# *Effect of Galvanic Vestibular Stimulation on Recovery from Gaze Palsy*

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## ABSTRACT

The purpose of this study was to evaluate the effect of galvanic vestibular stimulation (GVS) on recovery from gaze palsy. Twenty patients with gaze palsy, (14 males and 6 females) their age ranged from 20-63 years

with mean age 47.9±12.5 years. Duration of gaze palsy ranged from 4-24 months with mean of 10.6-^5.23. Twelvepatients were post stroke and eight patients with definite multiple sclerosis. They received galvanic vestibularstimulation three times/week for four weeks. They were assessed by using three point scale for gaze deviation, line

bisection test and line crossing test. These measures were recorded before the vestibular stimulation (pretreatment) and after four weeks (post treatment). Results of this study showed that, there was significant decreasein the grades of gaze deviation, significant improvement in line bisection and line crossing. It was concluded that,

galvanic vestibular stimulation is a beneficial central non invasive modality improve recovery from gaze palsy

Conjugate eye deviation (CED) occurs inapproximately 20% of patients with

cerebro vascular disease* and in 18%-39% ofpatients with multiple sclerosis[2]. The underlyingmechanism of CED is thought to be a disturbanceof the cortical center or subcortical pathways involved in the control of voluntary eye movements. A sudden unbalance between the left and right tonic frontal inputs on the superior colliculus and/or premotor reticular formations of the brain stem is the possible mechanism of the initial eye deviation observed after an acute frontal lesion1.

Disorders of ocular motility may occur afterinjury at several levels of the neuraxis. Unilateral supranuclear disorders of gaze tend to be transient; bilateral disorders more enduring.Nuclear disorders of gaze also tend to be enduring and are frequently present in association with long tract signs and cranial nerve palsies on opposite sides of the body[3]. Eye-movement disorders *commonly occur in vertebrobasilar stroke, although they are* often unappreciated. Vertebrobasilar strokes can yield varied disturbances of eye movements, by affecting specific centers and pathways contained in the brain stem and cerebellum. Unique disorders combining supranuclear, nuclear, and infranuclear

syndromes may occur[4,5].Vestibular system plays an important role in maintenance of human balance, posture, coordination of eye movement with head movement tand spatial representation

organs both contribute to gaze stabilization duringhead movement. The six semicircular canals form three functional pairs that lie in planes roughly orthogonal to each other. In addition, each canal works in a reciprocal arrangement with its paired partner in a push-pull fashion. The brainstem supplies the necessary neural connections todeliver the signals from the canals to the eyemuscles to move the eyes appropriately for thevestibulo-ocular reflex (VOR)[10].Two kinds of pathways ascend from thevestibular nuclei; some are concerned withoculomotor control and some are concerned withspatial orientation. Signals concerned with controlof the eye movements ascend the mediallongitudinal fasciculus to thenuclei of cranial
nerves III, IV, and VI. Both sets of vestibularnuclei send bilateral projections to the cranial
nerves some of which are excitatory and some ofwhich are inhibitory[11].
The vestibular system can be stimulated bygalvanic vestibular stimulation (GVS). Galvanicvestibular stimulation has been used for almost200 years for exploration of **vestibular system.**
The eye movement pattern induced by applicationof electric currents to labyrinth is known as the galvanically induced vestibule-ocular reflex[12]

## SUBJECTS AND METHODS

***Subjects:***

*Twenty patients with gaze palsy wher eincluded in this study, twelve patients with post stroke and eight patients with definite multiple sclerosis (MS). Patients with defmite multiplsclerosis (MS) were diagnosed as having clinically defmite MS according to poser criteria[13], or having MRI supported defmite MSaccording to Paty and Li[14]. All patients chosenfrom neurology department at El-Kasr El-AiniHospital, Cairo University, their age ranged from20 - 63 years with mean age of47.9±12.5 years.Duration of gaze palsy was ranged from four totwenty four months with mean of 10.6±5.23*
*months, they were 14 males (70%), 6 females*
***70}.***

***Exclusion Criteria:***

*Patients with vestibular disorders, othe rophthalmological problems, perceptual deficits,auditory, speech, and mental disturbances were excluded.*

***Methods:***

Subjects with defmite MS patients were subjected to the following.
1- Full clinical assessment including t
history taking to detect the disease di
the number of relapses, the type ofsyn
and the proper stage of the diseasi
clinical evaluation included also t]
clinical examination and assessment
disability by the expanded disability s
scale (EDSS).
**2-** Neurophysiological assessment by
different evoked potential.
3-Examination by MRI brain and cervica
if indicated.
4- Laboratory tests including
-Assay of Oligoclomal IgG.

