

“Whiplash” - Injury of the 2nd Cervical Ganglion and Nerve

William S. Keith

ABSTRACT: Amongst the many patients with persisting neck pain and headache following cervical injuries are a small number in whom the mechanism is compression of the second cervical nerve root and ganglion. This paper describes the clinical features in 14 patients seen by the author. The main features are unilateral pain in the upper cervical and occipital region, tenderness in the suboccipital region, and diminished sensation in the C2 dermatome. The anatomical basis for this syndrome is discussed and illustrated with dissections from a cadaver.

RÉSUMÉ: Blessure à «coup de lapin» du deuxième ganglion et nerf cervicaux Parmi plusieurs patients qui se plaignent de douleur cervicale et de mal de tête à la suite de blessures cervicales, il existe un petit nombre dont le mécanisme consiste de compression de la deuxième racine nerveuse et de son ganglion. Cet article décrit les données cliniques chez 14 patients vus par l'auteur. Les caractéristiques principaux sont la douleur unilatérale dans les régions cervicale supérieur et occipitale, tendresse dans la zone sous-occipitale, et la sensibilité réduite dans le territoire du dermatome C₂. La base anatomique de ce syndrome est discuté et illustré par les dissections d'un cadavre.

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Extension injuries of the neck following motor vehicle accidents are a common problem in our society despite the now universal extension of the seat back to protect the neck. The term “whiplash” is often used to describe this type of injury, but this should not be considered a specific diagnosis. As many as 10-15% of patients with this type of injury continue to have persisting symptoms after time intervals which should be sufficient for recovery and after litigation settlements have been completed.

In 1949, Hunter and Mayfield¹ drew attention to the vulnerability of the 2nd cervical nerve between the laminae of the atlas and axis. Between 1959 and 1979, I personally examined 14 patients in whom I concluded that a crushing injury of the 2nd cervical nerve and/or ganglion was the cause of their persisting occipital and post-cervical pain following neck injuries. This paper will summarize the clinical features of this syndrome and will describe some additional anatomical studies which demonstrate how unilateral injury to this nerve and its ganglion can occur.

CLINICAL MATERIAL

Most of the patients were young or middle aged adults with ages ranging from 19 to 59. There were 9 women and 5 men. Thirteen of the 14 patients were injured in motor vehicle accidents.

One man was injured at work when he was struck on his hard hat by a piece of flying steel. The average interval between the time of injury and diagnosis was 20 months. Two of the patients had their working lives completely and permanently disrupted by the injury.

All patients complained of pain confined almost entirely to the upper neck and occipital region on one side. Some of the patients also complained of lesser degrees of discomfort in the region of the eye and over the face on the same side as the occipital and neck pain. The pain was usually made worse by unguarded or sudden movements of the head.

None of the patients were unconscious more than momentarily at the time of the initial injury. Words like “dazed”, “shaken up”, “mildly disoriented”, and “dizzy” were used to describe the initial symptoms. Some patients described a blinding or explosive feeling at the time of the accident which I believe may have been the actual sensation of the nerve or ganglion being squeezed or crushed.

All patients had marked tenderness on palpation deep in the suboccipital region on the side of the pain. Pressure applied to the non-painful side was often followed by a dramatic reaction to the pain produced by the same pressure on the painful side. All patients had diminished sensation to pin prick and touch in the occipital and suboccipital regions on the painful side. Some patients were surprised that pin prick sensation was reduced.

From The Division of Neurosurgery, Toronto Western Hospital, Toronto, Ontario

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Reprint requests to: Dr. William S. Keith, 55 St. Leonard's Crescent, Toronto, Ontario, Canada M4N 3A7

having thought that it would be more acute in the area where they were experiencing pain. The area of decreased sensation merged with normal sensation in the posterior midline and also above and just behind the ear. Radiologic studies of the upper cervical spine were normal in all cases except one in whom there was apparent widening of the gap between the odontoid and lateral mass of the atlas on one side.

