

Acupuncture Treatment of Whiplash Injury

Bruno Fattori,¹ Francesco Ursino, Cristina Cingolani, Luca Bruschini,² Iacopo Dallan,² and Andrea Nacci¹

¹Otorhinolaryngology Unit, University of Pisa, and ²Otorhinolaryngology Unit, Azienda Ospedaliera Pisana, Pisa, Italy

Abstract: We evaluated by computerized static posturography the postural changes after acupuncture treatment in a group of 27 patients (12 men and 15 women; mean age, 35.7 ± 6.8 SD) having balance disorders caused by cervical torsion due to whiplash injury. Acupuncture was performed by piercing deeply and bilaterally acupuncture points bladder 10 and gall bladder 20 with steel needles that were twirled manually for 20 seconds. All patients underwent posturographic evaluations before and just after each session of acupuncture. The posturography was performed with open eyes (OE), closed eyes (CE), and closed eyes with retroflexed head (CER). The control group consisted of 25 patients complaining of the same symptoms as those recorded by the study group due to whiplash injury but treated with nonsteroidal anti-inflammatory drugs and myorelaxation or with physiotherapy only. The data presented in this study revealed a considerable difference between the two groups as regards the reduction of the CE and CER length of the statokinesigram just before each session of acupuncture; the frequency oscillation on the sagittal plane in CER was reduced in the study group, whereas we noticed a progressive increase of its values in the control group. The high percentage of positive results in whiplash injury patients leads us to advocate acupuncture for balance disorders due to cervical pathology.

Key Words: acupuncture; cervical vertigo; posturography; whiplash injury

Many clinical reports confirm the efficacy of acupuncture in balance disorders when performed according to the traditional methods established by ancient Chinese energetic medicine, but very few experimental data have addressed the neurophysiological or neuroendocrinological mechanisms (or both) of the effects of acupuncture in vertigo of cervical origin. In recent years, much progress has been made in establishing the anatomy and physiology of the acupuncture points, but modern acupuncture specialists have shifted their interest mainly toward research into the physiological aspects of the points.

The experiments performed on animals showed that the lateral vestibulospinal tract stimulates the extensor

motoneurons of the lower limb muscles in a monosynaptic manner, whereas the descending fibers in the ventral quadrant, including those in the lateral vestibulospinal tract, are capable of exerting a monosynaptic stimulus in the neurons with ascending axons in the ventrolateral cord [1]. These ascending neurons have bilateral receptive fields and respond to stimulation of high-threshold, cutaneous, and muscle fiber afferents (flexion reflex afferents), which often originate in the four limbs [2]. This ascending tract, called the *bilateral ventral flexion reflex tract*, is believed to project toward neurons situated both in the main reticular formation and in the lateral reticular nucleus [2].

Neurophysiological experiments have demonstrated how stimuli originating in the neck muscles are capable of modulating not only the issue of lateral reticular nucleus neurons but the frequency of neuron discharge from the vermis cortex of the anterior cerebellar lobe through activation of the ascending reticulocerebellar pathway [3,4]. The Purkinje cells in this part of the cerebellar cortex transmit important signals down to Deiter's nucleus [5,6], one of the principal structures in

Reprint requests: Dr. Bruno Fattori, Department of Otorhinolaryngology, University of Pisa, Via Savi, n. 10, 56100 Pisa, Italy. E-mail: bfattori@ent.med.unipi.it

This research was presented at the Thirtieth Neurootological and Equilibrimetric Society Congress, Porto, Portugal, April 3–5, 2003.

the vestibulospinal reflex arc [7]. Nowadays, studying postural function is possible with computerized stabilometric methods that allow easily repeated objective evaluations [8]. In this study, we assessed the posture function of whiplash injury (WI) patients treated with acupuncture by means of a static stabilometric system.

PATIENTS AND METHODS

We chose 27 patients (12 men, 15 women; mean age, 35.7 ± 6.8 SD) suffering from balance disorders after cervical torsion caused by WI. The criteria for recruitment of patients were based on the clinical and radiological parameters described in Table 1.

