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EFFECTS OF WAVELETS TRANSCORNEAL-STIMULATION ON LOW VISION PATIENTS WITH CENTRAL RETINAL ARTERY OCCLUSION CRAO

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The present work presents the effect of wavelets waveforms electrical stimulation applied on low vision (LV) patients suffering central retinal artery occlusion CRAO. Stimulations is done via transcorneal electrical stimulation (TES) by means of an adaptive wavelets system generator. The applied waveform signal is generated into a digital processor, and is based on a healthy eye's multi-focal wavelet signal obtained from electroretinography (MF-ERG) response of healthy people. The stimulation protocol proposed in this paper is qualitatively different from others, like Inomata et. al. [1,2] that uses square bipolar signals. All stimulated patients improve at least one line in Fainbloom's visual acuity exams scale. Results are correlated with an important increased in the electrical A and B wave response in standard electroretinography and with subjective patient's visual acuity confirmed by the fact all stimulated patients improve at least one line in Fainbloom's scale at least, in visual acuity exams.

KEY WORDS: *eye, wavelet, patient, time stimulation*

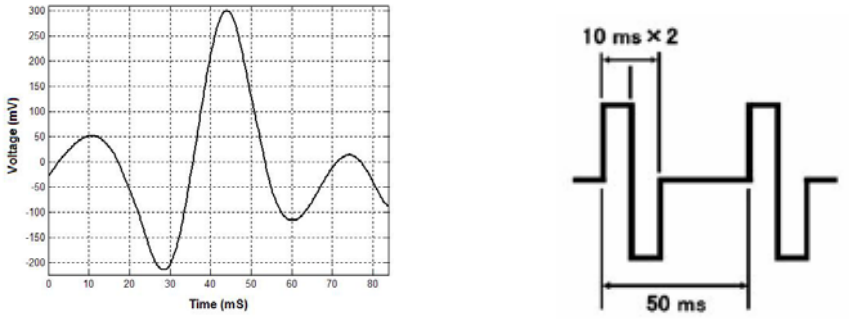
1. INTRODUCTION

CRAO is blockage of the central retinal artery, usually due to an embolism. It produces drastic and painless, unilateral loss of vision as symptom in acute face. It is considered an emergency, and in chronic face there is no conventional treatment; almost always vision loss is permanent [3,4]. The electrical stimulation of neural tissues seems to

have a neuroprotective effect, and the mechanism for this effect has been suggested to be an up-regulation of neurotrophic factors [5,6].Research in artificial retina affirms that the effect of electrical stimulation on corneal tissue evoke visual sensations (phosphenes) [6,7,9]. Patients report that TES produce “luminous sensations” during stimulation. These observations aim us to investigate if TES used for therapy improves the visual acuity of patients suffering from CRAO.

2. METHODOLOGY

Electronic aye stimulation is a wavelet model from a set of mathematical approximation functions [8-12]; we modeled the curve by means of the mean square statistical regression method [9]. The electronic device was completely designed in order to stimulate tissue with low power signals indicated in Fig. 1. Figure 2 shows patient’s electroretinography A and B waveform measurements.



a) b)

FIG. 1: a) Proposed waveform stimulation of 11.8 Hz, b) 20 Hz Inomata’s proposed waveform

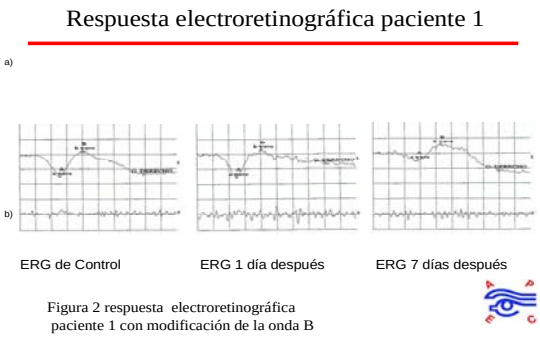


FIG. 2: Patient electroretinography

The digital-to-analog converter (DAC) circuit, connects the patient's eye with the waveform proposed [9]. The micro controller μC sends a group of hexadecimal 8 bit coded words, in order to build an analog voltage wavelet [8]. This μC is always waiting by the master's instruction in order to stop the waveform generation. The generated analog signal is conditioned, limiting the current and filtering the implicit noise by the attenuator circuit.

This research followed the tenets of the Declaration of Helsinki, informed consent was obtained from subjects after explanation of the nature and possible consequences of the study; the research was previously approved by the human experimentation institutional committee (APEC hospital). We selected 9 volunteers suffering LV because of CRAO and divided them in 3 groups: Group number 1 is defined as a control group; those patients did not receive TES therapy. Group number 2 received 45 minutes of TES twice per month, and group number 3 received 45 minutes of TES once per week. A standard ERG and visual acuity (Fainbloom's scale) test were performed 7 days before the first TES to all patients, then once per month during two months along the TES experiment. Table 2 shows the patients characteristics and groups of test. **Patient's preparation.** Patients in groups 2 and 3 were prepared with the electrodes following the standard ERG procedure, previous to each TES session [1,8,9].