CASE REPORTS

The following case histories will further illustrate the main features of this syndrome.

Patient #1 (Male, Age 41)

This 41 year old finishing carpenter was involved in a collision with another vehicle in July 1958. He reported that he was thrown forward so that the right side of his hard hat hit the window frame. Neck x-rays taken soon after the accident were reported as negative.

When he was assessed in December 1959, his main complaint was pain in the back of the head and neck, much more severe on the left side. This was aggravated by hammering, riding in the streetcar, or by any jarring or turning of his head. He said that he did not want to move his head at all.

There was tenderness in both suboccipital regions, much more marked on the left, and sensation was very much reduced over the left occipital region.

Repeat x-rays of the cervical spine including anterior-posterior views through the open mouth showed that the gap between the odontoid and lateral mass of the atlas was about 1 mm wider on the right than on the left.

The patient was seen again in August 1963, long after the litigation associated with the injury had been settled. His condition was unchanged. He was still complaining of pain in the neck and occiput and also of some pain in the low back region and left leg. He was unable to work as a carpenter. It was recommended that the patient have a surgical division of the left cervical root, but this was never carried out. When last seen in September 1984, the patient was still a semi-invalid, but able to assist his wife in her shop.

Patient #2 (Female, Age 36)

This patient was involved in a rear end collision in May 1961 and sustained an extension injury of the neck. She felt a "horrible crack" in her neck but was not unconscious. Following this she had persisting pain in the right occipital region and right side of the neck and remained off work until March 1962.

When examined in February 1963, she was exquisitely tender on palpation in the right suboccipital region. There was marked loss of sensation for both pin prick and touch in the distribution of the right greater occipital nerve.

Several months later, an avulsion of the 2nd cervical nerve was carried out by another neurosurgeon. This resulted in complete and permanent relief of the pain.

Patient #3 (Male, Age 59)

This man was injured in April 1964 when he was struck on the left side of his hard hat by a flying piece of steel. He was knocked to the ground but did not lose consciousness. When he was seen in the hospital emergency room a short time later, he was complaining of suboccipital headache and pain in the midcervical region on the left side. This was aggravated by flexion and rotation of his head to the right. X-rays of the cervical spine were normal.

Seventeen months after the injury he was still complaining of severe occipital pain. He had been receiving procaine injections into the painful area which provided relief for about five days. Two years after the injury he had a cervical spinal fusion from C4 to C7.

He was first seen by the author in April 1968, four years after his initial injury. All this time he had been experiencing pain in the left side of his head and left suboccipital region. He had extreme tenderness on palpation in the left suboccipital region and also profound diminution of pin prick and touch sensation in the same area. In January 1969 the left 2nd cervical root was divided completely inside the dura. The patient

was re-examined in May 1969 at which time he was having no occipital pain and could turn his head freely in all directions without pain.

Patient #4 (Female, Age 48)

This patient was injured in 1967 when the car in which she was a passenger, was struck on the left side while she was reaching back for a cigarette being handed to her by someone in the back seat. She does not think she lost consciousness. All she could recall was a severe pain involving all of her right side, particularly the neck region with radiation down toward the scapula and up into the back of her head. She was examined in a hospital emergency department and x-rays of her neck were normal. I first examined her one year after the accident. At that time, she complained of a shooting pain, like an explosion, radiating from the lower part of her neck up into the right occiput. As this explosive feeling subsided, she was left with a feeling "like tiny hot cinders" in her right occiput. At the time of the explosive feeling, the vision in her right eye dimmed, but returned to normal in one or two seconds. On one occasion she developed a pain and explosive feeling in her neck and occiput when her head jerked back suddenly as she tried to avoid dropping a heavy bag from her arms.

Neurological examination was normal except for markedly diminished sensation over the right occiput, merging with normal sensation above and behind the right ear and also at the C3 level. There was extreme tenderness in the right suboccipital region. My clinical impression was that she had suffered a crushing injury of her right cervical nerve and/or ganglion in the accident. She was informed of the possibility of surgical division of the nerve root, but surgery was never carried out.

