Changes of Visual Evoked Potentials in Patients with Thyroid Dysfunction

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The visual evoked potentials technique records the cerebral bioelectric activity generated by light stimulation. Evoked potentials is a good method of assessing the electrical response of the brain to different stimuli and has been used extensively in the study of brain disturbances. We registered VEP on 18 hyperthyroid and 18 hypothyroid patients, without other endocrine, metabolic, ophthalmologic or neurological illnesses, the 2 groups having practically identical ages, but sex repartition, illness age and treatment duration being statistically different (p<0.001). Hormonal, radiological, biochemical dosages and physiological paraclinic determinations were performed on all 36 subjects, through classical methods, and VEP recordings, with a 4 channel polygraph through pattern reversal stimulation (1Hz), measuring all parameters (latency, amplitude, duration, surface, steepness etc.) of N75 and P100 waves. Between groups, the recorded hormone levels and other recordings showed great differences, very highly statistically significant (p<0.001), only arterial pressures being just statistically significant (p<0.05). The Pearson’s r correlation coefficients indicated extremely high correlations (r=0.90-0.98) between all parameters. Between the 2 groups, hypothyroid patients had latencies of P100 wave higher with 17.88% (p=0.0028) and of the N75 wave with 9.98% (p=0.016), and the duration of the N75 wave lower with 26.37% (p=0.026), the other parameters of VEP waves modifying up to 52.35%, not statistically significant due to high standard deviations. The duration of N75 correlates with the majority of humoral-paraclinic parameters, indicating a functional interdependency between them and the function of the cortex. The ratio of the amplitudes and of the areas of P100/N75 indicate a severe inhibition to hypothyroid patients, a precisely quantified reduction of the cerebral activity.

Keywords: hyperthyroidism, hypothyroidism, visual evoked potentials (VEP)

Evoked potentials can be defined as voltage variations that can be recorded at the level of some components of the nervous system in response to different sensory stimulation modalities [2-4]. The visual evoked potentials technique records the cerebral bioelectric activity generated by light stimulation [5, 7-9]. Visual evoked potentials is a electrophysiological test [10, 11], a good method of assessing the electrical response of the brain to visual stimuli for evaluation of impulse travel from the eye to the occipital cortex [40].

Thyroid hormone are involved in myelin production, axonal transportation, and neurotransmission [13-15]. Variations in thyroid hormone concentrations may cause abnormalities in the perception and conduction of impulses from the receptor level to the occipital cortex [35].

We studied the visual evoked potentials in 18 patients with hyperthyroidism and 18 patients with hypothyroidism, also, we compared hyperthyroid patients with hypothyroid patients [17,18] and we studied not only the P100 wave and the N75 wave latencies, but also all of their 7 parameters.

Experimental part

Materials and methods

This study was conducted in the period 2014-2017, through the collaboration between the Department of Physiology of UMF Craiova and the Department of Internal Medicine of Emergency Military Clinic Hospital Stefan Odobeja, from Craiova. Thirty-six patients with thyroid disease were investigated by the visual evoked potential, which of 18 patients with hypothyroidism and 18 patients with hyperthyroidism. The subjects presented an obvious thyroid pathology, diagnosed based on clinical manifestations and paraclinical determinations [6, 19, 20]. All patients had evidence of medium-intensity thyroid disease without complications of cardiovascular, ophthalmological, psychiatric or hematological nature [12, 16]. It is known that antithyroid drugs have been associated with development of agranulocytosis or secondary autoimmune neutropenia [1]. The questionable cases, with early-stage disease with unsafe diagnostics, with manifestations at the limit, have been removed. Records were made on each subject once, as soon as possible after hospital admission, 1-2 days after treatment commenced. The recording conditions have always been the same of thermal comfort, semi-security, lack of noise and mental relaxation [22, 23].

The modifications of visual evoked potentials (VEP) were determined by recordings of these potentials in parallel with the hormonal, biochemical and physiological manifestations (pressure, reflexes) [25, 26], on a total number of 36 patients with thyroid pathology, 18 with hyperthyroid and 18 with hypothyroid. The male gender predominated with 27 cases (75%). The predominance of the male gender was even higher on the hyperthyroid lot (16 cases, that is 88.89%), being lower at hypothyroid (11 cases- 61.11%) (table 1).

