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ORIGINAL ARTICLE

Polygraphy in hospitalized children under 3 months of age

Poligrafía en menores de 3 meses hospitalizados

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Abstract

Introduction: Apnea and apparently lethal events have great etiological diversity thus complementary tests may help diagnosis. The aim of this study was to describe the results of polygraph studies of children under 3 months hospitalized with suspected apnea. **Patients and Methods:** Retrospective case series. Children under 3 months with suspected apnea were considered and in whom a polygraphy (PG) was performed during hospitalization. General data, the apnea/hypopnea index (AHI), index of central. apnea, obstructive apnea index, average and minimum saturation were recorded. Desaturation index (ID) below 80% higher 1 per hour, one or more events of desaturation below 80% for more than 20 seconds or an AHI greater than or equal 1 were considered as criteria of sleep disorder breathing (SLB). Descriptive analysis was performed and the associations between AHI and saturation parameters were determined. **Results:** 51 patients, 32 males, entered the study. 15,6% had altered PG. In 5 of them coexisted more than one diagnostic criterion. Iin 15,6% of the patients was observed an IAH greater 1, in 7.8% a desaturation index below 80% and in 11,8% a desaturation index under 80% for 20 seconds greater than 1. The AHI was associated with the parameters of saturation. **Conclusion:** Most of the patients had normal PG and among patients with a suggestive SLB a pattern of respiratory immaturity prevailed, which is characteristic of this age.

Keywords:
Poligraphy;
Infant;
Apnea;
Sleep disorder breathing

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Introduction

Newborns and infants under 3 months can present symptoms difficult to evaluate and often unspecific. Therefore an appropriate data collection, exhaustive physical examination and sometimes complementary studies are fundamental to achieve a correct diagnosis[1].

In this age group, apneas and Apparent Life Threatening Events (ALTE) are a challenge because of their aetiological diversity and high stress generated by parents and/or caregivers when they witness an event that could potentially require cardiopulmonary resuscitation[2,3]. These episodes may occur both in the hospital and at home, which it is more frequent in premature infants and infants younger than 43 weeks[4].

In a significant percentage of patients it is not possible to identify a cause attributable to ALTE. Therefore, the implementation of studies aimed at directly assessing the existence of a cardiorespiratory disorder during sleep is necessary in this group of patients[2,5].

Night continuous saturometry is the most commonly used test in our field. However, it has obvious technical limitations by permitting only to record the parameters of saturation and heart rate. Consequently, its capacity is limited to the diagnosis of persistent and intermittent hypoxemia, and not apnea. Thus, it is essential to record the respiratory flow[6-8].

Although polysomnography is the gold standard for studying sleep, there are simplified alternatives such as polygraphy (PG). This test allows to evaluate, besides parameters of oxygenation and heart rate, the presence of obstructive or central apnea, by having additional channels for recording nasal flow and chest movement. PG has been shown to have a good performance by giving accurate diagnosis in pediatric patients, allowing its recommendation in both the hospital and home settings[10].

Recent studies suggest that the evaluation of children younger than 3 months using PG provides useful clinical information. Brockmann et al proposed baseline values for apneas, indicators of desaturation under 80% and periodic breathing, which suggests to consider this test for the evaluation of these patients[11]. In some infants of this age, especially in smaller ones, a suggestive pattern of respiratory immaturity has been described, where central apneas are more frequent and periodic breathing includes a higher percentage of sleep time[11].

There are few centers that use PG for sleep test in children younger than 3 months and at high risk of sleep apnea. For this reason, and in order to evaluate the applicability of this diagnostic instrument, the objective of the present study was to describe the results of polygraphic studies in a sample of children younger than 3 months of age with suspected apnea in a public hospital in Chile.

Patients and Method

The present study corresponds to a retrospective serie of cases.

Sample

The study enrolled children younger than 3 months hospitalized for suspected apnea in the pediatric and neonatology department of the Dr. Guillermo Grant Benavente Hospital in Concepción (Chile), between december 2011 and april 2015. In order to obtain a more homogeneous sample, only the first examination from those children who presented more than one PG was considered. Patients with cardiac disease and those users of oxygen therapy were excluded. The data was recorded by the same examiner.

Protocol of sleep studies

The tests were performed according to the methodology published by Zenteno et al[12]. Thus, the *ApneaLink Plus (ResMed)*, a 6-channel polygraph, was used: nasal flow (nasal pressure transducer), oxygen saturation, heart rate, microphone, thoracic band and position. Newborns and infants' parents came along with them during the examination, which reported on an ad-hoc record sheet the onset and end of sleep, awakening, feeding, controls, vomiting, crying and sensor output[12].