-Assay of IgG/Albumin Ratio in \
and CSF.
-Assay of CSF Myelin Basic Proteil
Subjects with stroke were subjected  to examination by MRI brain.

**Measurement procedures:**

**1- Three point scale of gazeevaluation[15].**

Gaze will be evaluated by asking the pto look to the left then to the right, to Icspecific objects within the left andfields and to follow slowly the m(objects leftward and rightward andpatient's behavior is scored othree-scale,**Line bisection** test[16].The subject marks the midpoint o\

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2- **Line bisection** test[16].The subject marks the midpoint o\
staggered lines of 20-mm, 40-mm, and mm lengths. In left neglect the pat typically displace their mark to the riglthe objective midpoint, neglecting part oleft of the line. The distance between th<edge of each line and the patient's i
showing the  subjective midpoint measured to the closest millimeter.

**3-Line crossing** test[17].

The patient was asked to cross out linesblack lines, 25X2 mm) slanted in vardirections and spaced randomlyon a 9 xinch card. All patients received GVS f sitting position on a chair with a backsupported, feet rested on the ground withflexed hips and knees, transmastoid GVS wasused through two applied plate electrodescovered with sponges after cleaning of theskin with alcohol. The anode was placed onthe mastiod process of the affected side,while the cathode was placed on thecontralateral mastoid process.
The measurements were conducted pretreatment and repeated after 4 weeks (posttreatment).

**Therapeutic procedures:**

All patients received GVS from sittingbposition on a chair with a back supported, feet tested on the ground with flexed hips and knees, iransmastoid GVS was used through two applied plate electrodes covered with sponges after cleaning of the skin with alcohol. The anode was  placed on the mastoid process of the affected side, while the cathode was placed on the contralateral mastoid process. The stimulation period lasted 5 minutes in every sitting with current intensity of about 4 MA and frequency of about 0.5-1 Hz. expressions and reactions of patients were watched carefully during stimulation period which was preceded by precise explanation of what he would feel during stimulation.

**Statistical Method:**

Statistical package for the social sciences (SPSS) (version 9) was for data analysis. Mean *»nd standard deviation were estimates of quantitative data.Paired t-test were used to test the significance of difference between two means within the same group. P value is significant at 0.05.

## RESULTS

**Table 1.** Changes in the mean values of the grades *of gaze deviation.*

| *Post* | *Pre* | |
|---|---|---|
| *1.6* | *2.4* | *Mean* |
| *0.753* | *0.502* | *SD* |
| *-2.85* | | *t* |
| *0.007** | | *P* |

** Significant at P0.05 Pre: before treatment.*
*Post: after the application of galvanic vestibular stimulation.*

***The** paired / test shows a statistical significant decrease of post gaze deviation mean value compared to its pre mean value ($P < 0.01$).*

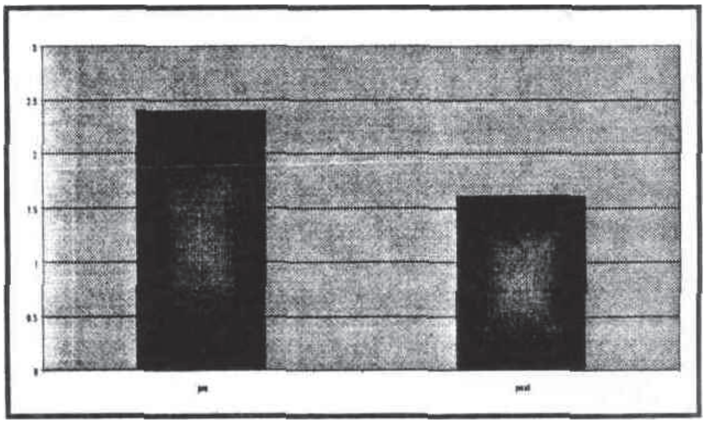

***Fig. (I):** Changes of mean values of gaze deviation*

**2- Assessment of the line bisection test:**
The mean values of the score of the line bisection before vestibular stimulation (pre)and after four weeks (post) are presented inTable (2) and Fig (2).