At the beginning of the study, all patients were wearing Swartz collars that had been applied on an average of 6.3 days previously. Such drugs as non-steroidal antiinflammatory agents and muscle-relaxing agents were limited to the first 7 days after the patients' injury. For a control group, we used 25 WI patients (12 men, 13 women; mean age, 36.6 ± 6 SD) whose injury, treated with medication and physiotherapy, had occurred at approximately the same time as the injuries of those in the study group. Before undergoing posturographic examination, all patients underwent Ulmer 1.3 System (Synapsys, Marseille, France) videonystagmography to detect the presence of spontaneous nystagmus and positional and positioning nystagmus; in addition, they underwent vestibular caloric testing according to Fitzgerald-Hallpike. The purpose of this testing was to exclude any change in the vestibulooculomotor reflex that could be the cause of the balance disorders in these patients.

We performed posturographic assessment with the Amplifon S.ve.p. 4.0 System. (Amplifon, Milano, Italy). The platform is able to detect the direction of the center of pressure underneath patients' feet, which are placed apart at 30 degrees in the Romberg position. We used a

5-Hz sampling rate to analyze low-frequency phenomena, particularly the oscillations near 1 Hz, which coincide with the muscular oscillations of equilibrium reset. To assess the response to treatment, we used data concerning the total length (L) of the pathway covered by patients during the test; the surface (S) of 90% of the pressure center (statokinesigram); the oscillations with respect to time on the sagittal and transverse planes (stabilogram); and the frequency spectrogram (Fourier's fast transformation [FFT]) on the sagittal (y) and transverse (x) planes.

The first session was divided into three tests. We performed the first of these in basal conditions. We conducted the second test after acupuncture simulation (i.e., by placing four needles at random points on the cervical region so that patients could feel only subjective stimulation). This simulation of acupuncture before the true insertion of needles served to detect the presence of any functional components. We performed the third test immediately after the session of actual acupuncture. In every session, we examined the patients with open eyes (OE), closed eyes (CE), and closed eyes with head retroflexed (CER) to assess the stabilizing effects of the visual inputs and the influence of cervicocolithic proprioceptive afferents on the posture of patients with WI.

Thereafter, we carried out further sessions once weekly for 3 weeks, monitoring the patients each time by means of the same method of posturographic examination as in the first session: before and after insertion of the needles.

We performed acupuncture by piercing deeply and bilaterally acupuncture points bladder 10 (Bl 10; Tiem Chou) and gall bladder 20 (GB 20; Fong Tcheou) with steel needles that we twirled manually for 20 seconds after insertion (Fig. 1). Each session lasted for 20 minutes. These acupuncture points were chosen on the basis of long-established Chinese experience in this field [9–11] and also on the basis of our previous studies [12].

We performed statistical analysis by means of variance analysis for repeated measurements (basal, after 1 week, after 2 weeks), with a separate comparison against controls of the results obtained before and after acupuncture. In the ANOVA model, the "F" statistic is the mean square due to each experimental factor divided by the mean square due to the error component, and *p* is the probability of type-1 error α . The interaction represents joint factor effects in which the effect of each factor depends on the levels of the other factors. The presence of a significant interaction between time and group factors allowed us to distinguish a pattern in the stance of patients submitted to acupuncture, which was different from that of the controls.

Table 1. Criteria for Recruitment of Patients

Clinical	Radiological
<ul style="list-style-type: none"> • Paravertebral and paraspinous pain • Hypomobility of the cervicospinal tract on physiologic movements • Neurovegetative symptoms: nausea, vertigo, headache • Neurological symptoms: paresthesia of the upper limbs, hypoesthesia, occipital neuralgia 	<ul style="list-style-type: none"> • Standard x-rays in anteroposterior and laterolateral projections for assessment of cervical lordosis: reduction, elimination, inversion • Transoral x-ray to exclude damage to the odontoid process of the axis • Functional x-rays at maximum extension to assess spinal stability



Figure 1. Location of the acupuncture points used in our study (BI 10 and GB 20).

