CLINICAL STUDIES ON SO-CALLED WHIPLASH INJURY, ESPECIALLY ON THE SIGNIFICANCE OF RETROGRADE BRACHIAL ARTERIOGRAPHY

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ABSTRACT

In recent years an increasing number of so-called whiplash injury of the neck following a rear-end collision have been seen at our Hospital and the problem of this whiplash injury has come to receive national importance to insure safety of the people.

So far, although many studies have been made on so-called whiplash injury, an important problem left is the clarification of the pathogenesis of this type of injury of the neck.

From times past, "the Barré-Lieou syndrome" (the posterior cervical sympathetic syndrome) after whiplash injury has been considered to be a form of traumatic neurosis or a compensatory neurosis. But from clinical experience, I have come to suspect the occurrence of vertebral artery involvement in some cases of whiplash injury presenting the Barré-Lieou syndrome.

Patients examined by the method of retrograde brachial arteriography with the head turned to either side, consisted of 36 cases seen at the 1st Surgical Department of Nagoya University Hospital and the Neurosurgical Division of the Chubu-Rosai Hospital. They consisted of two groups; 20 patients with the Barré-Lieou syndrome and 16 without the syndrome.

By the above means it was made clear that in cases with the Barré-Lieou syndrome, there are various changes in the vertebral artery angiographically with the head turned to either side and that as a cause of the Barré-Lieou syndrome following whiplash injury the changes in the vascular system are believed to play an extremely important role.

INTRODUCTION

So-called whiplash injury is produced by the sudden snapping of the head either forward, backward or from one side to the other, without direct violence from a blow or striking of the head against an object. This often occurs in automobile collision, particularly rear-end collision. The incidence of so-called whiplash injury is rising with the increased automobile travel in Japan. The problem of the whiplash injury has come to receive national importance in order to assure safety of the people.

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Although many studies have been made on so-called whiplash injury, an important problem left is the clarification of the nature of the pathogenesis of this type of injury of the neck.

From times past, nebulous, bizarre and atypical complaints after whiplash injury, namely, headache, vertigo, dizziness, tinnitus, blurring of vision, diplopia, nausea and vomiting, unsteady gait, numbness or tingling of the upper extremities and, at times, disturbance of speech and swallowing (the Barré-Lieou syndrome or the posterior cervical sympathetic syndrome), have been considered to be a form of traumatic neurosis or a compensatory neurosis, and studies have been made mainly of the various complaints from the aspect of psychogenesis.

Recently, although various suggestions have been made to account for the production of these vague symptoms, much remains to be discussed of the cognition of vertebral artery involvement in patients with whiplash injury of the neck.

Occasionally, mention has been made of vertebral artery involvement in patients with cervical spondylosis or post traumatic unstable spine, but, as far as I am aware, only little clinicoangiographic study of the vertebral artery in patients with whiplash injury has been reported previously.

From clinical experiences, I recognized that pre-existing spondylotic spine and/or posttraumatic unstable spine which was confirmed by roentgenographic examination of the cervical spine, is found in some cases of whiplash injury presenting vague symptoms and I also speculated on some relation to vertebral artery involvement in these cases.

My primary intention of this study, therefore, is to demonstrate vertebral artery involvement angiographically and to assess the findings which may contribute to the production of vague symptoms in case of so-called whiplash injury.

A REVIEW OF BIBLIOGRAPHIES

The term "whiplash" was coined by Crowe\(^1\) in 1928 for some injury of the neck and has been commonly used clinically. In 1945, Davis\(^2\) described that the majority of injuries of the cervical spine are in nature whiplash. Since Gay and Abbott's report\(^3\), in 1953, whiplash injury of the neck has received considerable attention regarding its mechanism, pathogenesis, symptomatology, diagnosis, roentgenographic evaluation of the cervical spine, treatment, follow-up study and medicolegal implications.\(^1\)\(^–\)\(^23\).

The review here is mainly concerned with various suggestions accounting for the production of vague symptoms in cases of whiplash injury of the neck. Typical symptoms in such patients include headache, dizziness, vertigo, blur-
ring of vision, diplopia, tinnitus, unsteadiness of gait, nausea and numbness or tingling of the upper extremities and these symptom complexes are called commonly "the Barré-Lieou syndrome".

