# Evaluation of Neck Vessel Injury in Patients with Blunt Trauma to the Cervical Spine

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**Abstract**

Injuries to the neck vessels often go undiagnosed in patients with cervical spinal trauma. In this prospective study, 50 patients of cervical spine injury who were hemodynamically stable were evaluated by CT angiogram for presence or absence of carotid and/or vertebral artery injury. Three (6%) patients were diagnosed to have vertebral artery injury. None of the patients had a carotid artery injury. The clinical presentation and management protocol are discussed.

**Keywords**
- cervical spine trauma
- vertebral artery injury

## Introduction

Acute spinal cord injuries are common medical emergencies that occur due to direct trauma to the spinal cord. Cervical spine injuries can be associated with vertebral and carotid artery injury.

Injury to carotid and/or vertebral artery may remain undetected either due to magnitude of injury or associated other injuries, but in large majority blunt carotid and vertebral injuries (BCVIs) are asymptomatic at the time of presentation. Early diagnosis and institution of treatment appear to improve outcomes. In the absence of recommended protocol for including angiography in the spinal injuries, one of these patients may have underlying vascular injuries and suffer neurologic consequences. The incidence of vertebral and carotid artery injury in patients with cervical spine trauma is not well documented in the available Indian literature. Knowledge of vascular injuries with appropriate neurologic deficits, management, and outcome is required for early identification and management. The aim of the present study was to detect incidence of carotid and/or vertebral artery injury in the patients of blunt cervical spine injury presenting to a tertiary care center.

## Materials and Methods

This is a prospective study of carotid and/or vertebral artery injury in patients with cervical spine injury presenting to the Department of Neurosurgery, PGIMER, Chandigarh. This study was performed over a period of 18 months from June 2013 to December 2014.

**Inclusion criteria:** Patients with clinical and/or radiologic evidence of injury to the cervical spine of all ages.

**Exclusion criteria:**

1. Patients with associated head injury who required emergency surgery
2. Hemodynamically unstable patients

**Clinical Course:** The demographic profile of all patients and the mode of injury were recorded. The patients were hemodynamically stabilized and managed as per the departmental protocol.

1. Clinical examination: All patients with cervical spine injury were examined as per inclusion criteria. Their neurologic status was assessed with the Glasgow Coma Scale (GCS) and cervical spine injury was graded as per ASIA (American Spinal Injury Association) scale. Patients

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with unstable spine injury were treated with hard cervical collar/traction.

2. Investigation: Routine investigations such as complete hemogram, electrolytes, renal function test, and coagulation profile were done in all patients. Patients with suspected cervical spine fracture were subjected to X-ray after complete stabilization as per the departmental protocol. The level and type of cervical spine injury were recorded. Computed tomography angiography (CTA) was done for the patients with radiologic evidence of cervical spine injury. In patients with clinical features suggestive of cervical injury but no radiologic evidence, magnetic resonance imaging and magnetic resonance angiography were done. To rule out cervical spine injury, patients were subjected to CTA; it images both the spine and artery. Injury to carotid and/or vertebral artery was documented and graded as per protocol attached.

The level, type, or grade of injuries were assessed by the neurosurgeons and radiologists. The vascular injury was graded according to the BCVI grading scale as mentioned in ►**Table 1**.[1,2]

## Observation and Results

In this study of 50 patients, 42 (84%) were males and 8 (16%) were females with male-to-female ratio of 5.2:1. The mean age group was found to be 40.08 years (range 19–75years). Thirty (60%) patients were aged 40 years or younger.

Fall from height was the most common type of injury, occurring in 28 (56%) patients, which included fall from tree, electric pole, and roof followed by road traffic accidents (RTA) in 16 (32%) patients. Others that included assault, railway accident, and fall of heavy object from height were seen in six (12%) patients.

The most common level of injury was C5–C6, present in 16 (32%) patients, followed by C4–C5 in 8 (16%), C2 in 6 (12%), C6–C7 in 4 (8%), and C1–C2 in 3 (6%). Either C5 and/or C6 vertebrae were involved in 33 (66%) patients. C2 vertebra was involved in 10 (20%) patients. According to the type of injury, anterior dislocation was most common 30 (60%), followed by fracture lamina and spinous process fracture each in 4 (8%) patients and posterior dislocation in 3 (6%) patients. ASIA grading system was used to assess cervical spine injury severity of the patients at the time of admission. Grade A indicates severe impairment, whereas grade E indicates no impairment. ASIA grade A was found in 26 (52%) patients, B in 3 (6%), C in 6 (12%), D in 2 (4%), and E in 13 (26%).