ANATOMICAL STUDIES

The anatomy of the second cervical ganglion and nerve root, including its anterior and posterior divisions, has been studied with great care and precision by Bogduk.^{2,3} He has demonstrated fibers in the anterior division of C2 which help explain the neck-tongue syndrome. The nerve does not pierce the atlanto-axial membrane as stated in older anatomy textbooks, but emerges from the spinal canal lateral to it. The following quotation from Bogduk's papers provide some insight into the mechanisms by which the C2 root and ganglion may be injured: "The C2 roots lie mainly within the vertebral canal deep to the atlas. Therefore, they themselves are not susceptible to bony impingement during any motion of the head" . . . "The only region where elements of the C2 nerves appear vulnerable to the compression between the atlas and axis is in the region of the lateral atlanto-axial joint. During rotation combined with extreme extension, on the side opposite to the direction of rotation, the posterior arch of the atlas is approximated to the dorsal edge of the superior articular process of the axis. This reduces the available space for the C2 dorsal root ganglion and spinal nerve which lie against the joint capsule. The ganglion, being the thickest neural structure, is the most susceptible to compression. In the cadavers studied it was noted that, during rotation combined with extension, the posterior arch of the atlas and the superior articular process of the axis were approximated sufficiently to contact the C2 ganglion. However, actual compression, with deformation of the ganglion occurred only if the ganglion was large or if the bony surfaces were strongly forced against one another. Otherwise, sufficient space remained for free passage to the ganglion, roots and spinal nerve."

Figure 1 illustrates an attempt to reproduce the situation described above. The atlas and axis are articulated using plasticine in place of joint cartilage. The atlas is rotated on the axis so that the face of the subject would be turned to the left. The atlas is also fully extended. The lamina of the atlas is closely approximated to the axis on the right side, but on the left side there is a

wide space between the laminae of the atlas and axis. With sudden unexpected hyperextension in this position of the head on the neck, the C2 ganglion and nerve may be crushed on the right side, but not on the left side.

Figure 2 shows a set of photographs and accompanied line drawings of a dissection of the suboccipital region in a cadaver in which the right posterior division of C2 is absent. Black markers have been used to identify the midline of the laminae of the atlas and axis. In Figure 2a there is no rotation of the atlas on the axis, and the ganglia and nerve roots are not subject to compression. When the cadaver's head is rotated well to the right and extended, the weighted string, representing the nerve root, is gripped between the laminae of C1 and C2 on the left side (Figure 2b). When the extension is relaxed the string is pulled out. In this same position the ganglion of C2 on the right side lies between the laminae of C1 and C2 with adequate space surrounding it (Figure 2c).

DISCUSSION

Injury of the C2 ganglion and nerve is probably a rare occurrence. The very existence of this injury has been denied by Weinberger⁴ in a paper on surgical treatment of cervico-occipital pain entitled "The myth of the bony millstones". However, I believe that buried within the large number of patients with persisting symptoms following neck extension injuries are a small number of cases in whom injury to the C2 root and ganglion is the mechanism for pain. This diagnosis should not be made in the absence of a clear cut history of injury or in the absence of any sensory change over the C2 dermatome.

Frykholm⁵ in a discussion of cervical migraine, describes something which sounds very similar to the C2 root syndrome:

"Some cases may develop into a typical occipital neuralgia with paroxysms of pain, provoked by movements of the head, clearly indicating that the upper cervical nerve roots are under the influence of some kind of mechanical pressure. These patients usually have hyperalgesia or reduced sensibility within the

distribution of the occipital nerve. If this nerve is exposed and avulsed together with its nerve roots, the patient is usually relieved of pain. Occasionally this operation has had a beneficial effect also in cases of cervical migraine without the signs and symptoms of paroxysmal occipital neuralgia, but on the other hand I have seen plenty of cases in which the operation was of no avail."

