Audio-luminous Biofeedback Training to improve visual functions and quality of life in patients with brain injury

Yulia Pyatova MD[1],, Michelle Markowitz OT, OD[2], Samuel N Markowitz MD FRCSC[1], Monica Daibert-Nido MD[1]
[1]Low Vision Rehabilitation Program, Faculty of Medicine, Department of Ophthalmology, University of Toronto. [2]Private practice, Toronto, ON, Canada

Introduction

Oculomotor control is affected in patients with visual fields defects, hemianopia included. Biofeedback training (BT) aims at improving oculomotor control and was never used before in patients with post-brain injury and hemianopia. Eccentric viewing training for central visual loss with BT showed to increase fixation stability, reading speed, contrast sensitivity, quality of life, and distance vision. [1-5] Dyslexia post brain injury has been treated also with prisms to promote field displacement enhancing the reading span and oculomotor training exercises.[6-9]

Objective

To improve visual functions and quality of life in patients with hemianopia.

Methods

Patients with diagnosis of hemianopia were studied prospectively in control and treated groups. Control patients crossed over to the treated group after 7 days. Randomization was in a 1:1 ratio. Treated patients were measured 1 week post-BT.

Outcome Measures:
Fixation stability (BCEA 63%), microperimetry C 10-2 , best corrected ETDRS Visual Acuity for distance and near, MNRead reading speed test, Frisby Stereotest, Contrast Sensitivity (VCTS) 1 cycle/deg channel, and Massof Quality of life questionnaire data were collected. To avoid bias, in the baseline visit, BCEA was tested twice for 20 seconds each, and the first measure was discarded.

Intervention:
The MAIA microperimeter BT module was used. A trained retinal locus (TRL) was selected in the eye ipsilateral to the hemianopia, 0.5 to 1^0 from the preferred retinal locus towards the better seeing fields. Audio and luminous biofeedback was delivered on 5 weekly sessions of 20 minutes each. A t-test was used for comparisons.

Results

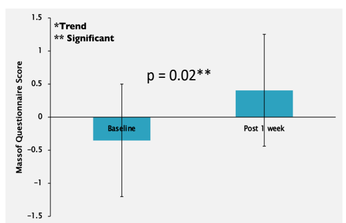
6 subjects completed the study. Age average was 67.5 +/- 17.9. 4 patients had left hemianopia and 2 right hemianopia. 50% were female. 3 patients were in the control group and crossed over, and 6 patients were in the treated group. The control and treatment groups were not significantly different in demographics. In the control group, there was no difference for any of the measurements pre and pos-BT.

Table 1 –Demographics, Etiology and Cohorts

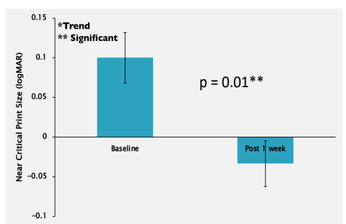
Patient ID	Age	Sex	Race	Cause of Hemianopia	Time with Hemianopia (months)	Control	Treated
1	57	Male	Black	Stroke	7	Yes	Yes
2	40	Female	White	Stroke	12	No	Yes
3	72	Male	White	Herpetic Encephalitis	7	Yes	Yes
4	64	Female	White	Neurosurgery for Brain Tumor	5	No	Yes
5	82	Male	White	Stroke	2	Yes	Yes
6	90	Female	White	Stroke	24	No	Yes

1 week post-BT, Massof questionnaire showed a significant improvement in subsection visual ability from 0.73 (± 1.82) to 1.75 (± 1.45) p=0.001, subsection reading from 1.79 (± 2.01) to 3.67 (± 1.55) p=0.006, mobility from -0.35 (± 2.41) to 0.41 (± 2.39) p=0.02, and visual information from 1.25 (± 1.49) to 2.19 (± 1.15) p=0.02. Near reading improved from 0.1 (± 0.09) to -0.03 (± 0.8) p=0.01, reading speed from 110.2 (± 53) to 149.3 wpm (± 59.7) p=0.05, BCEA 63% from 0.4 (± 0.3) to 0.2 s^{02} (± 0.2), p=0.09. Distance vision, contrast sensitivity, retinal sensitivity and stereopsis did not change significantly. No side effects were reported.

