

THE ROLE OF BINOCULAR STRESS IN THE POST-WHIPLASH SYNDROME*

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In its simplest terms, a whiplash injury is considered to be a product of a violent alternate flexion and extension of the head and neck following the impact of two automobiles. Usually this is the aftermath of the common rear-end type of collision and the extent of the injury is not directly proportional to the speed or force of the impact.

This whiplash syndrome is rapidly becoming a colossus in the medicolegal world. Such injuries of the spine are rapidly taking their place among the leading causes for litigation.

The very nature of a whiplash injury is conducive to pain and discomfort in the absence of visual evidence of bone, disc, ligament, or nerve trauma. When x-ray shows no change in these structures, the injury should respond to treatment within a reasonable period of time, or merely time itself would effect a cure; however, the evidence indicates that a great percentage of these patients complain of chronic pain for years after such an injury.

When there is no visible cause for pain, there are always those who immediately label such problems as psychosomatic. Many physicians and lawyers label the chronic post-whiplash syndrome as psychosomatic and maintain that the most effective cure is the "green poultice" applied by insurance companies.

It is the purpose of this paper to point out that many patients complaining of chronic severe headache, posterior cervical tension, and related symptoms following head or neck trauma are not malingerers or psychoneurotics but have a bona-fide problem which will respond to proper therapy.

HISTORY

In 1920, the Navy recognized that carrier pilots were sustaining cervical spine injuries as the result of being catapulted from a flight deck. The men would report sudden black-outs at the moment of violent acceleration and, if they were fortunate, would regain consciousness after becoming airborne. Many were not so fortunate. Symp-

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toms of cervical sprain developed and further injuries were prevented by the addition of a head rest to the cockpit seat.

As the automobile became more common, the accident rate began to multiply. More and more cases of cervical strain became evident. In 1934, Lownerblad¹ described a "hurling back syndrome" resulting in a snapping of the neck. In 1945, Davis² described the injury as we know it today. In 1949, Jackson³ reported a "cervical syndrome," but it was not until 1950 that it appeared in literature to any extent. In 1953, it was popularized by Gay and Abbott.⁴ Little is noted in foreign journals, as whiplash appears to be peculiarly American, with its primary incident related to the heavy, high-speed automobile, driven in congested areas.

The incident of whiplash injuries to the neck from automobile accidents has increased at a tremendous rate. In 1959, there were approximately 1,400,000 disabling injuries⁵ in motor vehicle accidents and, of these, 15 per cent were of the whiplash type. This means that in 1959 approximately 210,000 people sustained anywhere from mild to severe cervical injury from motor vehicle accidents alone.

DESCRIPTION

In demonstrating the force applied to the neck in such an accident, McLaughlin⁶ has shown that when a 3500 lb. car traveling at 10 m.p.h. strikes the rear of another car, it can transmit a force of twenty-five tons. The person's body in the car being struck continues to move forward, while the head, being hinged at the neck, snaps backward. The average head weighs eight to twelve pounds, and the cervical vertebrae are very delicate. The force that is pushing the head backward is even greater than believed, since the neck acts as a fulcrum and the leverage is applied near the top of the head. As a result, the head snaps back, with the equivalent of several tons of force, without any support, since the muscular control of the neck is caught off guard. There may even be more than one oscillation of the head and neck, especially in a three-car collision.

Small boys have found a sharp snap of the neck a very convenient method to decapitate small snakes. Mark Twain's Tom Sawyer and Huckleberry Finn used this method and referred to it as the whipsnap.

SYMPTOMATOLOGY

On the basis of the above analysis of the resultant force which produces the injury, it can readily be seen that extensive damage may result. Weinberg⁷ believes that a concomitant concussion of the brain may be produced by the acceleration-deceleration mechanism. Nielsen,⁸ Hackett,⁹ and others accentuate the spinal ligament and tendon sprain.

Billig¹⁰ has made an analysis of observable injuries and listed many such as narrowing of the intervertebral discs, chip fractures, compression fractures of the vertebrae, ligament tearing, and involuntary muscle spasm.