The survey by Gotten in 1956, reported the great difficulty of evaluating whiplash type of injury (because of many psychoneurotic symptoms) to be due to complicating factors of monetary compensation. Pietrobono, in 1956, described that the symptoms of whiplash injury are due to a combination of many factors, and among these factors are local injury, referred pain, radiculitis and stimulation of the sympathetic nervous system. Fields coined "autonomic nervous system concussion" to describe damage to the cerebral sympathetic ganglia and their connections and explained a variety of vague disorders in whiplash injury. In 1957, Cammack attempted to explain the complex symptomatology resulting from whiplash injury and divided it into four categories: (1) cerebral concussion; (2) cervical radiculitis and soft tissue neck pain; (3) fracture of the cervical vertebrae and (4) psychoneurotic overlay. In 1958, Seletz described a great majority of symptoms designated as psychoneurotic are to be all due to disturbed circulation of the vertebral artery after neck sprain.

Unconnected with whiplash injury of the neck, an original description of these symptoms was made by Barré in 1925, who pointed out the irritation of the vertebral nerve and of the sympathetic plexes surrounding the vertebral artery as the cause of these clinical manifestations. He believed that laterally placed uncovertebral osteophytes may involve the autonomic neural structures ascending in the transverse foramina of the cervical segment of the vertebral column and to incriminate the vertebral artery as the modus operandi for the syndrome. In 1949, Bärtchi-Rochaix coined "migraine cervicale" for those symptom complexes described by Barré. Postmorten studies of cadavers by DeKleyn revealed that the vertebral artery could be completely occluded by turning the head backward and to the opposite side. Ford, in 1952, described a patient who developed attacks of syncope followed by vertigo, unsteadiness, nystagmus and diplopia when his head was placed in hyperextension. This resulted from intermittent obstruction of the vertebral artery due to a defect in the odontoid process and excessive motility of the second cervical vertebrae. Hutchinson and Yates showed that spondylosis with vertebral artery compression commonly occurs in association with atherosclerotic of the major cerebral vessels, and when two conditions occur together, the liability to ischemic episodes of vertebral artery is increased. Jackson, in 1958, demonstrated that osteophytes can cause pronounced compression of the vertebral arteries as they traverse the transverse foramina of the cervical vertebrae and alluded to the strong possibility that this extrinsic compression of the vertebral vessels varied as the head is moved about. Toole et al., in 1960, and Hardesty
et al.\cite{32}, in 1963, measured the alternation of blood flow through the vertebral and carotid arteries with changing positions of the head. Tissington-Tatlow\cite{33} et al., in 1957, observed cervical vertigo and showed that the vertebral artery could be markedly narrowed by neck turning and this was shown by injection of the artery in a cadaver. Coburn\cite{34}, in 1962, concluded the vertebral artery was frequently involved by compression of overlying muscles in the suboccipital triangle, and that some of the symptoms were the result of this compression.

In 1960, Sheehan et al.\cite{35} reported cases of vertebrobasilar insufficiency due to cervical spondylosis in which percutaneous transbrachial vertebral arteriography with rotation or hyperextension of the neck proved the existence of compression. Baacke\cite{36}, in 1957, using venous as well as arterial angiography, demonstrated that the vertebral venous system was more apt to be compressed than the vertebral artery; he suggested the venous congestion in the basilar system may be responsible for the various symptoms observed.

Kovacs\cite{37}, in 1955, pointed out that the most common cause of this type of syndrome described in this paper was the vertebral artery compression due to dislocation of the superior articular process and the uncovertebral joint changes were rarely the cause of the syndrome. Pratt-Thomas et al.\cite{38}, in 1947, reported patients following chiropractic manipulation who died from thrombosis of the vertebrobasilar system but showed no fractures or dislocations. Duffy et al.\cite{39}, in 1958, collected data on patients with unilateral vertebral artery thrombosis and explained clearly the clinical syndrome in occlusion of a single vertebral artery.

Powers et al.\cite{40}, in 1961, reported on patients who exhibited complaints similar to those of the Barré-Lieou syndrome and relieved by division of the scalenus anticus and the entire musculo-facial membrane. There was intermittent vertebral artery compression due to an obstruction of the subclavian and/or vertebral artery and he recorded four principal complexes clearly that characterize the clinical features of vertebral artery insufficiency. Wagner et al.\cite{41}, in 1963, described a case of vertebral artery insufficiency after thyroidectomy due to cicatrices around the vertebral artery and emphasized the importance of retrograde brachial angiography. In 1966, Husni et al.\cite{42} reported that mechanical occlusion of the normal vertebral artery might be caused by contraction of the longus colli muscle and the scalene muscle at the level of the vertebral foramen of the sixth cervical vertebra on turning the head and to cause symptoms, the patient needs a hypoplastic contralateral artery.