PGs were analyzed and reported by a bronchopulmonary pediatrician as recommended by the American Academy of Sleep[8], considering also the adaptations suggested by Brockmann et al[11]. Obstructive apnea was considered to cease airflow for at least 2 respiratory cycles and maintenance of thoracic effort, such as hypopnea, reduction of airflow for at least 2 cycles major than 30%, with thoracic effort, associated with desaturation ≤ 3% and as apnea central to stop the airflow for at least 2 respiratory cycles, without thoracic effort and associated with desaturations ≤ 80%, or apneas longer than 20 seconds duration.

Variables

Demographic data, morbid and clinical history were recorded. On the other hand, Pgs recorded apnea hypopnea index (AHI), central apnea index (CAI), obstructive sleep apnea (OSA), mean and minimum saturation. In addition to the desaturation index ≤ 80% per hour. As criteria for sleep-disordered breathing (SDB), any of the following criteria were considered: the desaturation index (ID) below 80% greater than 1 per hour, one or more desaturation events below 80% for more than 20 seconds, or an AHI greater than 1 or equal.

The severity of Obstructive Sleep Apnea Hypopnea Syndrome (OSAHS) was defined according to AHI:

Normal less than 1, Slight 1 to 5, Moderate 5 to 10 and Severe greater than 10[11].

Increased periodic respiration was considered over 20% in children younger than 37 weeks and 10% in children older than 37 weeks of postmenstrual age (PMA).

A test was considered valid when it presented at least 5 hours of recording, with less than 20% of the recording time occupied by disconnections and/or artifacts.

Table 1. General characteristics of patients considered in study

Variables		
Total number (H/M)	51	(32 /19)
Age (days)	39.8 ± 22.8	
Distribution by age		
Newly born*	20	(39.2%)
Infants between 1 and 2 months	19	(37.2%)
Infants between 2 and 3 months	12	(23.5%)
Clinical characteristics of patients		
Premature	28	(54.9%)
Apparent Life Threatening Events	17	(33.3%)
Bronchopulmonary dysplasia	8	(15.6%)
Brothers with a history of SIDS	4	(7.8%)
Craniofacial malformation (Piere Robin)	2	(3.9%)
Down's Syndrome	1	(1.9%)
Laringomalacia	1	(1.9%)

H: man, M: woman; SIDS: Sudden Infant Death Syndrome. *Newborns are considered those patients less than 1 month old. The qualitative variables are expressed in absolute value and percentage, the quantitative variables are expressed as mean ± standard deviation.

Table 2. General results of polygraphs

Polygraphic variables[a]	
Total time (hrs)	9.5 ± 2.3
Total validated time (hrs)	7.4 ± 1.6
Average saturation (%)	96.5 ± 1.7
Minimal saturation (%)	80.6 ± 11.9
Desaturation index less than 80%*	0.2 ± 0.6
Desaturation index less than 80% and by more than 20 seconds on TTV	0.6 ± 2.5
Periodic breathing (%)	2.8 ± 7.5
Apnea hypopnea index*	1.0 ± 3.1
Central apnea index*	0.5 ± 2.4
Obstructive apnea index*	0.5 ± 1.6

[a]The results correspond to 51 analyzed polygraphs. *Respiratory rates are expressed in events/hour. TTV: total time validated. Results are expressed as mean ± standard deviation.

Ethical considerations

Each parent signed an informed consent for the test and they authorized the use of the results for scientific purposes. The study was approved by the ethical scientific committee of the Dr. Guillermo Grant Benavente Hospital of Concepción. Chile.

Statistical analysis

An exploratory analysis of the data and evaluation of normality of each of the variables was performed using the Kormogorov Smirnov test. Subsequently, descriptive statistics were calculated with average and standard deviation for the quantitative variables, as well as percentages for the qualitative variables. The association between the SDB diagnostic indexes (AHI, saturation index less than 80% and saturation index less than 80% for more than 20 seconds) was determined by the partial correlation calculations between them (r of Pearson), considering as covariables the existence of prematurity (dichotomous variable) and age (quantitative variable). In addition, linear regression analysis was performed to establish the correlation between AHI and mean and minimum saturation. Finally, a logistic regression analysis was performed to determine the influence of age and prematurity on polygraphic variables evaluated. For this analysis, the following variables were considered: AHI, desaturations lower than 80%, desaturations less than 80% for 20 seconds, periodic respiration and average saturation. And as independent variables, age and prematurity. Each of the independent variables were enrolled into the model using the *Enter* method, and later the model was verified by the *Forward* method. A p value of $p < 0.05$ was considered significant.