McNab⁶ stated "there is a remarkable paucity of information in the literature in regard to basic underlying lesions resulting from extension-acceleration injuries of the cervical spine. Gurdjian⁷ after studying over 200 hyperextension-hyperflexion injuries came to two significant conclusions:

1) A preponderance of symptoms amongst women, and 2) a continuation of the symptoms in many patients even after the cases had been adjudicated. Although injury to the C2 root and ganglion probably accounts for only a very small proportion of cases of existing pain following neck injury, lack of knowledge of the existence of this syndrome may be one of the reasons why the diagnosis is made so infrequently.

The patients rarely complain of numbness. Seletz⁸ writes "although an occasional patient will complain of numbness in the scalp or over portions of the face, the majority do not, and only careful testing by an interested and competent physician will elicit sensory change". Although most of the patients in the present series had been seen by other physicians, in many cases sensory examination of the scalp had not been carried out.

If the C2 ganglion is contused there may be sufficient scarring to account for continuing symptoms over a longer period of time. On the other hand, the injury to the ganglion may be slight so there are no symptoms during quiescent periods, but pain is provoked by the slightest insult.

Terms such as occipital neuralgia, occipital neuritis, and occipital migraine with or without the words "traumatic" or "post-traumatic" are used frequently in the medical literature to describe persisting neck pain. In attempting to treat post-traumatic occipital headache, Knight⁹ has excised the greater occipital nerve in over 20 cases. None of the six cases which he

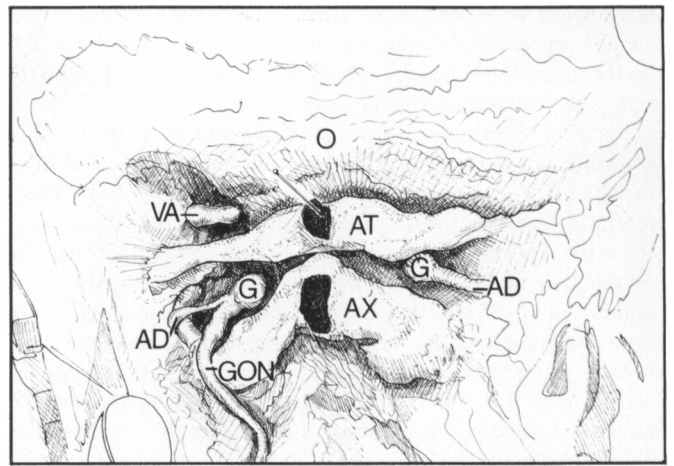


A
Figure 1 — Reconstruction of relationships between the atlas and axis showing posterior (A) and left lateral (B) views. The vertebrae have been articulated using plasticine in place of joint cartilage. The atlas is rotated on the axis as if the subject's head were turned to the left. Note the close approximation of the laminae of the atlas and axis on the right side and the relatively wide space on the left.