Schneider et al.\cite{43} described in detail that damage to the vertebral arteries would play a considerable role in the progression of spinal cord lesions secondary to severe cervical spinal trauma.
CLINICAL STUDIES ON SO-CALLED WHIPLASH INJURY

MATERIAL AND METHOD

1. Patient material. 36 patients were selected from the total of 150 patients with whiplash injury of the neck, following a rear-end collision, and seen at the 1st Surgical Department of the Nagoya university Hospital and the Neuro-surgical Division of the Chubu-Rosai Hospital. They consisted of two groups: 20 patients with the Barré-Lieou syndrome (A-group) and 16 without the syndrome as a control (B-group) (Table 1). After careful clinical history, complete neurologic examination and cervical spine roentgenograms, vertebral arteries were studied angiographically.

<table>
<thead>
<tr>
<th>Decade</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
<th>Patients with the Barré-Lieou syndrome (A-group)</th>
<th>Patients without the Barré-Lieou syndrome (B-group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>7</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>30-39</td>
<td>15</td>
<td>3</td>
<td>18</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>40-49</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>50-59</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>60-69</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>4</td>
<td>26</td>
<td>20</td>
<td>16</td>
</tr>
</tbody>
</table>

Average age of patients was 35 years. The youngest was 20 and the oldest 64 years old. Of the 36 patients 4 were women. The time between injury and arteriography varied from 1 month to 2 years, with the mean of approximately 6 months.

2. Arteriographic method. In the supine position, the arm is abducted from the side to an angle of about 45 degrees with the elbow extended. A pneumatic tourniquet is applied to the forearm and held ready to inflate to a pressure 2 times greater than the systolic, immediately prior to an injection.

Under local anesthesia, puncture is carried out after premedication with atropine sulphate 30 minutes prior to the procedure, using a 17 gauge needle, at a point where the vessel can be felt easily in front of the elbow; this is usually on a level with a line crossing the antecubital fossa from the upper border of the external to the upper border of the internal epicondylar process of the humerus. The puncture is made with care and in cases of difficulty immediate note is taken of any discomfort experienced by the patient which might indicate proximity to the median nerve.

Following successful puncture, a polyethylene tube is connected to the needle and syringe; 30 to 35 ml of 60% Conray or 60% Urografin as contrast solution is injected during three seconds each time with a 50 ml syringe by hand. Vertebral artery and its branches can be adequately visualized by four injections;
one each of the antero-posterior projection with the head turned to the right and to the left, the third, the antero-posterior projection with the head in the neutral position, and the fourth, lateral projection with the head in the neutral position.

When the investigation has been completed the needle is withdrawn and pressure is maintained over the puncture site for a few minutes. I have not experienced any arteriographic complications in the present series of 36 cases reported here.

RESULTS

The vertebral artery is the first branch of the subclavian artery, arising from the superior and posterior wall of the vessel. It is divided into four parts according to Sheehan and this terminology will be used throughout this paper.

Part 1. After arising from the subclavian artery, the vessel passes upward and backward to enter the transverse foramen of the sixth cervical vertebra.

Part 2. The artery takes a straight course encased in the bony canal formed by the transverse foramina of the upper six cervical vertebrae.

Part 3. After emerging from the transverse foramen of the atlas, the artery runs horizontally posteriorly and medially around the articular process of the atlas, lying in a groove on the upper surface of the posterior arch of the atlas.

Part 4. Finally, the artery passes anterior to the oblique ligament of the atlas and enters the vertebral canal. It pierces the spinal dura and passes upward into the posterior fossa through the foramen magnum, where it unites with the other vertebral artery to form the basilar artery.

The following Table 2 presents a summary of twenty cases of the author’s series of the whiplash injury presenting the Barré-Lieou syndrome. Arteriographic findings in the vertebral system in the A-group of 20 patients with the Barré-Lieou syndrome and in the B-group of 16 without the syndrome are summarized in Table 3 and Table 4.

Normal vertebral arteriogram. In 8 patients out of the total of 20 with the Barré-Lieou syndrome were found what I considered to be arteriographically normal vertebral arteries, but in this group there were 2 hypertensive and 3 hypotensive individuals.