The results of such injuries are found in symptoms of headache; posterior cervical tension; trapezius tension; vertigo; blurred vision; hyperesthesia; referred pain to arms, fingers, forehead, nose, eye, temple, and parietal region of the head; nausea; motor and sensory loss. Nielsen⁸ reports two cases where there was a complete loss of knowledge (memory) of life experiences without loss of intellectually-learned facts. This type of affection has been shown to result from lesions of the hippocampal gyri, which lends proof to the probability of intracranial trauma.

OCULAR CHANGES

That head trauma can produce heterotropias is by no means a recent observation. This has been well known and observed down through recorded medical history. That head trauma can produce heterophorias is, of course, a later observation since phoria testing has been available; however, that injuries to the cervical spine can induce latent binocular stress is a most recent observation.

Allbutt, in 1870, first called attention to the changes in the fundus in injuries to the spinal cord. Posey and Spiller¹¹ in 1906 showed that the cervical sympathetic was frequently involved in traumatic lesions of the spinal cord. They describe the ocular phenomena as consisting of: (1) changes in the optic nerve; (2) sympathetic phenomena; and (3) pupillary changes.

Billig,¹⁰ analyzing a series of cases of whiplash, referred to a symptom of "blurred vision unrelated to ocular visual defects." He said, "This was complained of in nearly all of the cases. In those of severe involvement the blurred vision was persistent, and those in which the involvement was milder it was described as transitory." He recorded one patient's comment, "I seem to lose my focus."

Frankel,¹² in observing eye changes following cervical trauma, has this to say: "Eye — pupils of the eyes and the associated structures can provide many valuable clues in the diagnosis of residual trauma from injuries about the neck. Interruption or dysfunction of the sympathetic pathways to the head may produce Horner's Syndrome: (1) dropping of upper eyelid, (2) constriction of pupil, and (3) loss of ability to tear or water. Patients with so-called whiplash injuries frequently complain of blurred vision or difficulty with focusing. Dilated pupils and a flattened lens may result from sympathetic stimulation. The study of pupillary oscillations with the slit-lamp may well become a routine

office procedure when the realization of the part that eye changes play in evaluating neck injuries becomes more apparent."

Sales Vasquez¹³ and associates reported three cases in which active spondylarthrosis produced, in addition to a cervicobrachial syndrome, visual disturbances, with changes in the field of vision and fundi.

HEAD, NECK, AND EYE REFLEX

The neck is a major organ of total body posture and orientation in space, along with the vestibular apparatus and the extraocular muscles. Schlesinger states that any type of neck disorder, whether static or dynamic, is capable of secondarily altering the postural information being fed centrally from the neck. He further states that vertigo and nausea are not necessarily evidence of a psychosomatic component in neck disorders but may well represent a specific organic response to abnormalities of neck dynamics.

That the organism's desire to maintain single binocular vision is also a major force in neck dynamics has long been shown in ocular palsies. In the face of a paresis of a vertically acting extraocular muscle, there must be a compensatory torticollis to alleviate the resultant diplopia. Here is a condition of the neck being forced into an abnormal position with its resultant gravitational pull, to be able to compensate for a binocular anomaly. Thus we see that lesions which create binocular stress will, in turn, cause resultant stress in the neck.

The importance of the neck in the role of a sort of gyroscope in spatial orientation is not always appreciated. The tonic neck reflexes, along with otolith organs, play a major role in the machinery of postural set. Duke-Elder⁴ emphasizes this head, neck, and eye reflex:

"... there is an intimate association between movements of the eyes and changes in posture, and a close functional reflex correlation exists between the extraocular muscles and the labyrinths which record movements of the head in space, and the muscles of the neck which register movements of the head with respect to the trunk.

"In the normal condition all these reflexes are summated, the one supplementing the other, with the result that there is an extremely well-developed correlation of ocular, labyrinthine, and neck reflexes, by means of which, both in movement and at rest, and in the various physiologically possible positions of the head with respect to the body in space, the correct visual attitude and the suitable correlation of the two eyes are ensured.

"Whatever be the exact mechanism, it is known that each labyrinth is associated with all the muscles of each eye."

Eckardt, McLean, and Goodell¹⁵ have shown with electromyographic evidence that a continued abnormal stress on the oculorotary muscles will result in neck muscle spasm which can be the basis of severe neck pain.

