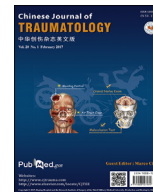




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## Case Report

# Penetrating neck injury: Collaterals for another life after ligation of common carotid artery and subclavian artery

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## ABSTRACT

Neck, being not protected by skeleton, is vulnerable to external trauma and injury which involves blood vessels, trachea, esophagus and other endocrine and nervous system organs. Vascular injuries can not only cause potentially life-threatening hemorrhage but also need profound surgical expertise in management. Development of collateral circulation in neck is well known; however, there is scarcity of literature on the role of collateral formation in neck trauma. Here, we present a unique case of penetrating gunshot injury to neck with right common carotid and right subclavian artery injury with hemorrhagic shock managed with ligation of these vessels as a life-saving procedure. The patient presented with no neurological or motor deficits in immediate postoperative period owing to the collateral circulation between right vertebral artery and right common carotid and right subclavian artery.

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## Introduction

With advancement in trauma care, the evaluation and management of vascular injuries of neck are of primary concern as they cause significant mortality.<sup>1</sup> Clinical examination along with computed tomography (CT) angiography plays a major role in assessment of vascular injury in neck.<sup>2,3</sup> Vascular injuries are managed by ligation of the vessels, surgical repair or endovascular intervention.<sup>4–7</sup> Ligation of major vessels of neck is preferred in cases of severe hemorrhagic shock with refractory hypotension.<sup>8</sup> Neck vessels are known for collaterals formation. Vertebrocarotid and vertebrosubclavian collaterals are well documented.<sup>9–12</sup> We present a unique case of gunshot injury to neck with right common carotid and right subclavian artery injury, and hemorrhagic shock was managed with ligation of these vessels as a life-saving procedure. Postoperatively patient presented with no neurological or motor deficits owing to the collaterals between right vertebral artery and right common carotid and right subclavian artery.

## Case report

A 32-year-old man presented to emergency department with a history of sustained gunshot injury to neck over suprasternal notch,

5 h after injury. The patient was evaluated according to the advanced trauma life support protocol and appeared stable. There was a 0.5 cm × 0.5 cm gunshot wound in suprasternal region. CT angiography of neck revealed nonvisualization of right common carotid artery with distal reformation with surrounding haematoma and partial tear of right subclavian artery (Fig. 1). One hour after the arrival, the patient developed active bleeding from the wound site, tachycardia (pulse rate 110 beats/min) and hypotension (blood pressure 85/65 mmHg).

Patient was shifted to the operating room. Incision was given by extending the wound margin to right side. Common carotid artery was found to be transected. Thrombus present in proximal end of transected common carotid artery was dislodged leading to heavy bleeding for which proximal and distal control was taken. Proximal and distal control was also achieved for a near complete transection of the right subclavian artery. In view of severe hemorrhagic shock, the innominate, right common carotid and right subclavian arteries were ligated. Bullet was retrieved. In postoperative period, oxygen saturation of right upper limb was 100% and patient had no central or peripheral neurological deficits. The patient was discharged on postoperative day 5.

A follow-up CT angiography done on postoperative day 7 revealed formation of multi-level vertebrocarotid and vertebrosubclavian anastomosis through the muscular branches of right vertebral artery maintaining distal right carotid and upper limb arterial supply (Fig. 2). The distal reformation was seen at the level of distal most right subclavian (by two major collaterals from the vertebral artery)

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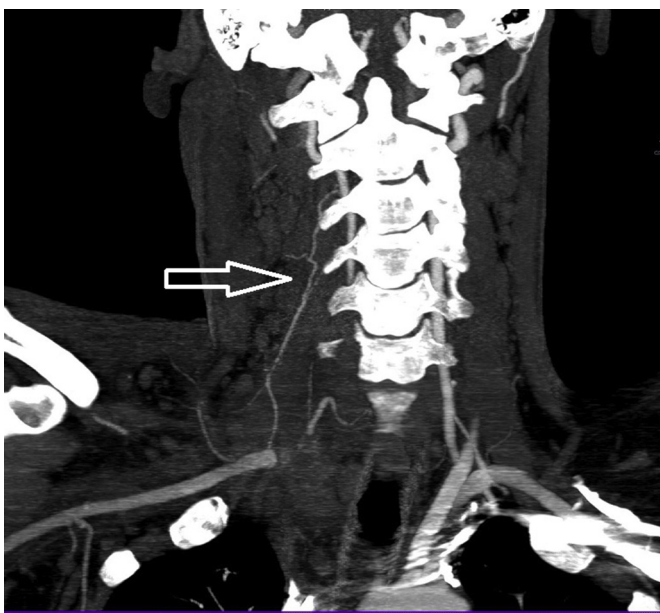


**Fig. 1.** Preoperative CT angiography showing transection of right common carotid artery with surrounding haematoma and partial tear of right subclavian artery with thrombus overlying it.

and at the level of carotid bulb (major collateral through the right occipital artery via the muscular branch of right vertebral artery) with distal opacification of right external carotid artery and right internal carotid artery. There was another collateralization through muscular branches from the ipsilateral vertebral artery supplying the right thyrocervical trunk which itself shows its nonopacified proximal part upto its origin from the ipsilateral subclavian artery.