RESULTS

Surface parameters in OE were different in the two groups before acupuncture treatment ($F = 9.5, p = .005$) and afterward ($F = 10.2, p = .003$); the same occurred in CE ($F = 6.5, p = .016$ before treatment; $F = 9.5, p = .005$) and in CER ($F = 7.3, p = .0011$ before treatment; $F = 8.5, p = .007$). The CE situations also revealed a significant interaction between the two groups of patients (treated and controls) before acupuncture ($F = 4.4, p = .016$).

The mean values of length in basal conditions were higher with the CE and CER tests than with the OE, both in the patients who had undergone medical treatment alone (OE: 515 mm; CE: 820 mm; CER: 885 mm) and in those treated with acupuncture (OE: 470 mm; CE: 755 mm; CER: 770 mm; normal values: OE = 410 mm; CE = 590 mm; CER = 615 mm). In OE, length was statistically and significantly different between the acupuncture group and the controls, both in basal conditions ($F = 9.6, p = .004$) and after reflex therapy ($F = 9.6, p = .005$). Length in the CE test also was different in the two groups in basal conditions ($F = 8.3, p = .008$) and after acupuncture ($F = 14.4, p = .0007$). Moreover, after acupuncture in this test situation, we noted a significant difference between times ($F = 5.1, p = .01$) and a significant interaction between the treated group and the controls ($F = 4.8, p = .01$), which indicates the presence of a statistically significant difference in the time pattern of length values in the statokinesigrams of both groups. In CER conditions, this parameter was significantly different in the two

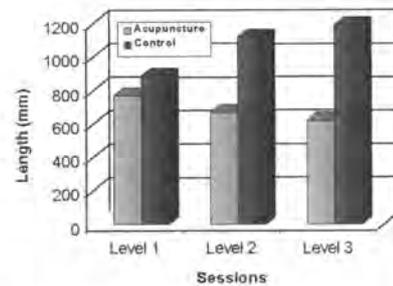


Figure 2. Test with closed eyes and head retroflexed (CER). The values of length in basal condition (level 1), prior to the second session (level 2), and prior to the third session of acupuncture (level 3), in patients treated with acupuncture and in the control group.

groups, both before acupuncture ($F = 16, p = .0004$) and afterward ($F = 16.5, p = .0004$). During this test, interaction was also significant before acupuncture ($F = 4.3, p = .018$; Fig. 2) and was of borderline significance after treatment ($F = 3.1, p = .054$).

Analysis of patient oscillation frequency, on both the transverse (x) and the sagittal (y) planes, yielded interesting data, particularly in regard to the sagittal plane in CER. In this testing situation, in fact, the patients treated with acupuncture showed a progressive reduction in the FFT values from their first acupuncture session, whereas those in the group who underwent medical treatment alone exhibited a progressive increase in these values (Fig. 3). Interaction between the two groups was nearly statistically significant ($F = 3, p = .058$).

DISCUSSION

Acupuncture stimulation in WI patients appears to activate the ascending reticulospinal cerebellar pathways

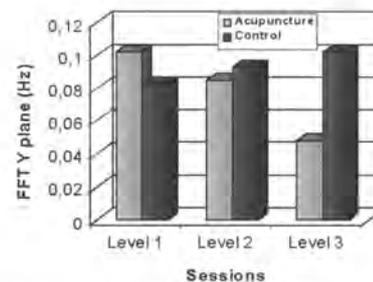


Figure 3. Test with closed eyes and head retroflexed (CER). Frequency of oscillation on the sagittal plane (FFTy) in patients treated with acupuncture and in the control group, in basal conditions (level 1), prior to the second session (level 2), and prior to the third session (level 3).

and, therefore, the descending projections that, from the cortical vermis area of the anterior lobe of the cerebellum, modulate the activity of the Deiter's nucleus, the basis of the vestibulospinal reflex. The application of acupuncture reflex therapy in these patients modulates the cervical proprioceptive inputs that are altered owing to stretching of the neuromuscular spindles and the osteotendon articulation receptors in the neck [13].