In the experiments, a three diopter vertical prism was placed in front of the subject's eye in whatever position caused the most discom-

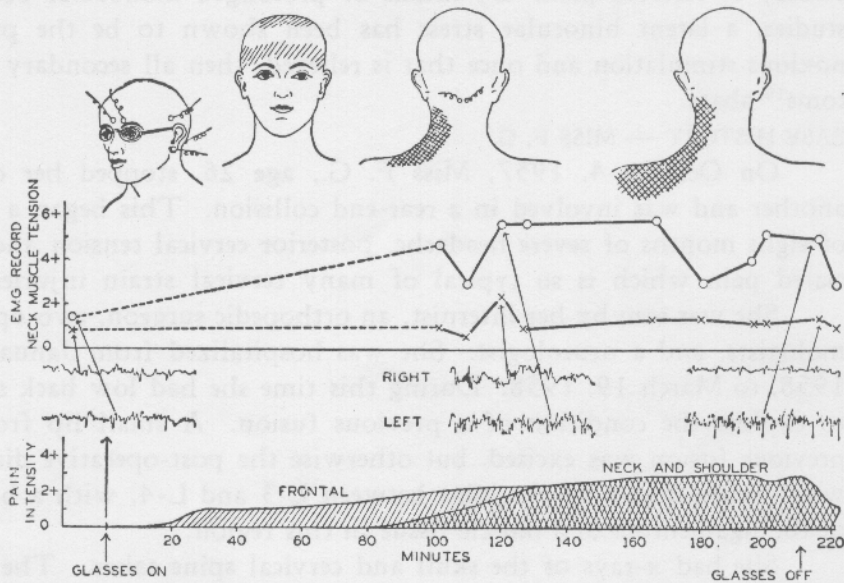


Fig. 1. The effect of abnormally sustained contraction of the external ocular muscles on the neck and head muscles. From *Headache and Other Head Pain* by Harold G. Wolff, by permission of the Oxford University Press, 417 Fifth Avenue, New York 16, N. Y.

fort. Diplopia was produced for about three minutes in all experiments. Electromyographic leads went to the frontalis, cervical, and trapezius muscles to record secondary muscle tension in these areas. The results show tension in the frontalis occurring within ten minutes; in the cervical area, within eighty minutes; and down the trapezius into the deltoid, within one hundred twenty minutes. The writers even describe the "stiff" muscle as definitely firmer to the touch and more bulky than its homologue.

Upon removing the vertical prism, this muscle spasm and discomfort lasted in some subjects up to several hours. It was shown in these experiments that neck massage gave temporary alleviation to the tonic spasm but soon afterward the tension increased to the original frequency.

This of course emphasizes that symptomatic relief of any referred pain can only be a temporary relief. It would be impossible to permanently eliminate a secondary pain unless the primary noxious stimulation is found and eliminated.

LATENT BINOCULAR STRESS

In the event of many of these post-whiplash syndromes, it has now been found that the physiotherapy, traction, and pharmacotherapy designed to relax the posterior cervical tension are only treating a sec-

ondary or referred pain. By means of prolonged monocular occlusion studies, a latent binocular stress has been shown to be the primary noxious stimulation and once that is relieved, then all secondary symptoms¹⁶ abate.

CASE HISTORY — MISS F. G.

On October 4, 1957, Miss F. G., age 26, stopped her car for another and was involved in a rear-end collision. This began a period of eight months of severe headache, posterior cervical tension and associated pain which is so typical of many cervical strain injuries.

She was seen by her internist, an orthopedic surgeon, two ophthalmologists, and a neurologist. She was hospitalized from January 14, 1958, to March 19, 1958. During this time she had low back surgery to explore the condition of a previous fusion. A small lip from the previous fusion was excised, but otherwise the post-operative diagnosis was a severe sprain of the joint between L-3 and L-4, with a bruising of the ligamentous and muscle tissue in this region.

She had x-rays of the skull and cervical spine taken. The spinal x-rays were lateral, oblique, and while in brace. The radiologist's report was, "No pathological process seen and no localized structural changes. The cervical curve now appears about normal. The disc spaces do not seem unusual. The Cranial Vault is normal in appearance."