On the other hand, in 13 patients out of the 16 patients were found normal vertebral arteries including 3 hypertensive and 4 hypotensive cases.
TABLE 2. Clinical table and arteriographic findings in 20 cases of whiplash injury with Barré-Lieou syndrome

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age and Sex</th>
<th>Blood press.</th>
<th>Time between injury and arteriography</th>
<th>Clinical summary</th>
<th>Radiographic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Y.S.</td>
<td>44 m</td>
<td>170/100</td>
<td>10 months</td>
<td>Headache, neck pain, nausea, dizziness and tinnitus, Abnormal EEG.</td>
<td>Ant. lipping C2-C4, Sublux. on flex. C2. Displacement and compress of left vertebral artery</td>
</tr>
<tr>
<td>3. K.S.</td>
<td>20 m</td>
<td>150/96</td>
<td>1 month</td>
<td>Suboccipital and nuchal pain, dizzy spells, paresthesia of left arm and left shoulder pain.</td>
<td>Ant. sublux. on flex. C1. Left P-3 stenosis on rotating neck to right.</td>
</tr>
<tr>
<td>4. S.K.</td>
<td>24 m</td>
<td>140/80</td>
<td>6 months</td>
<td>Left suboccipital headache, vertigo and dizziness on rotating neck to right, blurred vision, unsteady gait, hot flash on face.</td>
<td>Left P-3 stenosis on rotating neck to right.</td>
</tr>
<tr>
<td>5. K.K.</td>
<td>30 m</td>
<td>130/80</td>
<td>8 months</td>
<td>Suboccipital and frontal headaches and nuchal pain, nausea, dizziness, tinnitus and dysphasia occasionally Restricted neck movement.</td>
<td>Straighten cervical curvature with post. spurring C3-C4, C5-C6, C7-C8. Ant. sublux. C3-C4. Left P-3 stenosis on rotating neck to right.</td>
</tr>
<tr>
<td>6. H.M.</td>
<td>26 m</td>
<td>110/70</td>
<td>10 months</td>
<td>Suboccipital headache, pain in the ears and tinnitus, Left shoulder pain and paresthesia of left arm, Restricted neck movement, Positive Romberg's sign, Abnormal EEG.</td>
<td>Left P-3 stenosis on rotating neck to right.</td>
</tr>
<tr>
<td>7. Y.Y.</td>
<td>46 m</td>
<td>130/70</td>
<td>8 months</td>
<td>From suboccipital to back pain, dizziness and blurred vision.</td>
<td>Loss of cervical curvature. Post. sublux. on ext. C5. Normal vertebral arteries.</td>
</tr>
<tr>
<td>8. K.T.</td>
<td>46 m</td>
<td>110/60</td>
<td>9 months</td>
<td>Suboccipital headache, nausea, blurred vision, unsteady gait, dizziness on rotating neck to left, hypalgesia of both hands and irritability.</td>
<td>Narrowing C2-C6, C7-C8 with spurring. Left P-2 stenosis (compression) on rotating neck to left.</td>
</tr>
<tr>
<td>10. G.Y.</td>
<td>35 m</td>
<td>130/70</td>
<td>1 month</td>
<td>Suboccipital headache, nuchal pain, nausea, tinnitus, paresthesia of right hand and restricted neck movement.</td>
<td>Right P-3 stenosis and tortuosity on rotating neck to left.</td>
</tr>
</tbody>
</table>
The abnormal vertebral arteriogram. After reviewing the vertebral arteriograms in the 20 patients with the Barré-Lieou syndrome, certain features are considered to be characteristic of this whiplash injury.

The most common site of the vertebral artery stenosis was at Part 3 of the artery. This was found in 7 out of 20 patients of the A-group, on rotating the head to either sides. Stenosis of this portion occurred on the side opposite to which the head is turned by stretching (Fig. 1).

On rotating the head, compression or displacement of the vertebral artery by exostosis was found in 2 cases of the A-group, in whom spondylosis was