The sanguine concentration of the T3 and T4 hormones were dosed using classic methods [28, 33]. Lipemia and cholesterolemia were determined with the help of classical
biochemical analysis, on blood collected at a young, under identical conditions for all subjects and at the same time of the day. The basal metabolism was determined under rigorously kept basic conditions, through a modern device [30, 39]. The Achielen reflexogram was recorded with an efficient dedicated electronic device, and by classic clinical methods the cardiac frequency and the minimum and maximum blood pressure were measured, in a state of basal rest, at the same time of the day.

The subject is in absolute physical and psychical rest, in a dusky room, free of noise, in thermal balance, with no hunger; third, warm-cold, pain (headache, arthralgia) sensations, with no thyroid medication for 6 days, with no exciting, depressing substances (coffee etc.), tranquillizers, neurotropic vitamins [32, 36], the subject sitting comfortably on a chair and looking attentively at the screen through which the repeated photic stimuli are applied. If the subject has refraction vices, he will look through the vice-correcting glasses.

Placing of the EEG electrodes was performed according to figure 1, after degreasing the skin and applying electro-conductive paste, the electrodes being fixed by collodion gluing (fig.1). We used a Nihon-Kohden Neuropack M1 with Neurofax module.

In order to extract VEP signals from the EEGs, we recorded 300 ms after applying the photic excitation. The sampling frequency was 1000 Hz (therefore one sample/ms), and the analog-digital conversion (A/D) was done on 12 bits.

Normally 100-180 answers were summed. In order to precisely identify the level of the isoelectric line, we started adding the samples with 60 ms before the moment of applying the photic excitation technique. Therefore at each addition 360 samples were added, 60 before, 300 after the stimulation.

Of all the different techniques used for photic stimulation (flash, rotating mirror projector, TV screen, LED screen etc.), the on screen LED stimulation is the best, precise and physiological (2 and 5). The pattern reversal stimulation method was used, with the help of a matrix of approximately 10x15 cm, made from a few thousand yellow-green LEDs. The photic stimulation frequency was of 1 Hz the highest.

Results and discussions
The average ages of the two groups were a little different, 40.89 +/- 6.02 in hyperthyroid, with limits between 30 and 50 years and 38.22 +/- 11.08 in hypothyroids, with limits between 22 and 50 years (table 2).

The age of the illness in studied hyperthyroid was 2.33 years +/- 1.97, and the duration of the treatment 1.22 +/- 1.77 years, and in hypothyroid the age was 6.06 +/- 3.10 years and the duration of the treatment 5.36 +/- 3.6 years (table 2).
The average ages of the two groups (with very close values) was not statistically significant, (Student t test p>0.05), while statistic differences between the average age of the illness and the average duration of the treatment were highly significant (p = 0.0005, and 0.0004 respectively) (table 3).

Obtained hormonal, iodine uptake, biochemical, metabolism, reflectivity and cardiovascular values. Tables 4, 5, 6, 7, 8 present the average values, standard deviations, the coefficient of variation % (CV%) and other current statistic parameters for all the performed determinations, the absolute and relative differences (%) between the averages of the two studies groups and the statistic insurances of these differences, and in figure 2, 3, and 4 the important data in the quoted tables is exposed graphically in absolute values then percents [21, 27, 31], hypothyroid as opposed to hyperthyroid considered comparison standard (100%).

In tables 4 and 5 great differences can be observed (complying with familiar clinical and paraclinical semiology) between the average values of hyper and hypothyroids.

Then it can also be observed that the majority of obtained mediums have a very high safety and informative value, CV% being below 10% (see yellow colored boxes), and the ones with CV% over 10% have 11, 15, 16, maximum 21%.