**3- Assessment of the line crossing:**
The mean values of the grades before vestibular stimulation (pre) and after four weeks (post) are presented in Table (3) and Fig (3).

**Table 3.** Changes in the mean values of line crossing test.

| Post | Pre | |
|---|---|---|
| 30.3 | 26.8 | Mean |
| 5.292 | 4.942 | SD |
| -8.809 | | t |
| 0.001* | | P |

** Significant at P0.05 Pre: before treatment.*
*Post; after the application of galvanic vestibular stimulation.*

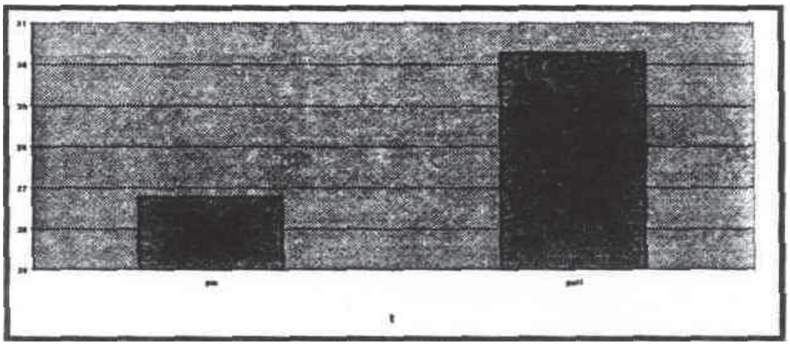

***Fig. (3):*** *Changes of mean values ofline crossing test.*

## DISCUSSION

Clinical results after four weeks of treatment indicated that patients who received GVS, showed significant improvement of the ability to gaze into the affected field.The improvement in gaze deviation could beattributed to inhibition of the tonic phase of contraction of antagonistic muscles which causes the horizontal gaze deviation, or facilitation of the agonistic yoked pairs of muscles, thus increasing their voluntary strength. Vestibular stimulation have a direct effect on enhancing alpha motorneurons which resulted in facilitation of[l] extraocular eye movements. This explanationagree with Marshall & Mynard[18].The improvement of conjugate eye movements could be also attributed to brainactivation induced by GVS. A significant activation due to vestibular stimulation wasdemonstrated in regions behind the primaryauditory cortex, the insular and retroinsularregions, the inferior parietal lobe, certain temporalareas, and other regions also take part in theprocessing of vestibular signals received from theperiphery. These areas are situated in both hemispheres, with a contralateral predominanceover the stimulated side. Additionally, increasedactivity has been registered in the postcentralgyrus, claustrum, putamen, precentral gyrus, andgyrus cinguli. This explanation agree with Lobeletal.'^andEmri etal.[20].GVS provides a direct repetitive stimulus tothe ascending tracts of the brain. Thus GVS could improve the reorganization process in which it strengths the synaptic activity. GVS provides more activation of brain areas resulting in improvement of cerebral blood flow. The increase of blood flow in a particular area of the brain is thought to reflect a greater metabolic activity resulting in increased synaptic activity within that region[21]. Trans- mastoidal stimulation with the anode over the right and the cathode over the leftmastoid induces an inhibition of the right and anexcitation of the left vestibular nerve.

Behaviorally, this provokes the following effects:The tonic vestibular tone imbalance results in lcviations of eye position (ipsilateral to the;»node) and the feeling of being tilte ipsiversively.

Concerning the patients of stroke, studies showed that most recovery after stroke occurredwithin the first three months following stroke[22,26].Recovery takes place very early as a result ofpost lesion reparative mechanisms in the brain asresolution of oedema and functional recovery[27].I he duration of illness is an important factor thatshouldn't be neglected in this study. The durationof illness of stroke patients ranged from six totwenty months, so the improvement attributed toGVS rather than spontaneous recovery. It was also(lie main cause that may be attributed to it than thenon-significant improvement in certain patients.

In the present study, a simple method of vestibular stimulation was used to be more;»pplicable, available and tolerable than previous method as caloric method[13]. In contrast with caloric vestibular stimulation which mediates itsciTect mainly via semicircular canals, galvanicvestibular stimulation has been shown to actequally on semicircular canal and otolith afferents,also galvanic stimuli can be controlled precisely[12].

**Conclusion:**

It was concluded that, galvanic vestibular stimulation is a beneficial central non invasive modality to improve recovery from gaze palsy.

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