Results

During the study period, 65 polygraphies were performed in children younger than 3 months with suspected hospitalized apneas in the care center. 8 were excluded for being controls, 1 congenital heart disease and 1 O2 DBP dependent. From the 55 cases that met inclusion criteria, 4 were not considered valid according to pre-established criteria. The study analyzed 51 patients, 32 men. The mean age was 39.8 ± 22.8 days. Table 1 shows the demographic and clinical characteristics of the sample.

Regarding the general results of the sleep studies, an average AHI of 1.0 ± 3.1 was observed, a lower desaturation index of 80% of 0.2 ± 0.6 and a desaturation index of less than 80% by more than 20 seconds of 0.6 ± 2.5. Table 2 shows the general results of the polygraphs performed in the study sample. 8 patients (15.6%) had altered PG, and in 5 of them (63%) more than one

Table 3. Proportion of altered studies according to established criteria

Criteria (n total = 51)		
AHI greater than 1*	8	(15.6%)
DI less than 80%*	4	(7.8%)
One or more desaturations less than 80% for more than 20 seconds on TTV	6	(11.8%)

AHI: apnea hypopnea index. DI: desaturations Index. *Indices expressed in events per hour. TTV: Total time validated.

Table 4. Correlation between the diagnostic criteria of SBD

	Desaturations less than 80% per more than 20 seconds	DI less than 80%	AHI
AHI	0.89 (p = 0.0001)	0.82 (p = 0.0001)	1
DI less than 80%	0.69 (p = 0.0001)	1	

AHI: apnea hypopnea index; DI: desaturations Index. Partial correlation coefficients are calculated considering age and existence of prematurity as covariables.

diagnostic criteria coexisted. Thus, in 4 patients the 3 diagnostic criteria were observed, in only one patient 2 criteria and in 3 patients 1 criteria. Additionally, it was observed that 15.6% of the study sample showed an AHI greater than 1 or equal, 7.8% had an 80% desaturation index and 11.8% an 80% desaturation index by more than 20 seconds greater than 1 (Table 3). Related to the severity of SDB, 2 patients had mild and 2 moderate OSAS.

On the other hand, a significant positive correlation was observed between the diagnostic indexes of SDB (Table 4). Additionally, the regression models made to establish the association between mean and minimum saturation with the hypopnea apnea index were statistically significant (Figure 1 and 2).

Finally, according to the logistic regression analysis, there was no significant association between age and prematurity, with the results of the variables that determined the diagnostic criteria of SDB.

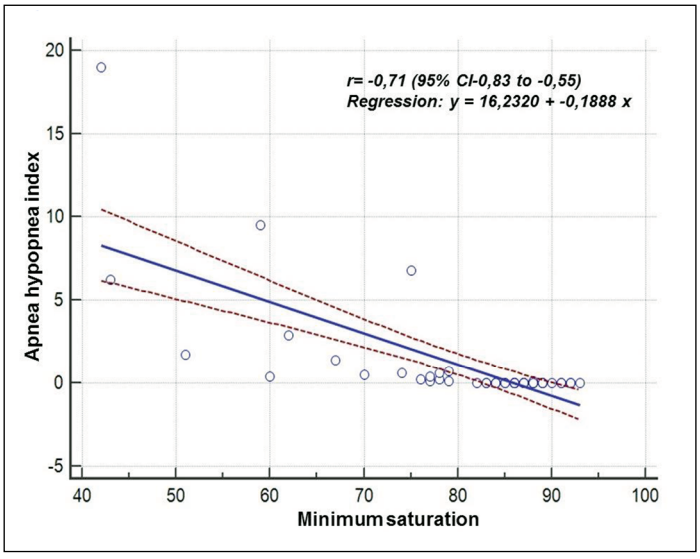

Figure 1. Regression analysis between apnea hypopnea index and minimum saturation.

Discussion

In our study, 93% of PGs were considered valid, which is in agreement with what is published in studies with older children. These results suggest that these tests can be performed under high quality standards in children, regardless of age[13].

In addition, there was no association between prematurity and the diagnostic criteria of SDB. Probably because the included premature patients had a postmenstrual age similar to those not premature.

