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ORIGINAL STUDY

Correlation between polysomnographic and endoscopic investigation data in patients with sleep-disordered breathing associated with post thyroidectomy recurrent nerve palsy

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ABSTRACT

BACKGROUND. Sleep respiratory pathology is closely related to physiological and pathophysiological characteristics of respiratory control during sleep. Due to the anatomical disposition of the muscles, changes in their tonicity may lead to upper airways obstruction during sleep. The upper airway of the patients with obstructive sleep apnea syndrome and vocal cord paresis of different aetiologies can significantly narrow during inspiration. The objective of the present study was to evaluate the influence of the laryngeal pathology, such as unilateral or bilateral recurrent nerve palsy, on the degree of sleep apnea.

MATERIAL AND METHODS. A retrospective clinical study was conducted (2010-2011) on a total of 30 patients with post-thyroidectomy unilateral or bilateral recurrent nerve palsy. The examination protocol included: flexible nasopharyngoscopy performed during sleep for evaluating the nasopharyngeal, retrovelar, oropharyngeal and hypopharyngeal region, followed by rigid laryngeal endoscopy and stroboscopy. Polysomnography was used as a method of identifying the patients with sleep respiratory disorders.

RESULTS. Out of the 30 patients, 28 were women (93.33%) and 2 men (6.67%) (mean age = 48 ± 1.4). The unilateral recurrent nerve palsy was the most frequently encountered - 70% of the patients. 3.33% had bilateral recurrent nerve palsy with vocal cords in lateral position, 20% had paramedian recurrent palsy, and 6.67% had bilateral recurrent nerve palsy with vocal cords in median position. Statistical data revealed significant differences between the apnea-hypopnea index (AHI) values, for different types of vocal cord paralysis.

CONCLUSION. Our statistical evaluation has shown that AHI increases in patients with bilateral recurrent nerve paralysis, compared to those with unilateral paralysis. Establishing curative medical, surgical, as well as foniatric or continuous positive airway pressure treatment, we can improve AHI value, sleep quality and patient's quality of life.

KEYWORDS: obstructive sleep apnea syndrome, nasopharyngoscopy, polysomnography, unilateral recurrent nerve palsy, bilateral recurrent nerve palsy

INTRODUCTION

Sleep respiratory pathology is closely related to physiological and pathophysiological characteristics of respiratory control during sleep. Respiratory neural units change during sleep and affect muscle activity of upper airway dilators, diminishing their tonicity. Due to the anatomical disposition of the muscles, changes in their tonicity can cause upper airway obstruction during sleep. Transient hyperpnea suppresses dilator muscles activity more than phrenic nerve activity, causing a mismatch during inspiration[1].

In most cases, sleep respiratory pathology is caused either by physiological changes in control of ventilation during sleep, or by pathophysiological conditions arising from these special features. There are several feedback loops in the ventilation control systems, which include the mechanical information of the

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lungs and the airways, as well as chemical information from the peripleural chemoreceptors and the central sensitive chemoreceptors.

There are interactions between the respiratory neural network and mechanical afferences, chemical or nonspecific, which can cause respiratory instability during sleep. Among patients with AHI greater than 30, there is a significant increase of chemoreflex sensitivity during the night, approximately 30%, which tends to destabilize breathing during sleep. While sleeping, considerable changes take place in cerebral circulation, which could explain the variation in CO2 from the "periphery". In order to maintain airway calibre, the muscles have a tonic and a phasic activation, including the sternohyoid and genioglossus muscles.

Muscle tone increases during inspiration and decreases during expiration. This activation is CO2 sensitive: hypercapnia increases airway muscle phasic activation. During sleep, the response to CO2 seems to be diminished. In addition, the respiratory muscles (including the diaphragm and intercostal muscles) seem to depend more on the CO2 unit than the airway muscles[2].

In some circumstances, this may favour the emergence of a mixed or obstructive apnea, especially if it comes after short periods of hyperventilation, when PCO2 falls below the threshold of apnea. The increase of PCO2 will reactivate the phrenic activity at the beginning, and then the increased PCO2 levels will activate airway muscles.

In addition, airway muscle activity is also dependent on other factors such as deformation of the airways, inspiratory flow pattern, air temperature and the functional residual capacity. In the airway shape changes may be caused by the glottic space modifications determined by recurrent nerve palsy[3-6].