She received very extensive pharmacotherapy, including a number of analgesics, vasoconstrictors, and tranquilizers. She was intermittently put in traction to relieve the cervical spasm and good use was also made of physiotherapy. This was in the nature of microtherm, massage, fomentations, neck halter, and, finally, a neck brace upon dismissal.

Perhaps one of the most complete consultants' reports was that of the neurologist. It is herewith reproduced in toto:

The following is my report on Miss F. G., who was seen for the first time at City Hospital on February 17, 1958:

CHIEF COMPLAINT: Headache.

FAMILY HISTORY: The patient's father is living but has arthritis. Mother and two sisters are living and well. She has never married. There is no allergy or migraine in the family.

PAST HISTORY: The patient has had measles, mumps, chickenpox in childhood; she had rheumatic fever at the age of nine. She suffered severe headaches from 1953 until 1955. These were believed to be due to overwork and tension. She was found, however, to be allergic to about forty foods and ten other things. She is still taking shots for this and her headaches were improved. She had a tonsillectomy, appendectomy, and had a benign tumor removed from the breast. In 1950 she had a spinal fusion. She has had no serious injuries, does not smoke or drink. Her menstrual periods are normal except for slight irregularity for which she is taking cytomel.

PRESENT ILLNESS: The patient states that aside from the headaches for which she has been treated with allergy shots, she was well until October 4, 1957.

when after going through an intersection, she stopped for another car, when she was hit from the rear. Her head was snapped. She felt a pain in her tailbone. She got out of the car, however, and took information and drove on and it was not until she had been driving for about fifteen miles that she began to have pain all over in her arms and legs and a headache. She stopped on her way home at a friend's home who is a masseur and received a massage which gave temporary relief. She had another such treatment over the weekend but her neck ached and it hurt to turn her head. She returned to work as a dental assistant but about this time developed the Asiatic flu and had a good deal of low backache which is attributed to this. Her headaches continued. She had an elevated temperature off and on for three weeks. When she started back to work, she had severe headaches and backache and x-rays were then taken and it was found that the spinal fusion done some years previously may have been damaged. After physiotherapy and a back support to relieve her, she was advised to have the back re-operated, which was done. However, she states that she has continued to have headaches near the base of the skull and in the frontal region. Her vision is blurred. It feels blocked out, but she is never sure. She states that immediately preceding coming into the hospital, her headaches were very severe. She could not sleep and she blacked-out for fifteen minutes and was sick for an entire evening, but she did not vomit. She has had momentary "blackouts" since being in the hospital. She states that she gets a dizzy feeling in the top of her head. She staggers to the right. Her headache has been worse on getting up. She had neck traction applied eight or nine days ago which helped some but did not completely relieve her headache. On questioning she says that she has vomited at times with the headaches. At times, she has a ringing in the ears. Sometimes her arms feel numb since the accident. She states that she has had trouble hanging onto things and has dropped instruments in her employer's office. She also complains of twitching in the left arm on occasion but not all the time. She states her back is much better since surgery. At times her vision is blurred and she has trouble focusing and this has happened three or four times after surgery. She has had trouble hearing and understanding what people say but no real loss of hearing.

GENERAL EXAMINATION: The patient is intelligent, cooperative, does not appear ill. Tonsil tags are present; teeth are well cared for. Blood pressure is 110/70. She is wearing an abdominal support and her abdomen is not examined. Breast and chest examination are negative.

NEUROLOGICAL EXAMINATION: A complete neurological examination was done and the following were noted: The biceps, triceps and supinator reflexes were bilaterally decreased -2. The patient was able to hear the watch tick on contact with the right ear (20 cm. normal).

ELECTROENCEPHALOGRAPHIC REPORT: A sixteen electrode electroencephalogram was taken on this patient February 13, 1958 at 1:00 p. m., and the following is my impression:

"**IMPRESSION:** Normal electroencephalogram. The patient exhibited a rather marked tendency to drowsiness."

OPINION: I believe this patient's headaches are on the basis of a tension state. I do not believe she suffers from any organic intra-cranial disorder. I think with constant reassurance she will make a good recovery. I believe there is a great deal of functional overlay in this case.