### Table 4

| Hyperthyroid Patients | T4 (mg/dl) | T3 (mg/dl) | RIC 2h | RIC 24h | Lipemia (mg%) | Cholesterol (mg%) | Basal metabol. (%) | Achilles Reflex (ms) | Cardiac Freq (bp/min) | MAX BP (mmHg) | MIN BP (mmHg) |
|-----------------------|------------|------------|--------|---------|---------------|------------------|-------------------|-------------------|---------------------|----------------|----------------|
| Average               | 18.72      | 254.2      | 0.27   | 0.43    | 669.5         | 179.5            | 0.35              | 253.17            | 103.94              | 146.67         | 63.89          |
| Standard Deviation    | 3.01       | 22.45      | 0.03   | 0.04    | 46.33         | 27.91            | 0.03              | 10.52             | 6.96                | 9.55           | 4.04           |
| CV (%)                | 19.28      | 8.83       | 11.0   | 10.4    | 6.92          | 15.5             | 7.76              | 4.08              | 6.69                | 5.51           | 3.33           |
| Standard Error        | 0.85       | 5.29       | 0.01   | 0.01    | 10.92         | 6.58             | 0.01              | 2.48              | 1.64                | 2.25           | 0.95           |
| Median                | 16.00      | 249.0      | 0.25   | 0.42    | 665.0         | 172.5            | 0.36              | 253.00            | 101.00              | 145.00         | 65.00          |
| Min                   | 14.00      | 231.0      | 0.23   | 0.35    | 560.0         | 145.00           | 0.30              | 240.00            | 92.00               | 130.00         | 60.00          |
| Max                   | 27.00      | 301.0      | 0.32   | 0.49    | 742.0         | 215.00           | 0.40              | 272.00            | 120.00              | 165.00         | 70.00          |
| Confidence interval - | 17.05      | 243.8      | 0.25   | 0.33    | 648.1         | 160.61           | 0.34              | 253.31            | 106.73              | 142.20         | 62.02          |
| Confidence interval + | 20.39      | 264.6      | 0.28   | 0.42    | 690.9         | 192.39           | 0.36              | 283.03            | 107.16              | 151.00         | 65.76          |
| Skewness              | 0.23       | 0.71       | -0.59  | 0.08    | -0.22         | -1.89            | -0.41             | -1.15             | 0.06                | 0.05           | -1.26          |
| Kurtosis              | 0.03       | 1.30       | 0.72   | 0.84    | -0.42         | 0.19             | -0.24             | -0.27             | 0.56                | 0.54           | 0.45           |

### Table 5

| Hypothyroid Patients | T4 (mg/dl) | T3 (mg/dl) | RIC 2h | RIC 24h | Lipemia (mg%) | Cholesterol (mg%) | Basal metabol. (%) | Achilles Reflex (ms) | Cardiac Freq (bp/min) | MAX BP (mmHg) | MIN BP (mmHg) |
|----------------------|------------|------------|--------|---------|---------------|------------------|-------------------|-------------------|---------------------|----------------|----------------|
| Average              | 3.07       | 51.22      | 0.11   | 0.21    | 919.8         | 343.17           | -0.14             | 361.23            | 70.61               | 137.22         | 72.78          |
| Standard Deviation   | 0.49       | 8.31       | 0.01   | 0.01    | 51.90         | 39.57            | 0.30              | 6.89              | 4.07                | 15.74          | 10.46          |
| CV (%)               | 15.97      | 16.22      | 11.7   | 2       | 7.04          | 5.73             | 11.53             | 21.87             | 1.91                | 5.77           | 11.47          |
| Standard Error       | 0.12       | 1.96       | 0.00   | 0.00    | 14.59         | 9.33             | 0.01              | 1.62              | 0.96                | 3.71           | 2.47           |
| Median               | 3.05       | 54.00      | 0.11   | 0.20    | 912.0         | 354.00           | -0.15             | 360.50            | 71.00               | 137.50         | 72.50          |
| Min                  | 2.30       | 38.00      | 0.08   | 0.18    | 310.0         | 270.00           | -0.20             | 350.00            | 58.00               | 120.00         | 60.00          |
| Max                  | 4.00       | 62.00      | 0.12   | 0.23    | 392.0         | 410.00           | -0.09             | 374.00            | 75.00               | 165.00         | 65.00          |
| Confidence interval -| 2.04       | 47.38      | 0.10   | 0.20    | 389.1         | 324.05           | -0.16             | 353.09            | 68.73               | 129.95         | 67.94          |
| Confidence interval +| 3.29       | 55.06      | 0.11   | 0.21    | 448.5         | 361.45           | -0.13             | 364.46            | 72.49               | 144.49         | 77.61          |
| Skewness             | -0.30      | -1.36      | 0.65   | 0.35    | -1.23         | -0.18            | -0.73             | -0.96             | 4.55                | -1.22          | -1.79          |
| Kurtosis             | 0.14       | -0.41      | 0.52   | 0.11    | -0.26         | -0.38            | 0.37              | 0.00              | -1.73               | 0.40           | -0.07          |
so not very high. Thus all the obtained mediums, generally speaking, are safe from an informative statistic point of view [24, 29].