<table>
<thead>
<tr>
<th>Case No. Age and Sex</th>
<th>Blood press.</th>
<th>Time between injury and arteriography</th>
<th>Clinical summary</th>
<th>Radiographic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. W.K. 29 m</td>
<td>120/70</td>
<td>16 months</td>
<td>Headache from both temporal to occipital. Blurred vision. Vertigo and tinnitus on rotating neck to right. Oppresion of the chest. All DTR's increased.</td>
<td>Narrow C₃-C₄. Ant. or post. sublux. on flex. or ext. C₆. Left P-3 stenosis on rotating neck to right.</td>
</tr>
<tr>
<td>15. M.S. 47 m</td>
<td>90/60</td>
<td>4 months</td>
<td>Left nuchal pain and tenderness, dizziness and blurred vision.</td>
<td>Normal cervical spine and vertebral arteries.</td>
</tr>
<tr>
<td>17. N.E. 33 m</td>
<td>110/80</td>
<td>3 months</td>
<td>Dizziness, unsteady gait, blurred vision and suboccipital headaches.</td>
<td>Ant. spurring C₆. Normal vertebral arteries.</td>
</tr>
<tr>
<td>19. I.K. 34 m</td>
<td>130/70</td>
<td>24 months</td>
<td>Vertigo and dizziness with rotation of the neck.</td>
<td>Ant. and post. spurring C₄-C₆. Normal vertebral arteries.</td>
</tr>
<tr>
<td>20. T.S. 54 m</td>
<td>150/90</td>
<td>8 months</td>
<td>Headaches, dizziness, unsteady gait, numbness of left leg and weakness of left arm.</td>
<td>Marked cervical spondylosis. Tortuosities of vertebral arteries.</td>
</tr>
</tbody>
</table>
CLINICAL STUDIES ON SO-CALLED WHIPLASH INJURY

TABLE 3. Vertebral arteriography of 20 cases of whiplash injury with the Barré-Lieou syndrome

<table>
<thead>
<tr>
<th>Findings of arteriogram</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal vertebral arteries</td>
<td>8</td>
</tr>
<tr>
<td>Stenosis of vertebral artery at Part 3 with rotation of the neck</td>
<td>7</td>
</tr>
<tr>
<td>Compression or displacement of vertebral artery at Part 2 with rotation of the neck</td>
<td>2</td>
</tr>
<tr>
<td>Stenosis of vertebral artery at Part 1</td>
<td>1</td>
</tr>
<tr>
<td>Tortuosity of vertebral arteries</td>
<td>2</td>
</tr>
</tbody>
</table>

TABLE 4. Vertebral arteriography of 16 cases of whiplash injury without the Barré-Lieou syndrome

<table>
<thead>
<tr>
<th>Findings of arteriogram</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal vertebral arteries</td>
<td>13</td>
</tr>
<tr>
<td>Tortuosity of vertebral arteries</td>
<td>2</td>
</tr>
<tr>
<td>Compression of vertebral artery at Part 2 with rotation of the neck</td>
<td>1</td>
</tr>
</tbody>
</table>

FIG. 1. (Case 10) Right vertebral arteriogram with head rotated to left; arrow indicates vertebral artery stenosis at Part-3 (A). With head turned to right no stenosis at Part-3 but mild tortuosity of vertebral artery seen (B).
confirmed by roentgenographic examination of the cervical spine. In these cases close inspection of the anteroposterior films usually permits identification of the compressing osteophyte attached to the uncinate portion of the vertebrae, which compresses and displaces the artery at each point of curvature or narrowing. The sites of compression were between the fourth and fifth and the fifth and sixth (Fig. 2).

Comparison of films taken before and after rotation of the neck shows that no stenosis of the vertebral artery may be converted into stenosis by this maneuver. Sometimes, the maneuver during arteriography was accompanied by symptoms of dizziness, blurred vision, etc.

Stenosis at the origin of the vertebral artery from the subclavian artery, that is part 1, was found in one case (Fig. 3).

Tortuous vertebral arteries were found in two cases, one might be due to arteriosclerosis and the other to be congenital (Fig. 4 and 5).

Only three out of the 16 patients without the Barré-Lieou syndrome of B-group revealed abnormalities of the vertebral arteries, one with tortuous verte-
bäl arteries due to arteriosclerosis and others with compression and/or stenosis of the vertebral arteries by osteophytes or spurring of the cervical spine.

DISCUSSION

(1) Arteriographic method. Although there are many methods of taking vertebral arteriograms, vertebral arteriography by direct puncture using the percutaneous antero-lateral approach has been widely adopted in Japan. There is no doubt that this method gives valuable information of the intracranial abnormality of the vertebrobasilar system but does not give information on the condition of the artery proximal to the site of injection. We must examine the entire course of the vertebral artery in patients with whiplash injury. In addition to technical difficulties of this method it is said that extremely rapid injection of a contrast medium into the vertebral artery would result in spasm of that vessel.