Recently published studies show that infants younger than 3 months not only are patients with an increased risk, but also they have specific characteristics in their respiratory pattern of sleep that differentiate them from other age groups. For this reason, the sample studied was made up specifically for children younger than 3 months (4, 11 and 14). In this study, the age of PG was 1.3 months with a range of 3 to 80 days.

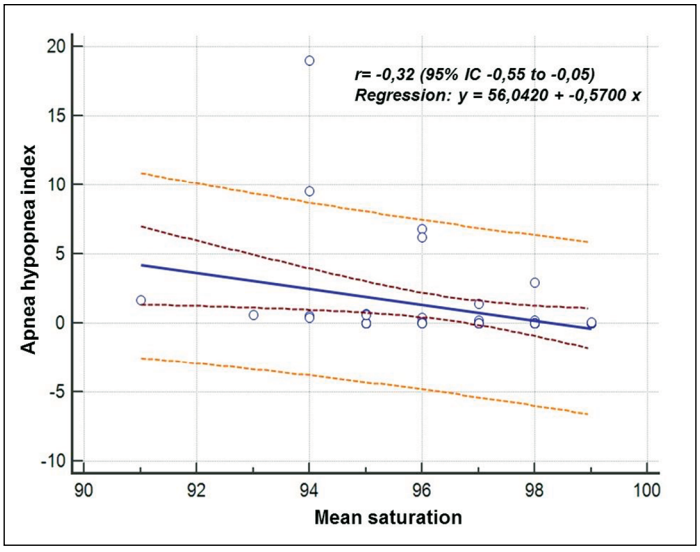

Figure 2. Regression analysis between apnea hypopnea index and mean saturation.

However, the highest percentage of patients was younger than 2 months (76%).

Regarding the antecedents of patients who were suspected of having apneas, 33.3% of the children presented a diagnosis of ALTE, with no apparent cause, or were considered high risk according to national recommendations (2, 3); 50.1% were premature, from which the 15.6% had a background of bronchopulmonary dysplasia at the time of examination without oxygen therapy and 4 infants had a background of siblings who died due to sudden infant death syndrome (SIDS).

One weakness of the study was that the patient sample was heterogeneous, since 24% of them had associated pathology. However, we consider relevant to include these cases, as they are part of the evaluations requested for a specialist by "apneas".

Although sleep studies have not been recommended to establish risk of SIDS, in the clinical context in which these infants were presented, with suspicious of apneas and a background of siblings with SIDS, and adding the uncertainty and anguish generated by the birth of a new son, our team determined to perform PG as other complementary study[14].

84.4% of PGs were normal, which is in agreement with the literature, since it was established that most of the cases are single episodes and have little complications during sleep (1, 5). On the other hand, specific measures aimed in order to avoid subsequent complications were adopted in patients with altered exams, such as: specific medical treatment, careful follow-up, and study of possible causes, parents' education in contingency aspects and prevention of SIDS (2).

From 4 patients in which the diagnosis of OSAHS was made, 2 were categorized as moderate and 2 as mild. Specifically, those patients with moderate OSAHS were patients with Pierre Robín Syndrome, who had an early mandibular distraction. On the other hand, five patients had an increased central apnea index. This was attributed to the immaturity of the respiratory center. These patients were monitored and the condition was resolved spontaneously, which it was verified in later studies. In most abnormal exams, there were more than two compromised polygraphic variables, with an AHI greater than 1 per hour, being the most frequent alteration. The second most prevalent criteria was the desaturation under 80% for more than 20 seconds, being found in 75.0% of the altered PGs. It is fascinating to notice that the association between AHI and saturation parameters confirms the existence of interrelation between both diagnosis. However, if the integration of both tests (PG and night continuous saturometry) increases the accuracy of diagnosis in this age group, it should be studied in future research studies.

It has to be acknowledged that the definition of significant central apneas in children younger 3 months (desaturation of less than 80% of oxygen or equal) should be considered with caution. Although this criteria has been recently suggested in international studies for PG and night continuous saturometry, it has not been included yet in the current consensuses (8, 11 and 15). Therefore, it may be appropriate to consider it in future recommendation guides.

Finally, it is possible to conclude that, in the sample studied, most of patients had normal PGs and a suggestive polygraph pattern of respiratory immaturity predominated among patients with SDB, which is an specific characteristic of this age.

On the other hand, PG could be a useful test to evaluate sleep-disordered breathing in children younger than 3 months. However, future research studies should be performed in order to establish their measurement properties in this age group.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

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Conflicts of Interest

Authors state that any conflict of interest exists regards the present study.

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