Three physiopathological mechanisms characterize the sleep respiratory pathology: (a) upper airway instability (e.g.: decreased muscle tone during sleep causes snoring as well as "obstructive" apnea and hypopnea); (b) respiratory instability (e.g.: hyperventilation with circulation delay, causing periodic breathing drives) and (c) respiratory diseases (e.g.: chest deformities with restrictive ventilatory dysfunction).

Upper airway collapse and instability occur during inspiration, when negative intraluminal forces prevail and the so-called deformation pressure (Pcrit) is negative or during expiration, when intraluminal pressure deformation is positive. Sleep is characterized by a single anatomical unit and it can be influenced by upper airway instability[4,5].

If we consider a change in 4 steps (1 - stand quiet, 2 - stage 1 and 2 of NREM sleep, 3 - stage 3 and 4 of NREM sleep or slow-wave sleep and finally 4 - REM) the sympathetic tone decreases from wakefulness to stages 1 - 2, it is reduced further during slow-wave sleep, and grows in REM sleep to levels occurring in the waking state.

Thus, sleep has a strong effect on the central nervous system activity. It seems that the parasympathetic activity is influenced not only by sleep, but also by the circadian rhythm. Instability of the upper airway during sleep, which leads to snoring, hypopnea or apnea, results in changes in autonomous control[7-9]. During apnea, the airflow is absent and hypoxia is installed, resulting in an acute reduction of the sympathetic activity. In periods of recurrent apnea, the sympathetic activity measured during wakefulness or sleep increases.

In normal circumstances, in wakefulness, breathing control is under the influence of several factors: cortical factors (that allow synchronisation between breathing and speech, swallowing, laughing, etc.), a waking neuronal factor and finally a metabolic factor. Studies on the genioglossus muscle activity suggested that patients with obstructive sleep apnea syndrome (OSAS) had a greater reduction of genioglossus EMG compared to normal subjects[8].

The upper airway in patients with obstructive sleep apnea syndrome can significantly narrow during inspiration, in case of a combination of vocal cord palsy of different aetiologies. Superior airway collapse level leads to greater obstruction of the airflow. Superior airway collapsibility may be caused by the pressure-flow curve[10-13].

The objective of the present study was to evaluate the influence of a laryngeal pathology, such as unilateral or bilateral recurrent nerve palsy type, has on the degree of sleep apnea. Few studies are published in the ENT literature related to the involvement of recurrent palsy of post thyroidectomy origin in the sleep apnea degree, which prompted us to be sensitive to this matter.

MATERIAL AND METHODS

We performed a retrospective study between 2010 and 2011, on a total of 30 patients on whom thyroidectomy for benign thyroid disease was performed, and who presented unilateral or bilateral vocal cord palsy. The cases with thyroid malignancy were excluded from the study.

The examination protocol included: flexible nasopharyngoscopy – in order to evaluate the nasopharyngeal, retrovelar, oropharyngeal and hypopharyngeal region - was performed during the medication-induced sleep, the so-called sleep endoscopy maneuver; rigid laryngeal endoscopy and stroboscopy for vocal cord assessment (mobility, position - middle, paramedian or lateral - and the degree of obstruction of the glottic space). We noted 1 - unilateral vocal cord paresis, 2 - bilateral paresis in lateral position, 3 - bilateral paresis in paramedian position, 4 - bilateral paresis in middle position (Figure 1).

Polysomnographic evaluation, as the method of

Figure 1 Unilateral vocal cord paresis – laryngeal endoscopy view

choice in evaluating the patients with sleep respiratory pathology, was performed using a sleep device, with required facilities to register sleep stages, apnea-hypopnea index value, data related to the degree of desaturation, snoring, heart activity using the ECG, leg movements and respiratory values related details. All data were concentrated in a report that can be used for a brief analysis of polysomnographic results (Figure 2).

It is important to point out that the recording was made in an accredited laboratory, equipped with all the necessary recording equipment for a period of naturally-induced physiological sleep. Patients were divided into 4 groups, according to the AHI value, as follows: chronic snoring AHI < 10, mild obstructive sleep apnea syndrome AHI ≤ 30, moderate obstructive sleep apnea syndrome AHI ≤ 50 and severe obstructive sleep apnea syndrome AHI > 50. It was considered that vocal cord paresis occurred in the first postoperatory weeks, not amenable to inflammatory cortisone treatment and vitamin therapy.