The differences between the average values obtained on the lot of hyperthyroid patients compared to the ones obtained on the lot of hypothyroid patients [37, 41] are very high, between 32.02% and 140.85% - the majority are 40 ± 91% at nine comparisons, only at 2 they are lower than 13.91% and 6.44 (table 6).

There are significant statistical assurances between the two lots for all the parameters.

These great differences are statistically significant [34, 38], with very high significance (p<0.001) in most cases, as shown by 3 calculus methods (Student, ANOVA, Chi²).

### Table 6

**AVERAGE ABSOLUTE VALUES OF HORMONAL, BIOCHEMICAL, PARA-CLINICAL, AND PHYSIOLOGICAL DETERMINATIONS FOR HYPERTHYROID PATIENTS AND HYPOTHYROID PATIENTS, ABSOLUTE AND RELATIVE DIFFERENCES FOR THE VALUES BETWEEN THE TWO LOTS AND STATISTICAL PROOFING OF THESE DIFFERENCES**

| Parameter | T4 (mg/dl) | T3 (mg/dl) | RIC 2h | RIC 24h | Lipemia (mg%) | Chol. (mg%) | Basal metab. (%) | Achilles Reflex (ms) | Cardiac Freq. (bpm) | MAX BP (mmHg) | MIN BP (mmHg) |
|-----------|------------|------------|--------|---------|--------------|-------------|------------------|---------------------|-------------------|---------------|---------------|
| Abs. Value for Hyperthryroid Patients | 18.72      | 254.22     | 27.00  | 48.00   | 669.58       | 179.50      | 35.00            | 258.17              | 103.94           | 146.67        | 63.89         |
| Abs. Value for Hypothyroid Patients  | 3.07       | 51.22      | 11.00  | 21.00   | 919.94       | 343.17      | -14.00           | 351.28              | 70.61             | 137.22        | 72.76         |
| Absolute difference                | 15.66      | 203.00     | 16.00  | 27.00   | -250.39      | -163.67     | 50.00            | -130.11             | 33.33             | 4.44          | -8.89         |
| Difference %                       | 83.62      | 79.85      | 59.33  | 48.62   | -37.40       | -91.18      | 104.85           | -39.94              | 32.07             | 6.44          | -13.91        |

### Table 7

**STATISTICAL ENSURING THROUGH STUDENT, ANOVA AND CHI SQUARE TESTS OF THE DIFFERENCES BETWEEN THE TWO LOTS OF THYROID PATIENTS (BETWEEN THE AVERAGE VALUES OF HORMONAL, BIOCHEMICAL, PARACLINICAL, AND PHYSIOLOGICAL DETERMINATIONS). THERE ARE VERY HIGH STATISTICAL ENSURANCES (VHS) FOR MOST OF THE PARAMETERS**

### Table 8

**PERCENTAGE FORMULATION OF THE DIFFERENCES BETWEEN THE 2 LOTS OF THE AVERAGE VALUES OF ALL PREVIOUSLY SPECIFIED DETERMINATIONS. THE DIFFERENCES BETWEEN THE AVERAGE VALUES OF THE TWO LOTS ARE STATISTICAL ENSURED WITH VERY HIGH SIGNIFICANCE (VHS)**

![Fig. 2. Above the superior part of any column is the absolute numerical value of the parameter. The small horizontal rectangles, colored green, blue or yellow, placed below the abscise expose the p values obtained through Student's t test, respectively how large the statistical assurance of differences between the 2 patient lots is.](http://www.revistadechimie.ro)
Fig. 3. Above the superior part of any column is the absolute numerical value of the parameter. The small horizontal rectangles, colored green, blue or yellow, placed below the abscise expose the p values obtained through Student’s t test, respectively how large the statistical ensurance of differences between the 2 patient lots is with p values between p=5.8x10⁻¹¹ and p=6.64x10⁻²⁰ (table 7 and 8).