Present-day research is still far from a thorough explanation of acupuncture and, although many theories have addressed this subject, the mechanisms of the observed effects are undoubtedly numerous [14–18]. Acupuncture is certainly capable of interfering with the mechanism of action of numerous neurotransmitters (endogenous opioids, serotonin, substance P, catecholamine, GABA, cortisol, etc.), and it also provokes excitation reflexes or inhibition of the spinal cord (gray gel substance of the periaqueduct), of the bulbar areas (reticular substance), and of the thalamic and cortical regions [19–21]. Another possible mechanism that must be considered, particularly in cases of vertigo of cervical origin, is a sympatholytic action exerted through inhibition of the brainstem reticular substance.

Posturographic investigation of patients with balance disorders demonstrated qualitative and, in particular, quantitative parameters that could be repeated and were, therefore, comparable with one another [22–24]. The use of this method in WI patients rendered possible the verification of the efficacy of acupuncture as compared with traditional medical and physiotherapy methods (control group).

The data relating to length in the stabilogram and surface in the statokinesigram show how these parameters behave in a statistically significantly different manner in patients treated with acupuncture as compared with those who were treated only with medication. The best results were seen in the CE and CER conditions, because a suppressed visual field requires good functioning in the other two systems (vestibular and proprioceptive) for stance to be correct. One of the main functions of acupuncture in this disorder is, in fact, the modulation of cervical proprioceptive inputs.

Another important feature is that the stabilizing effect of acupuncture does not reach its maximum response immediately after the session but in the days that follow it, as can be seen in the significant interaction in length in the CER test and in surface in the CE test, particularly in the tests performed before the second and third acupuncture sessions. The presence of a statistically significant interaction emphasizes the different stance behavior seen between patients treated with acupuncture and those who are not. Both these parameters showed significant improvement in the group treated with acupuncture, seen as a reduction in ampli-

tude and frequency of the patients' oscillations (length) and in a decrease in the surface of the oscillations from the center of gravity.

The frequency spectrogram (FFT) also showed considerable improvement after the series of acupuncture sessions; it was particularly evident on the sagittal plane (y), which demonstrated a decrease in amplitude and in the actual frequency of oscillations. The borderline statistical significance, seen when the cervical proprioceptive system was stimulated most (CER), is probably due to the rather small number of patients studied.

The positive effects of acupuncture, even though manifest at the end of the first session, tend to show up more in the days that follow; nevertheless, in our experiment, we noticed a decrease in effect over time, which we overcame by applying acupuncture for at least three weekly sessions to stabilize the results, as can be seen in the follow-up of these patients.

The data in this study indicate that this treatment is capable of directly modifying the reflexes that start from the cervical region and are responsible for balance disorders. One must also take into account, however, both an antiedema activity that can reduce the effects of pressure on the posterior roots of the cervical nerves and a more generalized activity of stabilization of the vertebrobasilar system.

REFERENCES

1. Abrahams C, Richmond FJR. Specialization of sensorimotor organization in the neck muscle system. *Prog Brain Res* 76:125–135, 1988.
2. Coulter JD, Mergner T, Pompeiano O. Effects of static tilt on cervical spinoreticular tract neurons. *J Neurophysiol* 39:45–62, 1975.
3. Boyle R, Pompeiano O. Convergence and interaction of neck and macular vest inputs on vestibulospinal neurons. *J Neurophysiol* 45:852–868, 1981.
4. Denoth F, Magherini PC, Pompeiano O, Stanojevic M. Responses of Purkinje cells of cerebellar vermis to sinusoidal rotation of neck. *J Neurophysiol* 43:46–59, 1980.
5. Kubin L, Manzoni D, Pompeiano O. responses of lateral reticular neurons to convergent neck and macular vestibular inputs. *J Neurophysiol* 46:48–64, 1981.
6. Pompeiano O, Andre P, D'Ascanio P, Manzoni D. Role of the spinocerebellum in adaptive gain control of cat's vestibulospinal reflex. *Acta Otolaryngol Suppl (Stockh)* 520:82–86, 1995.
7. Marchand AR, Manzoni D, Pompeiano O, Stampacchia G. Effects of stimulation of vestibular and neck receptors on Deiters neurons projecting to lumbosacral cord. *Pflugers Arch* 409:13–23, 1987.
8. Karlberg M, Johansson R, Magnusson M, Fransson PA. Dizziness of suspected cervical origin distinguished by