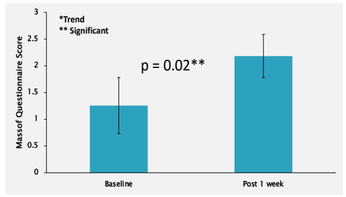
Questionnaire QoL : Massof Subsection Mobility



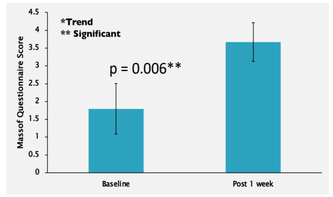
Near Vision Continuous Print Critical Print Size



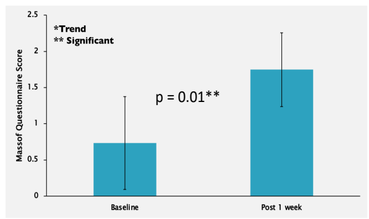
Questionnaire QoL : Massof Subsection Visual Information



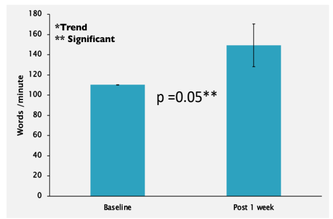
Questionnaire QoL : Massof Subsection Reading



Questionnaire QoL : Massof Subsection Visual Ability



Reading Speed (MNRead)



Fixation Stability (BCEA 63%)

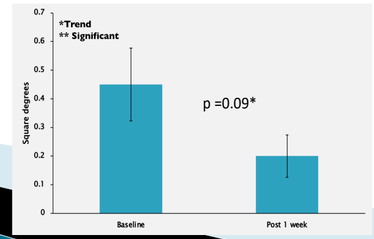
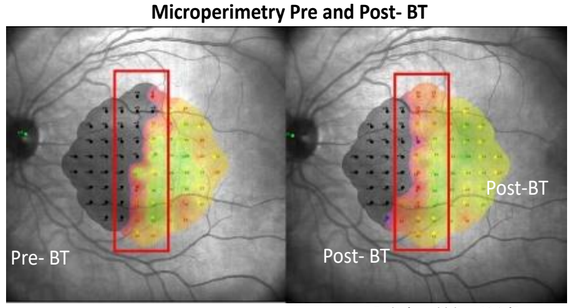


Table 2 –Visual Functions Outcomes Pre- and Post-BT for Treated Group

Treated Group			
Outcome	Baseline (Ave, SD)	Post 1 week	P ** significant, * trend
Distance Vision – ETDRS (LogMAR)	0.17 ± 0.25	0.05 ± 0.08	0.2
Near Vision – ETDRS (critical print size)	0.1±0.09	–0.03 ± 0.8	0.01 **
Contrast Sensitivity – VCTS (1 Cyc/deg)	1.74 ± –0.23	1.88 ± 0.12	0.1
Reading speed (words/ minute)	110.2 ± 53	149.3 ± 59.7	0.05 **
Stereopsis for near (arc degrees)	1265 ± 1372	604.1 ± 1182.3	0.2
Retinal sensitivity MP 10–2	16.4 ± 3.5	16.5 ± 3.9	0.8
Fixation stability (BCEA 63%, square degrees) MAIA Fixation 20 seconds Test	0.4 ± 0.3	0.2 ± 0.2	0.09*

Microperimetry Pre and Post- BT



Retinal sensitivity = 12.6 dB
Two central columns average = 13.6 dB

Retinal sensitivity = 13.8 dB
Two central columns average = 18.2 dB

Conclusion:

In our sample, biofeedback training for patients with hemianopia resulted in a significant improvement of near vision, reading speed, and a trend for improvement of fixation stability. Furthermore, the Massof validated quality of life questionnaire pointed a significant benefit in four from 4 subsections: mobility, visual information, reading, and visual ability. The benefits were maintained after cessation of BT until the present.

The mechanisms of BT therapy involve attention and brain plasticity in neural pathways responsible for oculo-motricity.[10-14] Patients with brain injury from different etiology may benefit from BT in the future.

Quality of live assessment is the most sensitive method in vision rehabilitation research to evaluate interventions' impact and significance. While noticeable changes in the visual acuity may not occur from an intervention due to limitations from the disease, the patient's quality of life may show the benefits obtained.

This study has the limitation of a small cohort. Continuation of the study is mandatory for validating its findings and broadening its conclusions.

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