In figure 2, 3 and 4 the differences of the average absolute values between the 2 groups (fig. 2, 3) and relative values % (fig. 4) can be seen. Following these measurements, there was also a great mathematical correlation coefficient r between the majority (9) of studied parameters [42, 45] (except for blood pressures), with values over 0.9 (0.902 to 0.986), correlations calculated by the Pearson formula [43, 44]. That shows that if a parameter increases with 100%, the other one for which the correlation was calculated to the first one modifies (plus or minus) with 90.2% respectively 98.61%, which is an interesting scientific fact (table 9).

This precise mathematical determination of the thyroid function on the 2 groups was necessary to know exactly what thyroid pathology, how severe, we explore through VEP.

Modifications of visual evoked potentials

Tables 10 and 11 show that in hypothyroid patients the latency of the P100 increases by 17.88% (p<0.01), and the one of the N75 wave only with 9.88% (p<0.05), as proved by the Student’s t test, but also by the Mann-Whitney and ANOVA tests (table 10). Also, the duration of the N75 wave drops with 26.37% (p = 0.0265). All these differences of the VEP waves, statistically significant or not, are presented % in figure 5.

In addition to the quoted authors we found important percentage differences, highly significant (p<0.001) for P100 and only significant (p<0.05) for N75, because we had greater differences of the thyroid function between hyper and hypothyroid patients, while all previously quoted article showed smaller differences between normal thyroid and hypothyroid patients (in most articles) or between normal thyroid and hyperthyroid patients. Moreover, some authors note statistically significant differences, others don’t, but no information is given on the severity of thyroid pathology. Possibly the pathology was more severe for some authors, and easier for others, where the increase of the latency of the P100 wave was not statistically significant.

The other parameters of the VEP, other than N75 and P100 waves, although presenting great percentage differences, up to 52.35%, due to the high dispersion of the individual values obtained on them (with CV% between 25.17 and 151.16%, the majority around 80%), showed no statistic significant differences – as observed more clearly in table 11 and figure 5.

In order to interpret all the differences of the average values of all VEP parameters on the two main waves N75 and P100, even if they are not statistically significant (beside latency differences), we must start, in order to interpret

Table 9

|            | T4 (mg/dl) | Lipemia (mg%) | Chol. (mg%) | Achilles Reflex (ms) | Cardiac Freq. (bpm) | MAX BP (mmHg) | MIN BP (mmHg) |
|------------|------------|---------------|-------------|----------------------|---------------------|---------------|---------------|
| T4 (mg/dl) | 0.985      | -0.922        | -0.930      | -0.999               | 0.962               | 0.351         | -0.511        |
| Lipemia (mg%) | -0.906        | -0.914        | -0.969      | 0.961                | 0.397               | -0.495        |
| Cholesterol (mg%) | 0.976        | 0.962        | -0.908      | -0.446               | 0.361               |               |               |
| Achilles Reflex (ms) | -0.918        | -0.918        | -0.393      | 0.413                | 0.500               |               |               |
| Frequency (bpm) |               |               |               | 0.346                | 0.524               |               |               |
| MAX BP (mmHg) |               |               |               | 0.449                |                     |               |               |
Table 10

AVERAGES, STANDARD DEVIATIONS, CV%, STANDARD ERRORS IN HYPOTHYROID PATIENTS AS OPPOSED TO HYPERTHYROID PATIENTS FOR THE IMPORTANT PARAMETERS OF THE VEP WAVES (N75, P100). DIFFERENCES AND STATISTICAL INSURANCES OF DIFFERENCES. HERE WE FOCUS ON STATISTICAL ENSURED DIFFERENCES, AND NONE IS VERY HIGH SIGNIFICANT.