- posturography assessment of human postural dynamics. *J Vestib Res* 6:37–47, 1996.
9. Coan RM, Wong G, Coan PL. The acupuncture treatment of neck pain: A randomized controlled study. *Am J Clin Med* 9:327–352, 1982.
 10. Senelar R. Les Caractéristiques Morphologiques des Points Chinois. In Niboyet GEH (ed), *Nouveau Traité d'Acupuncture*. Paris: A&J Maisonneuve, 1979:249–277.
 11. Zhang S, Luo Y, Bo M. Vertigo treatment with scalp acupuncture. *J Tradit Chin Med* 11:26–28, 1991.
 12. Bonuccelli L, Fattori B, Ghilardi PL, et al. Agopuntura e vertigine cervicale: Valutazione posturografica. *G Ital Riflessol Agopunt* 3:2–3, 1991.
 13. Hinoki M, Niki H. Neurological studies on the role of the sympathetic nervous system in the information of traumatic vertigo of cervical origin. *Acta Otolaryngol Suppl (Stockh)* 330:185–196, 1975.
 14. Pomeranz B, Stux G. *Scientific Bases of Acupuncture*. Berlin: Springer Verlag, 1988.
 15. Omura Y. Effects of an electrical field and its polarity on an abnormal part of body or organ representation point associated with a diseased internal organ, and its influence on the “Bi-Digital O-Ring Test” (simple, noninvasive dysfunction localization method) and drug compatibility test [editorial]: Part 1. *Acupunct ElectroTher Res Int J* 7:209–246, 1982.
 16. Omura Y. Noninvasive circulatory evaluation and electro-acupuncture and TES treatment of diseases difficult to treat in Western medicine: 1) abnormal brain circulation and blood pressure: cephalic hypertension or cephalic hypotension syndromes and their related conditions—headache, insomnia, blindness due to macular degeneration and retinitis pigmentosa, and some psychiatric problems; 2) severe lower extremity circulatory disturbances, with intractable pain, intermittent claudication, ulceration and/or severe diabetic neuropathy [editorial]. *Acupunct ElectroTher Res Int J* 8:177–255, 1983.
 17. Omura Y. Highlights of the forthcoming First International Symposium on Acupuncture and Electro-Therapeutics to celebrate the 10th anniversary of *Acupuncture & Electro-Therapeutics Research: The International Journal*. *Acupunct ElectroTher Res Int J* 10:1–12, 1985.
 18. Omura Y. *Acupuncture Medicine: Its Historical and Clinical Background*. New York: Cognizant Communications Corp., 1996.
 19. Baohian P, Li G. The ultrastructure and enzyme histochemistry of the substantia gelatinosa of rat spinal cord under the influence of electro acupuncture analgesia. *World J Acupunct Moxibust* 3:43–48, 1993.
 20. Han J. Central Neurotransmitters and Acupuncture Analgesia. In Pomeranz B, Stux G (eds), *Scientific Bases of Acupuncture*. Berlin: Springer Verlag, 1988:7–33.
 21. Omura Y. Patho-physiology of acupuncture effects, ACHT and morphine-like substances, pain, phantom sensations (phantom pain, itch and coldness), brain microcirculation, and memory [editorial]. *Acupunct ElectroTher Res Int J* 2:1–31, 1976.
 22. Norre ME, Forrez G. Application otoneurologiques cliniques de la posturographie. *Les Cahiers d'ORL* 3:255–273, 1985.
 23. Norre ME, Forrez G. La posturographie dans la pathologie vestibulaire périphérique. *Ann Otolaryngol* 102:503–509, 1985.
 24. Norre ME, Forrez G, Stevens A, Beckers A. Cervical vertigo diagnosed by posturography? Preliminary report. *Acta ORL Belg* 41:574–581, 1987.