Because of the above reasons, I adopted the retrograde brachial arteriography, described previously, without using a Seldinger canula for the sake of simplicity. With this method, arteriography could be carried out by only one physician without troublesome preparation.
The dose of contrast solution may appear rather large, but much of the contrast solution flows into the brachial artery itself and the dose in the vertebral system probably small. Other recommendations for the use of this method are:

1. Local anesthesia only is used.
2. The injection of a contrast solution into the vertebral artery is done by heart action.
3. The entire course of the vertebral artery is visualized.
4. No damage occurs to the vertebral artery.
5. The needle punctured is stabilized against rotation of the neck.

(2) Relation between arteriographic findings and clinical manifestation. The vertebral artery generally is considered to supply the pyramidal fibers in the lower pons, the dorsal vagus and glossopharyngeal nuclei, portion of the hypoglossal nucleus, the nucleus and tractus solitarius, the nucleus and spinal tract of the trigeminal nerve, the ventral and superior dorsal portions of the inferior olive, the dorsal accessory olives, the central tegmental tract, and the lateral portion of the olivocerebellar fibers.
It is natural to consider that the decrease in blood supply to the above mentioned area due to stenosis or compression causes many clinical manifestations such as the Barré-Lieou syndrome.

Rotation of the head is necessary to demonstrate angiographic abnormality in the vertebral artery. 7 cases out of 20 patients of the A-group presented Part 3 stenosis with the neck rotated to the opposite side. Although Tissington-Tatlow and Sheehan demonstrated Part 3 stenosis as a physiological narrowing none of my 16 cases without the Barré-Lieou syndrome showed Part 3 stenosis angiographically. This fact suggests some correlation of Part 3 stenosis to some clinical manifestations of whiplash injury. In addition, as Coburn stated, the commonest site of the vertebral artery involvement in cervical trauma appears to be in the suboccipital triangle. Here, the vertebral artery can be compressed by the muscles bounding the triangle and by the muscles that are innervated by the first cervical root.

Two cases of the A-group showed Part 2 stenosis. There was compression by osteophyte or spurring confirmed by roentgenographic examination of the cervical spine. I believe that these features are characteristic of cervical spondylosis, not to whiplash injury and I consider whiplash injury is just an
exaggerating cause.

Kovacs pointed out vertebral artery compression due to subluxation and deformation of the cervical apophyseal joints, but in this series, the relation between loss of cervical lordosis or unstable spine or subluxation of the cervical spine to abnormality of the vertebral artery was not clear. Some positive correlation was found between abnormality of the vertebral artery and spondylyotic changes in the cervical spine. In this case, rotation of the head was necessary to demonstrate angiographic abnormality.

Powers and Husni et al. reported intermittent vertebral artery occlusion of the normal vertebral artery at Part 1 by turning the head. Only one case showed Part 1 stenosis in this series. This may be due to arteriosclerosis or compression by surrounding muscles.

Hutchinson and Yates showed if spondylosis and atherosclerosis occur together, the liability to ischemic episodes of vertebral artery is increased. One of my case out of the two with tortuous vertebral artery had marked spondylosis of the cervical spine and arteriosclerotic tortuosity and these findings seem to cause the clinical manifestation. The other case was considered to be congenital tortuosity of the vertebral artery.

In spite of presenting clinical manifestation of the Barré-Lieou syndrome, 8 patients of the A-group showed no findings in the arteriograms. But in these cases there were 2 hypertensive and 3 hypotensive cases. I consider that cardiovascular disease plays some role in producing the Barré-Lieou syndrome.

Consequently, angiographic study of the patient of whiplash injury with the Barré-Lieou syndrome revealed many findings in the vertebral artery by rotating the head to either sides. These findings in the vertebral artery may have some relation to clinical manifestation such as the Barré-Lieou syndrome in whiplash injury. And I emphasize the importance of performing retrograde brachial arteriography in these cases.

CONCLUSION

(1) Vertebral arteriograms were taken in 36 patients with whiplash injury of the neck by retrograde brachial arteriography with the head turned to either side; 20 patients with the Barré-Lieou syndrome and 16 without the syndrome.

(2) In 20 patients with the Barré-Lieou syndrome, they were revealed Part 3 stenosis in 7 cases, Part 2 stenosis in 2 cases by turning the head to either side, Part 1 stenosis in one case and tortuous vertebral arteries in two cases.

(3) Comparison of this result with that of 16 patients without the Barré-Lieou syndrome led to the conclusion that the above mentioned angiographic abnormalities of the vertebral arteries play some important role in producing the Barré-Lieou syndrome following so-called whiplash injury.
(4) I emphasize the importance of performing retrograde brachial arteriography with the head turned to either side in patients of whiplash injury with the Barré-Lieou syndrome.

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