|                      | HYPERTHYROID PATIENTS | HYPOTHYROID PATIENTS | Difference | Statistical insurance by: |
|----------------------|------------------------|-----------------------|------------|---------------------------|
|                      | Mean | StdDev | C.V. % | StdErr | Mean | StdDev | C.V. % | StdErr | Abs  | Rel. % | Student | Mann | ANOVA |
| Latency N75 wave     | 69.97 | 4.49   | 6.51   | 1.5    | 75.05 | 6.81   | 8.98   | 1.97   | 6.68 | 9.58   | 0.0166  | S    | 0.0159 |
| Latency P100 wave    | 83.88 | 12.8   | 15.25  | 4.27   | 98.06 | 6.94   | 6.11   | 1.62   | 15   | 17.08  | 0.0028  | NS   | 0.0031 |
| Amplitude N75 wave   | 1.95  | 1.01   | 51.79  | 0.36   | 1.71  | 1.59   | 92.98  | 0.48   | -0.24| -12.31 | 0.74    | NS   | 0.72   |
| Amplitude P100 wave  | 4.10  | 2.26   | 54.55  | 0.76   | 4.91  | 3.46   | 70.47  | 1.64   | 0.73 | 17.40  | 0.61    | NS   | 0.58   |
| Duration N75 wave    | 22.45 | 6.02   | 25.82  | 1.74   | 16.53 | 6.81   | 41.20  | 1.76   | -5.92| -26.37 | 0.0255  | S    | 0.025  |
| Duration P100 wave   | 34.41 | 8.86   | 25.17  | 3.66   | 27.69 | 10.47  | 37.95  | 2.7    | -6.82| -16.82 | 0.15    | NS   | 0.1277 |
| Sleepness N75 wave   | 0.25  | 0.12   | 48.00  | 0.04   | 0.19  | 0.1    | 52.63  | 0.03   | -0.06| -24.00 | 0.25    | NS   | 0.2241 |
| Sleepness P100 wave  | 0.28  | 0.21   | 75.00  | 0.67   | 0.32  | 0.21   | 65.63  | 0.04   | 0.04 | 14.29  | 0.65    | NS   | 0.6482 |
| Area N75 wave        | 31.71 | 29.04  | 91.50  | 10.27  | 17.03 | 22.5   | 127.02 | 7.11   | -14.98| -44.40 | 0.29    | NS   | 0.2683 |
| Area P100 wave       | 95.51 | 51.31  | 53.72  | 18.14  | 107.51| 91.9   | 85.48  | 29.06  | 12   | 12.56  | 0.76    | NS   | 0.7411 |
| IBA N75 wave         | 0.79  | 0.85   | 127.59 | 0.3    | 0.43  | 0.05   | 151.16 | 0.21   | -0.36| -45.57 | 0.36    | NS   | 0.53   |
| IBA P100 wave        | 1.49  | 1.4    | 93.96  | 0.49   | 2.27  | 2.6    | 114.54 | 0.82   | 0.78 | 52.35  | 0.41    | NS   | 0.5345 |
| LAI N75 wave         | 35.30 |        |       |       | 44.35 |        |       |       | 0.98 | 25.41  |        |       |       |
| LAI P100 wave        | 20.06 |        |       |       | 20.13 |        |       |       | 0.071| 0.35   |        |       |       |

Table 11

ABSOLUTE AND RELATIVE VALUES AND DIFFERENCES OF VEP PARAMETERS BETWEEN THE 2 LOTS OF THYROID PATIENTS AND THEIR STATISTICAL INSURANCES

|          | Latency N75 | Ampliff N75 | Duration N75 | Sleepness N75 | Area N75 | IBA N75 | LAI N75 | Latency P100 | Ampliff P100 | Duration P100 | Sleepness P100 | Area P100 | IBA P100 | LAI P100 |
|----------|-------------|-------------|--------------|---------------|----------|---------|---------|-------------|-------------|--------------|---------------|----------|---------|---------|
| HIPER    | 100.00      | 100.00      | 100.00       | 100.00        | 100.00   | 100.00 | 100.00 | 100.00      | 100.00      | 100.00       | 100.00        | 100.00   | 100.00  | 100.00  |
| Hipo     | 100.98      | 87.60       | 73.63        | 76.00         | 55.60    | 54.43  | 125.41 | 117.88      | 117.46      | 80.18        | 114.29        | 112.58   | 152.35  | 130.36  |
| DIF      | 0.98        | 12.31       | 26.37        | 24.00         | 44.40    | 45.57  | 35.41  | 17.38       | 17.46       | 19.82        | 14.29         | 12.56   | 52.35   | 0.36    |
| p Student| 0.0165      | 0.7490      | 0.0235       | 0.2500        | 0.2900   | 0.3900 | 0.0239 | 0.6100      | 0.1500      | 0.0500       | 0.7600        | 0.4130  |         |         |

