS victims, 4 in the control infants; range values: 0 to 103); number of mixed apneas per hour of sleep (3 in the future SIDS victims, 2 in the control infants; range 0 to 17); or the duration of apneas (under 12 seconds for all apneas in both groups of infants).

A total of 218 sighs were scored during sleep (135 in the future SIDS victims, 83 in the control infants). In the two groups of infants, pre-apnea sighs were seen most frequently (72.6% of sighs in the future SIDS victims, 55.4% in the control infants), followed by isolated sighs (23% of sighs in the future SIDS infants, 39.8% in the control infants), post-apnea sighs (3.7% of sighs in the future SIDS, 2.4% in the control infants), and intra-apnea sighs (0.7% of sighs in future SIDS, 2.4% in the infants). Sighs were found in all sleep states but were more frequently seen in NREM sleep (84.5% of the sighs in the future SIDS victims and 78.3% in the control infants), than in REM sleep. The types and sleep stage distribution of the sighs were not significant different between the two groups of infants.

The number of pre-apnea sighs per hour of sleep was greater in the future SIDS victims than in the control infants (Table 1). No significant differences were found between the two groups of infants for the frequency of the other types of sighs. Oxygen blood saturation values preceding the sighs was lower in the SIDS infants, and in 2 of 83 sighs (2.4%) of control infants (p = .027).

No statistically significant differences between the future SIDS and the control infants were found for the following variables: basal heart rates preceding the sighs (median of 126 bpm in both groups of infants; range values 90 to 168 bpm); heart rates following the sighs (median of 120 bpm in the future SIDS infants, 126 bpm in the control infants; range values 96 to 162); respiratory rates preceding the sighs (median of 30 pm in both groups of infants; range values 18 to 48 pm); respiratory rates following the sighs (median of 24 pm in both groups of infants; range values 12 to 42 pm); oxygen saturation following the sighs (median of 99% in both groups of infants; range values 92 to 100%); number of sleep stages changes associated with sighs during NREM sleep (6.1% changes in sleep state in the future SIDS victims, 17.5%, in the control infants) or REM sleep (4.8% in the future SIDS infants, 5.6 % in the control infants). Following the sighs, no differences were seen between the two groups of infants for the frequency of EEG spindle activity suppression (mean of 19 % in both groups); or muscular artifacts (5.2% in the future SIDS victims, 2.4% in the control infants).

Table 1. Number of sighs scored per hour of sleep in two groups of infants

	Future SIDS victims	Control infants	p
Number of sighs per hour:			
All sighs	1.2 (0-3.0)	0.6 (0-2.4)	ns
Pre-apnea sighs	1.2 (0-2.4)	0.6 (0-1.8)	.035
Isolated sighs	0 (0-0.6)	1 (0-1.0)	ns
Post-apnea sighs	0 (0-0.02)	0 (0-0.01)	ns
Intra-apnea sighs	0 (0-0.01)	0 (0-0.01)	ns

SIDS victims (median of 99%, range values 92 to 100%), than in the control infants (median of 100%, range values 96 to 100%) (p= .004).

Transient increases in EEG frequencies following the sighs were observed significantly more frequently in the future SIDS victims than in the control infants. Such EEG changes were seen in 16 of 135 sighs (11.9%) of the future

DISCUSSION

Sighs preceding central sleep apneas were significantly more frequent in future SIDS victims than in control subjects. The findings contradict previous reports on infants victims of SIDS who were shown to have less (10) or as frequent sighs than control infants (11). Most other characteristics of sighs found in the present study are reminiscent of findings reported in infants and adults sleep studies. If sighs occurred in all sleep states (3,5,14-16), sighs followed by an apnea were found more frequently during NREM sleep (13,15,17).

The apparent discrepancy between the present and previous reports in future SIDS victims could result from the types of sighs analyzed, as previous studies focused only on the frequency of isolated sighs. In the present study, isolated sighs, that were less frequently seen than sighs followed by an apnea, occurred equally frequently in the SIDS and control infants, while significant differences were found for the frequency of sighs followed by a central apnea. The discrepancy in findings could also result from differences in patient selection.

In the scope of this study, the observation of a lower blood oxygen saturation in the future SIDS victims, compared to the control infants, cannot be explained. The finding should be confirmed by further studies. It could, however, have contributed to the development of a greater frequency of sighs in the future SIDS victims (5,19,20). The apneas that followed the sighs could have been initiated by a rapid decline in carotid body chemoreceptor afferent discharge, due to the sigh-induced increase in arterial oxygen concentration and decrease in blood carbon dioxide (3,13). The association between sighs and apneas could however result from the complex interactions of factors, including peripheral chemoreceptor sensitivity, the degree of maturation and behavioral state (8), or central control mechanisms, including forebrain structures (3).

An association between sighs and reticular formation-related arousal mechanisms has been suggested (9,21). The greater frequency of increases in EEG frequencies seen in the future SIDS victims following the sighs preceding a central apnea could reflect a sleep-maintaining process (22,23). This finding could be reminiscent of the reduced arousability from sleep reported to occur in victims of SIDS (24).

In conclusion, some infants who died during sleep had a greater frequency of sighs preceding central apneas. Oxygen saturation values preceding the sighs were lower in the SIDS than in the control infants. The mechanisms responsible for these findings remain to be determined.

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