In our study were included patients with a normal weight (BMI ≤ 26), non-smokers, non alcohol consumers, with adequate sleep hygiene, without cardiac, metabolic or neurological pathology associated. Polysomnographic data were correlated with the degree of narrowing of the glottic space as follows: for the 4 groups of patients with sleep pathology according to the AHI index value, we had different subjective values for the degree of laryngeal obstruction rated from 1 to 4.

All values were statistically analyzed using the IBM SPSS Statistics 20 and Microsoft Office Excel (including one sample t-test and bivariate correlation).

RESULTS AND DISCUSSIONS

It is known that thyroidectomy is a surgery performed more frequently on female patients, thyroid pathology being more frequent among them. It should be noted that, in our patients, partial or total thyroidectomy was performed for benign thyroid pathology.

The study group consisted in 30 patients - 28 were women representing 93.33%, and 2 men, representing 6.67%, the mean age being 48 ± 1.4 years. Recurrent nerve palsy was interpreted in most cases as the

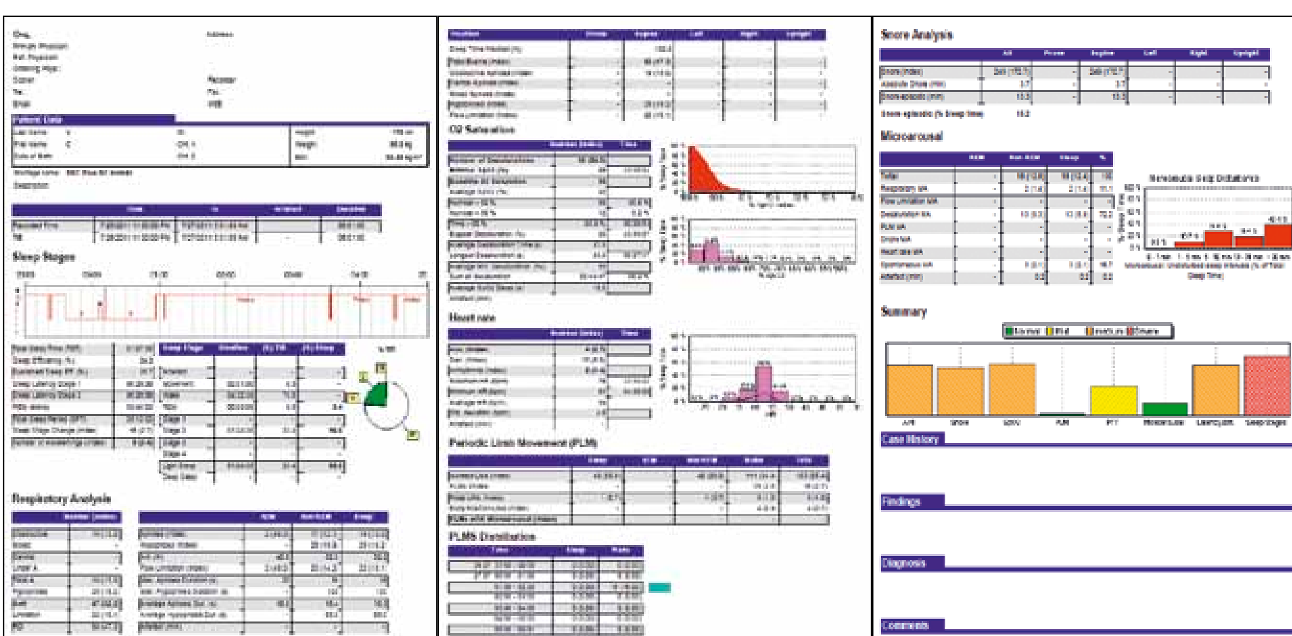

Figure 2 Polysomnography report

result of possible postoperative inflammatory processes affecting the functionality of recurrent nerve, and not as irreversible nerve damage, consecutive to a surgical sectioning.