B



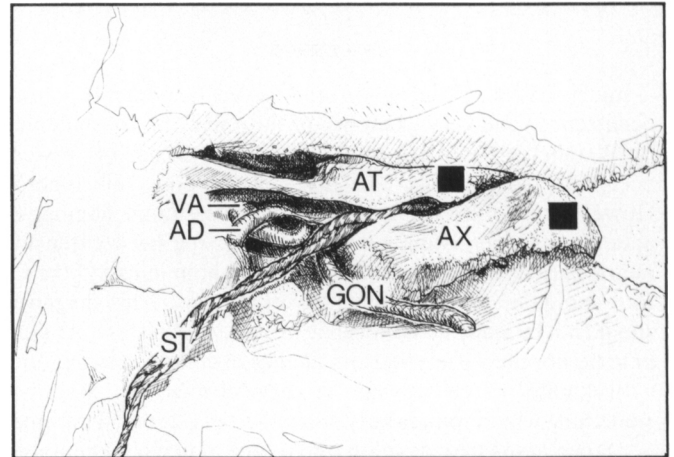
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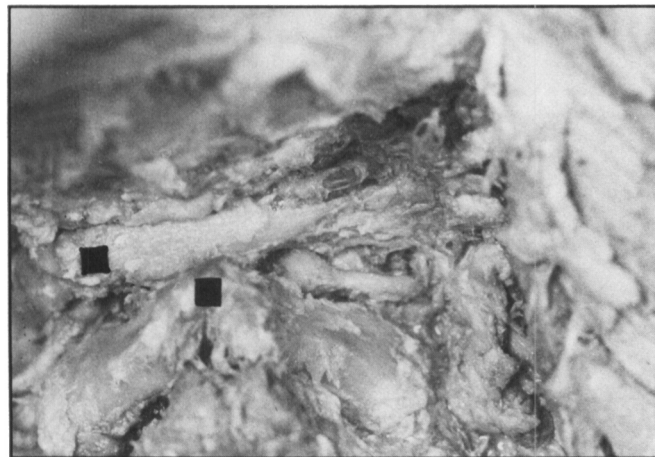
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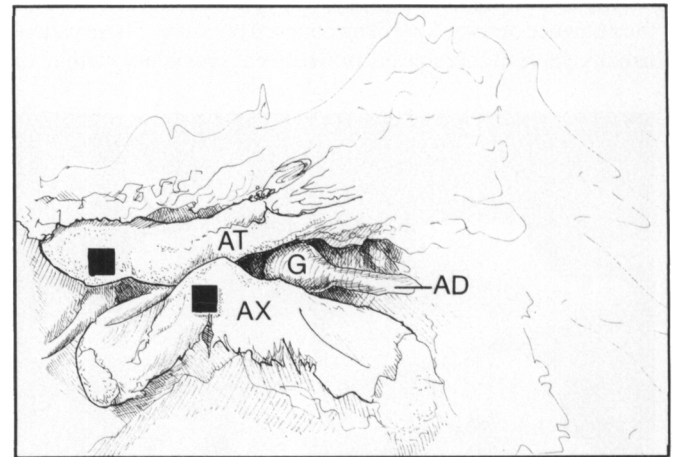
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B



C



C

Figure 2 — Photographs and line drawings of a dissection of the suboccipital region in a cadavera. Black markers indicate midline of the laminae of atlas and axis. A) no rotation of atlas on axis. B) head turned well to the right and extended. String representing left C2 nerve root is gripped between laminae of C1 and C2. C) same position showing C2 ganglion on the right side with adequate space between laminae of C1 and C2.

Abbreviations

AT - atlas, AX - axis, G - C2 Ganglion, AD - anterior division of C2, GON - great occipital nerve, VA - vertebral artery, ST - weighted string, O - occiput.

describes in detail had any reduction of sensation over the scalp. Knight uses the term "post-traumatic migraine" which he says is common and increasing in frequency with the increased incidences of road accidents. It is possible that some of these cases diagnosed as post traumatic migraine may have had C2 nerve root injury.

Poletti¹⁰ reported a case of C2-C3 nerve root decompression for post-traumatic arthritis with entrapment. In that paper he listed at least 24 causes of occipital neuralgia. Ehni & Benner¹¹ have reported a group of elderly patients who had unilateral occipital neuralgic pain due to degenerative changes in a C1-C2 lateral joint. No sensory deficit in the C2 distribution was reported. Mayfield (personal communication) now has a series of cases of entrapment of the greater occipital nerve and/or the greater occipital artery as a result of lymphadenopathy, vascular anomaly, and direct trauma. The anatomical studies of Bogduk^{2,3} and also those described in this paper, showing the relationship of the atlas to axis in various positions, clearly demonstrates the vulnerability of the C2 nerve root and ganglion to hyperextension injury. The persisting pain and suffering experienced by some patients with this syndrome may indicate a need for surgical treatment. I am opposed to avulsion of the nerve and would use only laminectomy with division of the root inside the dura-arachnoid. Surgical treatment should be considered only after careful discussion between the doctor and the patient and explanation of the mechanism of the injury. It is likely that operations for this syndrome will be done only quite rarely.

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