Out of 50 patients with cervical injury, 3 had associated vascular injury all involving vertebral artery. One patient had bilateral (b/l) vertebral artery dissection, grade II injury according BCVI. Other two patients had right vertebral artery thrombosis (grade IV BCVI). Patients with bilateral involvement of vertebral arteries died of cerebellar infarction. All the three patients with vertebral artery injury were involved in RTA. We did not find any involvement of carotid artery in our study population.

In this study, all the three patients with vertebral artery involvement had ASIA grade A (complete loss of motor and sensory function) at the time of admission (►**Table 2**).

**Table 1** Cerebrovascular injury grading scale based on angiographic appearance

| Grade | Description |
|---|---|
| I | Irregularity of vessel wall or a dissection/ intramural hematoma with $<$ 25% luminal stenosis |
| II | Intraluminal thrombus or raised intimal flap is visualized, or dissection/intramural hematoma with $\geq$ 25% luminal narrowing |
| III | Pseudoaneurysms |
| IV | Vessel occlusions |
| V | Vessel transactions or hemodynamically significant arteriovenous fistula |

### Individual Cases with Vertebral Artery Involvement

**Case 1:** A 32-year-old man who met with RTA presented to trauma OPD after 3 months from the time of RTA. At admission, GCS was 15/15 and ASIA grade was A. X-ray of the C-spine revealed atlantoaxial dislocation. CTA was done, which revealed grade IV BCVI of the right vertebral artery (►**Fig. 1**). However, the patient did not have any symptoms related to the vertebral artery injury. Surgery (C1–C2 fusion) was done to stabilize the cervical spine. No anticoagulation was started because the patient presented after 3 months.

**Case 2:** A 28-year-old man presented to us after 3 days of RTA with GCS of 15 and ASIA grade A with C5–C6 anterior dislocation. CTA revealed bilateral BCVI grade II vertebral artery injury (dissection) (►**Fig. 2**). Anticoagulation was started with heparin continuous intravenous infusion. After 48 hours of admission, the patient died of cerebellar infarction. He had a very rapid deterioration and expired before any surgical intervention could be undertaken.

**Table 2** Correlation of mode, level, and type of cervical injury with vascular injury

| S. no | Mode of injury | Level of injury | GCS | ASIA | Type of injury | Vascular injury |
|---|---|---|---|---|---|---|
| 1 | RTA | C1–C2 | 15 | A | Anterior dislocation | Right vertebral artery thrombosis |
| 2 | RTA | C5-C6 | 15 | A | Anterior dislocation | B/L vertebral artery dissection |
| 3 | RTA | C2 | 15 | A | Type 1A Hangman's fracture | Right vertebral artery thrombosis |

Abbreviations: ASIA, American Spinal Injury Association; ASIA grade A, complete loss of motor and sensory function below the level of injury; RTA, road traffic accident.

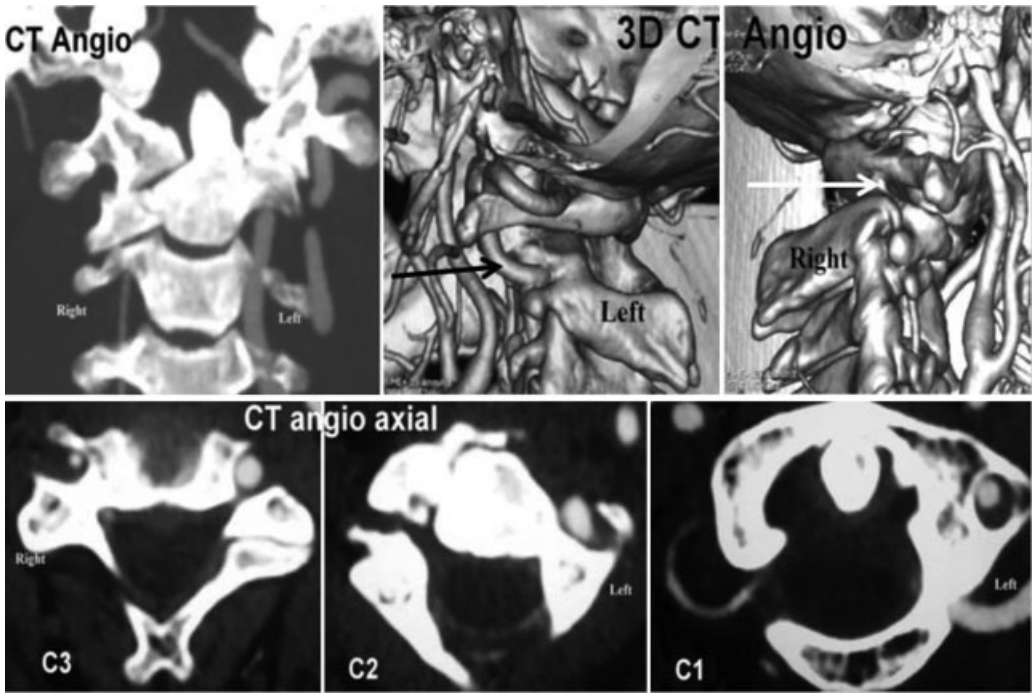


**Fig. 1** CT angiogram of case 1 shows occlusion of the right vertebral artery (white arrow) with normal visualization of the left vertebral artery (black arrow).