Clinical examination conducted through nasopharyngoscopy ruled out other anatomical changes, like tonsillar hypertrophy (over 5 mm increased webbing); uvula or retrovelar changes; anterior, posterior or circular narrowing of the hypopharyngeal region. We excluded from the study those patients with the above-mentioned pathologies, taking into account only the cases with isolated recurrent nerve palsy.

Unilateral recurrent palsy was the most frequently encountered; out of the 30 patients, 21 (70%) had unilateral recurrent nerve palsy, without a significant difference in percentage between right and left, 9 patients were diagnosed with bilateral recurrent nerve palsy - 1 patient (3.3%) presented vocal cords in lateral position, 6 patients (20%) in paramedian position with reduced mobility of the vocal cords, and 2 patients (6.7%) in median position, presenting reduced mobility of the vocal cords, both in phonation and in inspiration (Table 1).

The upper airway assessment using flexible nasopharyngoscopy was performed during medication-induced sleep, with Propofol 5 - 20mg per kg body

Table 1
Type of paralysis and frequency

	Frequency	Percent	Valid Percent	Cumulative Percent
Unilateral paralysis	21	70.0	70.0	70.0
Bilateral paralysis in lateral position	1	3.3	3.3	73.3
Bilateral paralysis in paramedian position	6	20.0	20.0	93.3
Bilateral paralysis in median position	2	6.7	6.7	100.0
Total	30	100.0	100.0	

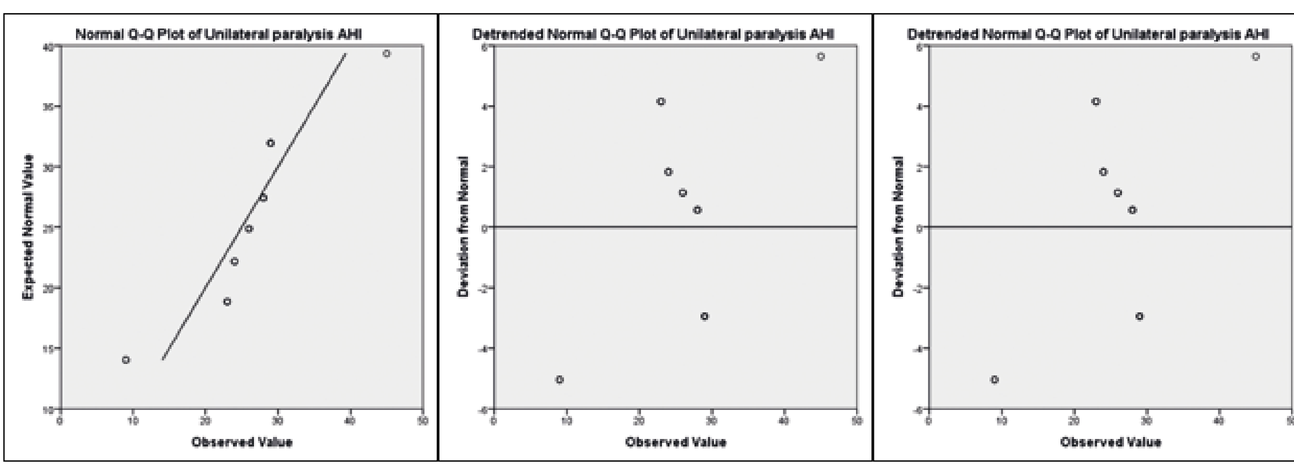

Figure 3 Unilateral paralysis and AHI correlation

Table 2
Apnea-hypopnea index (AHI) and frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AHI<10	3	10.0	10.0	10.0
	AHI<30	20	66.7	66.7	76.7
	AHI<50	5	16.7	16.7	93.3
	AHI>50	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	

Table 3
Model description and estimated distribution parameters

Model Name			MOD_1
Series or Sequence		1	Unilateral paralysis AHI
Transformation			None
Non-Seasonal Differencing			0
Seasonal Differencing			0
Length of Seasonal Period			No periodicity
Standardization			Not applied
Distribution		Type	Normal
		Location	Estimated
		Scale	Estimated
Fractional Rank Estimation Method			Blom's
Rank Assigned to Ties			Mean rank of tied values