Table 12

TABLE OF RATIOS OF VEP, P100/N75, WAVES FOR AMPLITUDES AND SURFACES AND THE PERCENTAGE DIFFERENCES OF THE RATIOS BETWEEN HYPO AND HYPERTHYROID PATIENTS

| Parameter | P100/N75 ratios for hyperthyroid patients | P100/N75 ratios for hypothyroid patients | Differences % between hypo and hyperthyroid patients (considered as 100%) |
|-----------|-------------------------------------------|------------------------------------------|---------------------------------------------------------------------|
| Amplitude| 2.1433597                                 | 2.871345                                 | 133.5497 %                                                          |
| Surface  | 3.0981884                                 | 5.0981281                                 | 202.71759 %                                                        |
There are weak statistical correlations between some VEP parameters and biochemical, hormonal and paraclinical parameters.

| Table 13
| CORRELATION COEFFICIENTS R BETWEEN THE MAIN ELECTROPHYSIOLOGICAL, HORMONAL AND PARACLINICAL PARAMETERS. THERE ARE WEAK STATISTICAL CORRELATIONS BETWEEN SOME VEP PARAMETERS AND BIOCHEMICAL, HORMONAL AND PARACLINICAL PARAMETERS |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Latency N75 wave                 | T4                               | T3                               | Achilles Reflex                 | Cardiac Freq                     | MAX BP                           | MIN BP                           |
| Latency P100 wave                | -0.222                           | -0.27                            | 0.344                           | -0.288                           | -0.442                           | 0.263                           |
| Duration N75 wave                | -0.871                           | -0.559                           | 0.603                           | -0.651                           | 0.566                            | 0.66                            |
| Duration P100 wave               | 0.007                            | 0.198                            | -0.206                          | 0.168                            | -0.402                           | -0.23                           |
| Amplitude N75 wave               | -0.211                           | -0.204                           | 0.193                           | -0.220                           | -0.08                            | 0.064                           |
| Amplitude P100 wave              | 0.082                            | 0.069                            | -0.071                          | 0.056                            | 0.153                            | 0.095                           |

It is noticeable that, in all researched literature regarding VEP modifications induced by thyroid pathology, no safe statistical researches are performed through several formulas, nothing is said about the severity of the pathology mirrored in several hormonal, biochemical and paraclinical analyses, and VEP[4]. No correlation calculus is performed between all non-electrophysiological parameters and some electrophysiological parameters - statistical processing that brought a safe base to the existence of a liason of the severity of thyroid pathology with VEP modifications[26].

Plus, all global clinical and VEP researches, in all literature, with no exception, have only followed or shown modifications of the latency of the P100 wave, sometimes of the amplitude and very rarely of the duration [17]. Nothing about the other important waves of VEP (N75 and N135), and measure of all their parameters (latency, amplitude, duration, surface, steepness of wave increase). New, original indices proposed by us, IBA = steepness x amplitude index and LAI = latency/amplitude index, weren't even experimentally determined in literature [25]. Whereas its impossible to make a statement about the balance between excitation (represented by N75) and inhibition (represented by P100), about the mathematic ratio between them and its modification according to thyroid pathology [19].

Conclusions

Following the recording of visual evoked potentials and of 11 humoral and paraclinical parameters on two thyroid patients groups (18 hyperthyroid, 18 hypothyroid), the result were:

- The age of the illness and treatment duration are much higher in hypothyroid patients (highly significant differences, p<0.01).

- The 11 humoral and paraclinical determined parameters, in their majority, have very different values between the 2 groups, with statistically significant differences (p<0.001).

- Seven humoral and paraclinical parameters correlate extremely well with each other, (Pearson’s r correlation coefficients over 0.9) showing that they modify in parallel with the level of thyroid activity.

- The latency of the N75 wave is significantly increased, and the one of the P100 wave is significantly high in hypothyroid patients, with 9.98%, and 17.88% respectively.

- The duration of the N75 wave is significantly lower, with statistical significance, in hypothyroid patients, by 26.37%, and 17.52% (fig. 5).

- The amplitude of the N75 wave increases almost double, up to 17.88% - highly significant (p<0.001).

- The ratios of the amplitudes and of the areas of the P100/N75 are much higher (3.008 as opposed to 6.098), thus a predomination of the inhibition in the visual cortex in hypothyroid patients.

- New, original indices proposed by us, IBA = steepness x amplitude index and LAI = latency/amplitude index, weren’t even experimentally determined in literature [25]. Whereas its impossible to make a statement about the balance between excitation (represented by N75) and inhibition (represented by P100), about the mathematic ratio between them and its modification according to thyroid pathology [19].
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