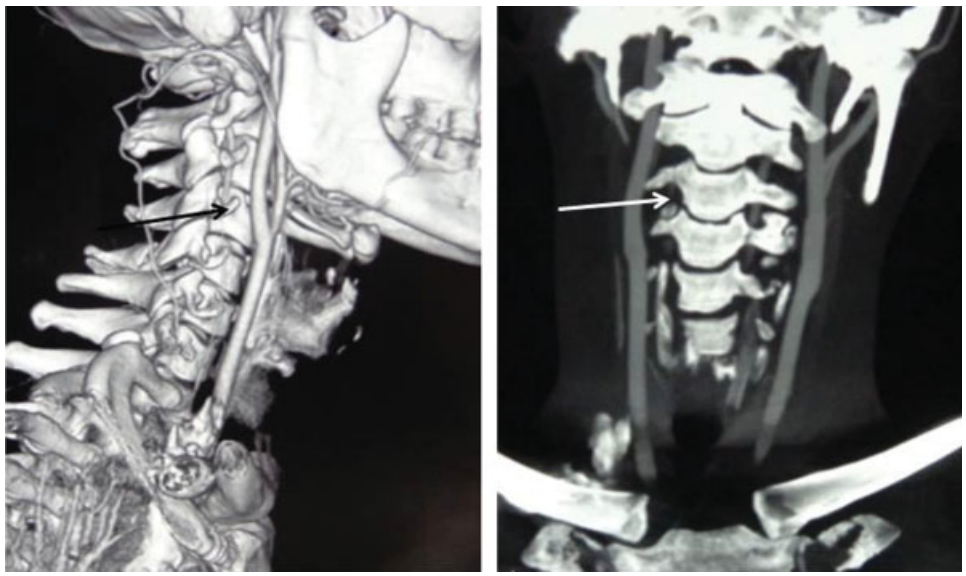

**Fig. 2** CT angiogram of case 2 shows partial obstruction of the vertebral artery (arrows) secondary to dissection.

**Case 3:** A 40-year-man with history of RTA with GCS 15/15 and ASIA grade A diagnosed to have type Ia Hangman's fracture with right vertebral artery thrombosis BCVI grade IV. The patient refused to continue further treatment in our hospital and left against medical advice. Further clinical course of this patient is not known as he was lost to follow-up.

## Discussion

The incidence of BCVI is difficult to quantify because many remain asymptomatic or symptoms may be attributed to associated brain (or other) injury. Spinal cord injury often occurs in the setting of multisystem trauma particularly head injuries, and symptoms may be masked by depressed consciousness or attributed to intracranial injury.

The incidence of BCVI varies depending on the criteria used and the sensitivity of the diagnostic test applied. Biffl et al[1] described an alarming incidence of 1.07% for blunt carotid injuries and 0.53% for blunt vertebral artery injuries (BVI) among patients admitted with blunt trauma (those at risk) in the prospective arm of their 9-year study. In a study by Miller et al,[2] out of 216 patients screened over 2 years,

angiography identified a carotid artery injury in 24 patients and a vertebral artery injury in 43 patients. The overall screening yield in this selected population was 29% or a 1% incidence of BCVI for the entire population with blunt trauma. In the present study, incidence of vertebral artery injury was 6% and there was no carotid artery injury. Low incidence of vertebral and carotid artery injury in our study may be due to small study population and exclusion of patients with associated head injury and poly trauma patients. BVIs result in damage to the carotid and vertebral arteries secondary to direct, nonpenetrating trauma to the neck. Up to 80% of BVIs are caused by motor vehicle accidents. Nonpenetrating trauma of the neck is a much less common cause of cervical vascular injury.[3] It occurs in less than 1% of cases and tends to involve the vertebral artery rather than the carotid artery.[4] Most injuries result from hyperflexion, extension, or rotation, often from motor vehicle accidents.[5] No carotid artery injury occurred in our study.

In a study by Mueller et al,[6] the most common level of injury was C5–C6 in 26.3%, followed by C2 in 15.8% of patients. In this study, the most common level of injury was C5–C6 in 16 (32%) patients, followed by C4–C5 in 8 (16%), C2 in 6 (12%), C6–C7 in 4 (8%), and C1–C2 in 3 (6%) patients. According to the type of injury, anterior dislocation was most common in 30 (60%) patients, followed by fracture lamina and spinous process fracture each in 4 (8%) patients and posterior dislocation in 3 (6%) patients. Most common mode of injury was fall from height, and it was associated with C5–C6 level of injury in 11 (22%) followed by C4–C5 in 6 (12%) patients. RTA is the second most common type, but it was associated with C2 level injury in 5 (10%), followed by C5–C6 in 3 (6%). In our prospective study, the most common type of injury was anterior dislocation and it was commonly associated with C5–C6 level in 16 (32%) followed by C4–C5 in 6 (12%) patients.