Because of the eventual outcome of this case, one ophthalmologist's report is herewith reproduced. The second ophthalmologist, in essence, gave a similar report.

HISTORY:

1. Constant headaches.
2. Blurred vision periodically.
3. Difficulty in changing focus from distance to near and vice versa at times.
4. Pain—sharp, shooting to dull ache accompanied by nausea at times through upper inner aspect of orbits—outside of eyes.
5. Double vision occasionally.
6. Patient also has had difficulty keeping her mind on what she was doing on occasion since the accident.

EXAMINATION:

E. O. M. (Extra Ocular Muscles) Normal in all excursions.

Fundi—Normal in both eyes.

Vision—RE 20/20+ LE 20/20+.

Phorias—distance—normal

near—6Δ—4ΔExo.

Visual Fields—Found to be normal in both eyes.

IMPRESSION:

1. Occasional double vision may be due to her exophoria.
2. The other complaints listed above (1, 2, 3, 4, 5 & 6), in fact, all probably could be attributable to the after effects of the accident—however, there are no eye findings pathological or otherwise to account for her complaint. She is a myope and her present correction is adequate.

As can be seen from the above reports, this patient did not reveal any pathology or functional problem as related to the accident, per se. For this reason, the consultants suggested the post-whiplash syndrome was from an anxiety tension state, with hysterical overlays, and that psychiatric help be secured.

Her physician, however, by the latter part of February had begun a trial series of monocular occlusion. His entry in the patient's hospital record on March 5, 1958, showed that the first noticeable relief was obtained by bandaging the left eye for one day. The relief was very slight but was at least the first clue of a binocular stress. There was no relief when the right eye was occluded nor when both eyes were occluded. She was, therefore, referred for an investigation of a possible latent binocular stress.

Miss F. G. was first seen by the author on May 6, 1958. She was wearing a neck brace which had been a constant companion since she had left the hospital seven weeks previously. The pain in the cervical region was so intense when the brace was removed, that all of the findings on the first three visits were taken with the brace in place. Her current lens Rx which was one month old was:

O. D. -1.25 $\overline{\text{C}}$ -1.00 x 135

O. S. -0.75 $\overline{\text{C}}$ -1.00 x 30

The first analysis showed:

Subjective: O. D. -1.50 $\overline{\text{C}}$ -1.25 x 150

O. S. -0.75 $\overline{\text{C}}$ -1.25 x 20

Distance

Phoria: $\frac{1}{2}$ Δ Exophoria

Vertical

Phoria: Negative

Vertical

Duction: O. D. Supra $1\frac{1}{2}$ Δ/1Δ Infra $\frac{1}{2}$ Δ/0Δ

O. S. Supra $\frac{1}{2}$ Δ/0Δ Infra $1\frac{1}{2}$ Δ/1Δ

Near

Cross Cyl.: O. D. -2.25 $\overline{\text{C}}$ -1.25 x 150

O. S. -1.25 $\overline{\text{C}}$ -1.25 x 20

Near

Lateral Phoria: 3Δ Exophoria

Near

Vertical Phoria: $\frac{1}{2}$ Δ Right Hyperphoria

The new subjective was made up in temporary lenses to use while going through a standardized prolonged monocular occlusion routine.¹⁷ On May 10 the patient occluded her left eye and kept it bandaged until the morning of May 13. She reported much less headache these three days, so that she was able to cut her analgesic intake to about one-half. The cervical tension was better and she could even leave the brace off for short periods. Her findings now showed:

Distance Phoria: 4 Δ Exophoria
 Vertical Phoria: 2 Δ Left Hyperphoria
 Vertical Ductions: O. D. Supra -1 Δ /-1½ Δ Infra 3 Δ /2½ Δ
 O. S. Supra 3 Δ / 2½ Δ Infra -1 Δ /-1½ Δ

Immediately following this test the right eye was occluded and remained under occlusion for three days. On May 16 she reported the headaches were still keeping down somewhat, but her vision was blurred at times and it created more general tension. She was still able to remove the neck brace for short periods. Her findings now were:

Distance Phoria: 8 Δ Exophoria
 Vertical Phoria: 1 Δ Right Hyperphoria
 Vertical Ductions: O. D. Supra 2 Δ /1½ Δ Infra 0 Δ /-½ Δ
 O. S. Supra 0 Δ /-½ Δ Infra 2 Δ /1½ Δ

With the vertical phoria showing 1 Δ R. H. following occlusion of the O. D. and 2 Δ L. H. following occlusion of the O. S., it was decided to begin the temporary prism clip-over with 1 Δ base-down on the O. S. and 2 Δ base-in. This she wore for one week.