TABLE 1: Groups of patients under test

Number	Age	Affected eye	Time With LV Years/Months	Group
2	68	Left	1/3	1
3	69	Left	0/10	1
3	72	Right	1/0	1
1	66	Left	10/5	2
5	74	Right	4/9	2
5	81	Right	11/2	2
7	77	Left	4/6	3
8	79	Right	3/1	3
9	72	Left	5/9	3

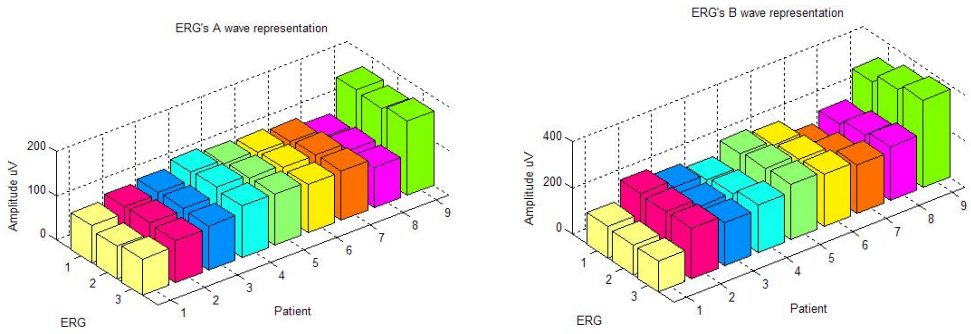
3. RESULTS

Table 2 shows the voltage amplitudes measured in every ERG tests, for each patient during the experiment. A wave represents the cone and rod cells electrical response, depicted after a light Numeric results in Table 3 confirm that B wave amplitudes of patients in group 1 have not significant changes. B wave amplitudes of patients in group 2 have a minimum growing rate about 10 μV per month, meanwhile patients in group 3; B wave have a minimum rate above 24 μV per month statistically calculated.

TABLE 2: Comparison of different group of patients ERG results

Number	Control ERG (μV)		1 Month ERG (μV)		2 Months ERG (μV)	
	A Wave	B Wave	A Wave	B Wave	A Wave	B Wave
Group 1						
1	83.76	136.6	74.45	130.2	82.16	132.4
2	97.44	222.7	99.21	217.4	95.84	219.5
3	102.97	190.7	103.52	183.5	100.23	187.8
Group 2						
4	120.21	166.6	123.43	182.3	117.23	207.4
5	111.33	224.0	115.76	235.4	116.18	239.3
6	107.96	205.7	110.82	217.9	108.56	225.7
Group 3						
7	103.76	136.6	110.62	172.6	111.53	210.3
8	86.17	183.2	92.64	211.4	90.21	232.1
9	164.31	309.0	159.82	350.4	168.15	378.6

Figure 3 shows A and B waves amplitude changes indicated in Table 2 for each patient. In this figure, we can appreciate significant A wave changes. During the experiment, patients in group 2 and 3 reported their subjective improvement perceptions; in all cases they have the sensation of better visual acuity than before TES therapy. Neither pain nor uncomfortable sensations were described when TES was applied.



a) b)

FIG. 3: Standard ERG's A and B amplitude wave variation during the experiment for each group of patient

Figure 4 shows the ERG wave A and B variations for each group patients as a function of time stimulation. We can see clearly amplitude improvement in A and B when TES is applied more frequently.

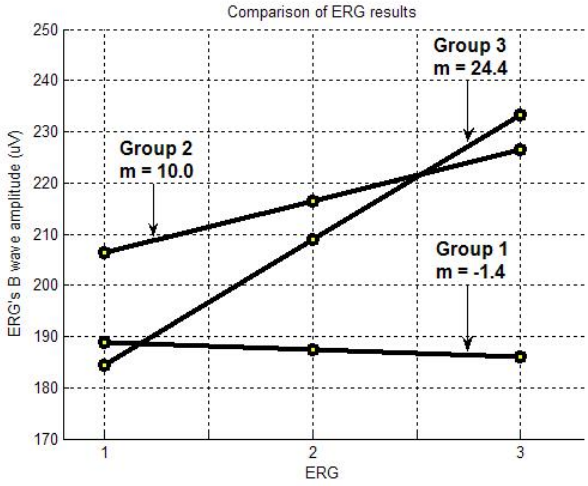


FIG. 4: Standard ERG`s wave variations as a function of time stimulation

4. CONCLUSIONS

The subjective vision improvement reported by patients, important modification of the A an B electroretinogram waveform and visual acuity test let us affirm that the applied wavelets waveform in CRAO patients causes the retinal reactivation, that phenomena must be studied deeply in order to understand properly the effect of trans corneal electrical wavelets stimulation with the parameters proposed. The visual acuity test and standard ERG analysis indicates, that the TES indeed causes an effect on neuronal activity recovery. All stimulated patients improve at least one line in Fainbloom's scale at least, in visual acuity exams Frequency of stimulation seems to produce an important effect in visual sensation.

5. ACKNOWLEDGEMENTS

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