## Discussion

Neck injuries can lead to laceration of major vessels causing hemorrhagic shock. Moreover, the central neurologic deficits are a



**Fig. 2.** CT angiography 7 days after surgery showing collateral formation of multi-level vertebrocarotid and vertebrosubclavian anastomosis through the muscular branches of right vertebral artery maintaining distal right carotid and upper limb arterial supply.

major concern due to extracranial arterial injuries including brachiocephalic, common carotid and vertebral arteries. The overall stroke and mortality rates can range between 5% and 50%.<sup>1</sup> CT angiography has significantly improved the detection of vascular and extravascular injuries in penetrating neck trauma.<sup>2</sup> Penetrating neck trauma is classically studied under three anatomical zones of neck. On basis of anatomical zones, stable patients with Zone I and Zone III should undergo CT angiography for characterizing the location and extent of vascular injuries as well as evaluating the potential aerodigestive injury while patients with symptomatic Zone II injuries should undergo early operative neck exploration.<sup>3</sup>

The vascular injury in penetrating neck injury includes extravasation, dissection, pseudoaneurysm, occlusion or arteriovenous fistula formation. The vascular injuries are principally managed by ligation, graft placement or endovascular treatment. Though ligation was predominant in managing the vascular injuries through the end of world wars, vascular repair, venous graft bypass and endovascular treatment have grown as effective modalities in management of vascular injuries.<sup>2</sup>

Multiple cases of surgical repair of internal carotid artery injury have been reported. Gimenez et al<sup>4</sup> reported a case of gunshot injury in Zone II leading to internal carotid artery thrombosis which was managed with surgical intervention. With advancement in intervention radiology, endovascular management has shown promising results.<sup>2</sup> Werre et al<sup>5</sup> reported a case of gunshot injury to the innominate artery and origin of right common carotid artery with shunting to brachiocephalic vein in Zone I of neck region, managed successfully with endovascular intervention. Kim et al<sup>6</sup> successfully showed the role of endovascular stenting in management of penetrating carotid artery injury in Zone II of neck. Faure et al<sup>7</sup> reported a case of high flow arteriovenous fistula with a large false aneurysm of common carotid artery, post gunshot injury to neck, managed with endovascular stenting successfully.

Although surgical repair and endovascular intervention are preferable options in management of vascular injury of neck, ligation may still appear to be a reasonable option where hemorrhage control is a priority owing to continuous refractory hypotension.<sup>8</sup>

In our case, ligation of the major vessels was preferred over primary repair or endovascular intervention owing to the severe hemorrhagic shock. Ligation of the major vessels of neck including internal carotid artery can lead to neurological deficits and morbidity. However the formation of collaterals in the neck is a known entity which may help in resumption of flow to arm and head and neck region.

The collateral formation between vertebral artery and subclavian artery after its proximal occlusion is well documented. This simulates the picture of subclavian steal syndrome. Subclavian steal syndrome is asymptomatic in majority of cases with retrograde flow being dependent on the duration of block in the subclavian artery, size of vertebral arteries and the extent of development of collateral channels.<sup>9</sup> A systolic blood pressure difference of greater than 20 mmHg between upper extremities is highly correlated with the symptoms, complete steal and need of intervention.<sup>10</sup>

The vertebrocarotid anastomosis after the common carotid artery occlusion has also been described. Bacci et al<sup>11</sup> investigated subjects with the common carotid artery as well as internal carotid artery occlusion and found the superior thyroid artery and ophthalmic artery as the major contributors of collateral formation respectively. In an interesting case of bilateral internal carotid arteries post gunshot injury of neck, the ligation of left common carotid and endovascular repair of right common carotid artery was done. Patient showed no cerebral deficits owing to the cross-filling of the left cerebral vessels from the right.<sup>12</sup> In our case, the innominate, right common carotid and right subclavian vessels were ligated. The development of vertebrosubclavian and

vertebrocarotid anastomosis and rapid establishment of this collateral circulation in acute neck trauma, thereby, salvaging the brain and the right arm is a unique phenomenon.

In conclusion, though primary repair and endovascular techniques are most advocated for vascular injuries of the neck, ligation of the vessels to control life-threatening hemorrhage may appear reasonable option in selected cases owing to the formation of collaterals between vertebral, subclavian and common carotid artery—collaterals for another life!

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