Applying the model specifications from MOD_1

Table 4
Univariate statistical description of nominal and numeric variables

		Unilateral paralysis AHI	Bilateral paralysis AHI
N	Valid	21	9
	Missing	0	0
Mean		25.71	37.44
Std. Error of Mean		1.575	5.378
Median		26.00	48.00
Mode		29	49
Std. Deviation		7.219	16.133
Variance		52.114	260.278
Skewness		-.293	-.603
Std. Error of Skewness		.501	.717
Kurtosis		3.838	-1.023
Std. Error of Kurtosis		.972	1.400
Range		36	47
Minimum		9	9
Maximum		45	56
Sum		540	337

weight. This sleep endoscopy maneuver allowed us to assess the upper airway appearance and its collapse. Despite the advantages, this examination procedure remains a subjective investigation method, its results depending on the examiner's experience, as well as the anaesthetist's versatility.

Clinical data could not be interpreted independently, but in the actual context of the disease, so they were correlated with the polysomnographic findings.

Depending on the AHI value, patients' distribution was as follows (Figure 3, Table 2):

- 3 patients or 10% of the corresponding degree of recurrent nerve palsy (2 patients with type 1 and 1 with type 2) presented an AHI < 10;
- 20 patients, meaning 66.7% (18 patients with type 1 recurrent nerve palsy and 2 patients type 3), had an AHI ≤ 30;
- 5 patients, meaning 16.7% (1 patient had type 1 nerve palsy and 4 patients type 3 nerve palsy), presented an AHI ≤ 50;
- 2 patients (6.7%), both with type 4 nerve palsy in paramedian position, had an AHI > 50.

Table 5
Pearson's correlation test between type of paralysis and apnea-hypopnea index

		Unilateral paralysis AHI	Bilateral paralysis AHI
Unilateral paralysis AHI	Pearson Correlation	1	.614
	Sig. (2-tailed)		.078
	N	21	9
Bilateral paralysis AHI	Pearson Correlation	.614	1
	Sig. (2-tailed)	.078	
	N	9	9

Table 6
Chi-test statistic analysis results

	N	Mean	Std. Deviation	Std. Error Mean
Unilateral paralysis AHI	21	25.71	7.219	1.575
Bilateral paralysis AHI	9	37.44	16.133	5.378

Table 7
t-test statistic analysis results

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval	
					Lower	Upper
Unilateral paralysis AHI	16.323	20	.000	25.714	22.43	29.00
Bilateral paralysis AHI	6.963	8	.000	37.444	25.04	49.85

A normality test was used to validate the information, the evaluation emphasizing a low deviation from the normal line, which explains a normal value distribution (Table 3). Univariate statistical description of nominal and numeric variables showed a standard deviation of 7.219 in patients with unilateral paralysis and of 16.133 in those with bilateral paralysis; the average AHI value in the group with unilateral paralysis was 25.71 and in those with bilateral paralysis 37.44 (Table 4).

To describe bivariate data and to determine the association degree between AHI values and the type of paralysis, the values were statistically analyzed applying the chi-test, one sample t-test and the bivariate correlation. Pearson's test revealed a correlation coefficient of 0.614. This value getting closer to the value 1 proved that there is a correlation between the data and the values obtained for the two groups (Table 5).

Both the chi-test and the t-test showed a statistically significant difference between the values obtained for the two groups, $p < 0.05$ (Table 6, Table 7), with a higher AHI score in the bilateral nerve palsy group.

CONCLUSIONS

The sleep respiratory pathology is a continuing concern for ENT specialists and not only. Knowledge of respiratory mechanisms, of involved anatomical elements, as well as fibroscopic and polysomnographic evaluation is essential before starting any therapy. ENT pathology is, in many cases, involved in the onset of obstructive sleep apnea syndrome. A special category is unilateral and / or bilateral vocal cord paralysis occurred after thyroidectomy.

Our statistical evaluation has shown that the apnea-hypopnea index increases in patients with bilateral paralysis, compared to those with unilateral paralysis.

Establishing the curative medical, surgical and foniatric recovery treatment of the recurrent paralysis improves AHI value, sleep quality, as well as patient's quality of life. The alternative treatment, especially in those cases in which surgical treatment is ineffective, may be the continuous positive airway pressure therapy (CPAP), which may reduce the apnea-hypopnea index up to 50% from the baseline value.

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