On May 23 new findings were taken after she had worn the temporary prisms constantly. She was instructed to close her left eye whenever she removed her glasses or clip-overs, so that at no time would a compensatory stress be set up in the binocular act. She now reported a considerable improvement in the headache intensity; in fact, so much so, that, by taking a few analgesics, she was free of headache until very late in the day. She was so much relieved of the posterior cervical tension that she was removing the neck brace for several hours at a time. She was now able to ride in a car without an increase in headaches and without the nausea she had previously had. There was still a mild vertigo, but this was only at short periods. Her findings now showed:

Distance Phoria: 5 Δ Exophoria
 Vertical Phoria: 1½ Δ Left Hyperphoria
 Vertical Ductions: O. D. Supra -½ Δ /-1 Δ Infra 2½ Δ /2 Δ
 O. S. Supra 2½ Δ /2 Δ Infra -½ Δ /-1 Δ

Her temporary prism clip-overs were changed to 1½ Δ base-down over O. S. and 3 Δ base-in, and she wore these until May 28.

She reported some difficulty in adjusting to the new prism the first day, but by the second day it cleared up and the remainder of this trial period was even more asymptomatic than before. She was now

going without the neck brace for long periods and, in fact, on the 27th did not wear it all day. Her findings on this analysis were a duplication of those taken on May 23, so the following lenses was made:

O. D.: $-1.50 \overline{\text{C}} -1.25 \times 150 \overline{\text{C}} 1\frac{1}{2} \Delta$ In
 O. S.: $-1.00 \overline{\text{C}} -1.50 \times 20 \overline{\text{C}} 1\frac{1}{2} \Delta$ In & $1\frac{1}{2} \Delta$ Down

After this lens prescription was delivered to her, she removed the neck brace permanently and has had no need of it since. By June 23 she began reporting an increase in the headache frequency and intensity. She was instructed to occlude the left eye for one day so new findings could be made. This was done on June 25. She now showed another $\frac{1}{2} \Delta$ increase in the left hyperphoria and another $1\frac{1}{2} \Delta$ increase in the exophoria, so new clip-overs of $\frac{1}{2} \Delta$ down O. S. and $1\frac{1}{2} \Delta$ In were put over her lenses.

By July 3 she reported complete cessation of headaches. She was taking no analgesics, and there was no feeling of posterior cervical tension. She was busy and active and leading a normal life. Her final lenses in a No. 1 tint were:

O. D.: $-1.50 \overline{\text{C}} -1.25 \times 150 \overline{\text{C}} 2 \Delta$ In and 1Δ Up
 O. S.: $-1.00 \overline{\text{C}} -1.50 \times 20 \overline{\text{C}} 2\frac{1}{2} \Delta$ In and 1Δ Down

SUMMARY

It is the purpose of this article to point out that:

1. A great percentage of the patients complaining of severe headache, cervical tension, and related symptoms following cervical trauma are not malingerers or psychoneurotics but have a bona-fide problem which will respond to proper therapy.

2. A severe cervical strain can produce a heterophoria, which can be found by using a standardized prolonged monocular occlusion test.

3. After the binocular stress is alleviated, the secondary syndrome will gradually dissipate.

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NEW BOOK RECEIVED

UVEITIS AND TOXOPLASMOSIS. E. S. Perkins, M.D. Published by Little Brown and Company, Boston. 142 pages. Illustrated. Cloth. 1961. \$8.00.

MANUAL OF REFRACTION. Albert E. Sloane, M.D. Published by Little Brown and Company, Boston. 171 pages. Illustrated. Cloth. 1961.