Three types of cervical fractures are cited in the literature as significant risk factors for VAI: (1) fractures involving a transverse foramen, (2) subluxation, and (3) fractures involving the upper cervical spine (C1–C3).[7–9] Cothren et al reported a 37% frequency of VAI in patients with these three fractures and suggested that a screening protocol using these three fracture patterns would detect 93% of VAI.[10] The frequency of VAI derived from other clinical series ranged between 17.2 and 26%.[11–14] The vertebral artery is most susceptible to injury at the point of entrance into the transverse foramen of C6. The second most common site of VAI is at C1–C2.[15,16] In the present study, one patient had vertebral artery injury at the level of C5–C6, and other two at the level of C2. Of these patients with C2 level injury, one had right foramen transversium fracture and the other had atlantoaxial joint dislocation. Out of three patients, one with C5–C6 anterior dislocation had bilateral vertebral artery injury.

A review of the literature done in 2002 showed a combined moderate and severe permanent neurologic deficit approximating 25 to 40% in survivors.[17] Mortality varies from 15 to 40%. Patients with an ipsilateral ischemic deficit on CT of the brain suffered a mortality of 47%, whereas mortality was 0% in those with a normal CT scan.[18] Death directly related to BCVI was documented in 8.3% (2/24) patients in a recent series of patients.[19] Recurrence rates for dissection and, more importantly, stroke have been reported between 1 and 4% over 2 to 5 years.[20,21] There is typically a latent period between the time of injury and the onset of symptoms. Most of the patients with vertebral artery injury are asymptomatic, and those with symptomatic may present with vertebrobasilar insufficiency, Wallenberg syndrome, and anterior spinal cord syndrome rarely with embolic stroke. In this study, out of three patients, one patient presented with bilateral cerebellar infarct. This patient was planned for surgical stabilization, but deteriorated rapidly and expired before surgery could be undertaken. Of the other two patients, one did not have any neurologic symptoms and the second was lost to follow-up.

The aim of early treatment is to prevent development of a neurologic deficit or prevent the progression of an existing one. There are two possible mechanisms for this: either hemodynamically important occlusion or the formation of small thrombi, which subsequently embolize the cerebral circulation. Embolic events are likely to be the more significant of the two. Treatment options include observation, anticoagulation, and stenting with/without thrombolysis.

There have been no randomized trials to advocate treatment with anticoagulation and all recommendations are level III evidence. Some studies have shown that the cerebrovascular complications that accompany these injuries are often preventable with simple anticoagulation.[22] Treatment with aspirin and/or other antiplatelet regimens is equally contentious. So far, no prospective studies have been conducted comparing antiplatelet regimen with heparin. Endovascular stenting has evolved into an attractive alternative to surgery with lower risks than surgery in patients where anticoagulation is contraindicated.

In the present study, one patient was started on heparin infusion but expired due to bilateral cerebellar infarct. The other patient presented after 3 months, so no anticoagulation was started. The third patient did not continue the treatment.

Compared with other studies, the incidence of vascular injuries in this study is low. Patients with head injury and poly trauma were excluded from this study, in whom the incidence of BCVI may be higher compared with that of isolated cervical spine trauma victims. For the studies to be comparable from different centers, we have to follow a uniform selection criterion. Patients with signs/symptoms suggestive of BCVI (viz., arterial hemorrhage, cervical bruit, expanding cervical hematoma, focal neurologic deficit, and ischemic stroke) or risk factors for BCVI (viz., Le Fort II/III fractures, cervical spine fractures involving C1–C3, transverse foramen fractures, basilar skull fracture with carotid canal involvement, near hanging, and diffuse axonal injury with GCS $\leq$ 6) should be screened.[23]

Aggressive screening has been shown to identify injuries in asymptomatic patients, allowing prompt antithrombotic treatment to prevent ischemic neurologic events. Importance of this study is that BCVI is associated with increased mortality rate; hence, early identification, and appropriate steps would be lifesaving. In this study, the incidence of BCVI was 6% in isolated blunt cervical spine injuries, and in future routine screening for all cervical injury, patients may support our result. Vertebral artery injury is more likely to occur in patients with ASIA grade A, especially those with severe fracture/dislocation. However, if one has to detect the exact incidence, possibly screening all patients may be necessary. A larger study is warranted to justify routine angiographic study for diagnosing vertebral artery injuries in patients with cervical spine trauma.

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