# Vascular Injuries of the Neck; Decision Making

Abdullah Musleh

Department of Otolaryngology, Head and Neck Surgery, Armed Forces Hospital, South Region, Saudi Arabia
shahrani99@hotmail.com

**Abstract: Objective:** Vascular injuries in the neck have the potential of creating serious morbidities and mortalities. The most important part of these injuries which have very serious outcomes is their having necessity for emergent surgical intervention. This study reviews a recent 6 years experience with 25 vascular injuries in the neck and focuses on the surgical management of the injuries. **Material &Methods:** A retrospective analysis of 34 patients admitted through ER with a history of suspicious of vascular trauma in the neck, between March 2005 and February 2011 by a team of otolaryngology and vascular surgery. All the surgically treated vascular injuries in the neck were 25 out of the 34. In our patients who have been taken to immediate operation, hemodynamic parameters were quickly corrected and in order to provide artery wholeness urgent measurements were taken. **Results:** 25 patients (75%) who were proved to have vascular injuries in the neck from 34 patients admitted with a suspicion of vascular injuries in the neck. 48% were haemodynamically stable and were taken into operation under elective conditions. 13 (52%) patients who were hemodynamically unstable and with hard sign of vascular injuries were immediately taken into operation room. Arterial injuries were 44% of all patients and 56% of them had venous injury. No one of our patients had post operative vascular compromise. Mortality occurred in one of patients at the 12$^{th}$ postoperative day as a result of multiple organ injury (etiologic agent was severe lung contusion and brain hemorrhage).
**Conclusion:** Patients who have unstable condition, who have hematoma and serious bleeding should be immediately taken into surgery. Expeditious decision making often is required to prevent catastrophic airway, vascular, or neurologic sequelae.
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**Key Words:** Neck injury, carotid arteries, jugular veins.

## 1. Introduction

Neck injuries can be some of the most overwhelming and dramatic scenarios we'll see during our career. These injuries often involve airway concerns, potential spinal cord injuries and large amounts of blood loss from external wounds[1-2]. All neck injury patients should be taken seriously, and rapid transport to the closest appropriate facility should be facilitated. The care provided in the field is often what separates a patient who survives from one who dies [1-2].

The mechanisms of blunt trauma can vary greatly. It's not always easy to identify blunt trauma, but the effects to the neck and spine can have significant consequences. These types of injuries are usually identified by multiple assessments. With blunt injury, the concern for spinal cord injury is high. Other concerns include blunt fractures of the larynx and trachea, along with blunt cerebrovascular injuries to the carotid arteries [1].

Penetrating neck injuries (PNIs) refer to neck injuries induced by gunshot wounds, stab wounds, or penetrating debris such as shrapnel. Before World War II, all PNIs were treated expectantly and mortality rates were as high as 35 percent [3]. In an attempt to reduce the high death rates associated with PNIs, a mandatory surgical approach was adopted, even for stable patients. This approach reduced mortality rates [4].

Mandatory surgical exploration remained widely accepted well into the 1990s, when it became obvious that while the mortality rate was low, the rate of negative surgical explorations was unacceptably high (58 percent in one series) [5]. From this observation came the concept of selective surgical management, which offers a spectrum of diagnostic approaches.

PNI, defined by platysma violation, comprises a sizable number of traumatic injuries in adults and remains a difficult management issue [3]. While surgical intervention is required in approximately 15 to 20 percent of PNI cases, the management of stable patients remains a source of debate [3, 6-7].

Penetrating neck trauma may pose a diagnostic and therapeutic dilemma to emergency physicians and trauma surgeons. Approximately 5% to 10% of all traumas involves penetrating neck trauma, with multiple structures being injured in 30% of patients. Thorough knowledge of the anatomy of the neck, physical assessment, and current recommendations for diagnostic and therapeutic interventions are necessary for appropriate management. Expeditious decision making often is required to prevent catastrophic airway, vascular, or neurologic sequelae.

Overall mortality because of penetrating neck trauma is as high as 11%. Injury to certain anatomic structures (e.g., the carotid or subclavian vessels) may be fatal in two thirds of cases, however. Compounding difficulties in evaluation and management is the complicated anatomy of the area, in which a dense concentration of vital vascular, aerodigestive, and nervous system structures are located within a very small space. In addition, there is a lack of consensus among trauma surgeons regarding injuries that mandate surgical exploration and those in which a conservative selective approach can be taken[8].

**2. Material and methods**:

A retrospective analysis of 34 patients admitted through ER with a history of suspicious of vascular trauma in the neck, between March 2005 and February 2011 by by a team of otolaryngology and vascular surgery, for suspecious of vascular injury. 25 of them were with vascular lesion the other 9 patients explored, but no major vascular lesion was found.

Patients presented with wounds in the neck and admitted to our side were investigated and kept under observation for 24 hours without surgical interference were not included in our study.

All unstable patients were resuscitated along Advanced Trauma Life Support guidelines. Patients with active uncontrolled bleeding, expanding or pulstile hematoma and/or haemodynamic instability with little or no response to resuscitation were taken to surgery immediately. Stable patients as well as those who stabilized after simple resuscitation and had evidence of a vascular injury (bruit, large hematoma), proximity lesions and Trans cervical gunshot wounds, underwent routine aortic arch and four vessel neck CT angiography. The Glasgow Coma Score (GCS), preoperative systolic blood pressure (SBP) and gross focal neurological signs of central origin of each patient were recorded prior to surgical intervention. All of the patients were evaluated by Neurologist preoperative and post operative period. Computerized axial tomography (CAT) scan of the brain was performed in stable patients who had been in coma for more than four hours duration and/or who had focal neurological signs. Injuries to the Common carotid artery (CCA) and internal carotid artery (ICA) detected at emergency exploration were repaired-even in the presence of coma and /or neurological deficit. Similarly, injuries to the CCA and ICA discovered with angiography without the disruption of distal flow were repaired. Carotids arterial Doppler ultrasonography was applied to 7 patients whose conditions were stable.

Some patients were with difficult Intubation through orotracheal rout; due to a big hematoma in the neck or difficulty in opening the mouth, transnasal Intubation was done using a fiber optic bronchoscope.

While the patients were under general anesthesia, from the medial side longitudinal incision of sternocleidomastoid muscle, extra cranial carotid artery was reached.

The arterial lesion was repaired primarly or using a venous graft for interposition, or ligated. Venous injuries were legated as all their inuries were unilateral. Two patients with venous injuries were repaired primarily.

Patients were followed up at the outpatient clinic and duplex scan done for those with arterial repairs.

**3. Results:**

Twenty five patients (22 males) [88%] and (3 females)[12%] were operated upon found to have a vascular injury in the neck. Their ages ranged from 12- 63 years with a mean age of 34 years.

Twelve patients [48%] presented to ER unstable with hard signs of vascular injury and taken immediately to OR. 13 patients [52%] were stabilized and evaluated by further investigation especially, duplex scan and or CTA.

The total arterial injuries were found in 11 patients [44%], the venous injuries were in 14 patients [56%].

Exploration was done through the anterior border of the sternocleidomastoid muscle. One patient was added a left anterolateral thoracotomy for subclavian artery injury.

The common carotid artery was injured in 4 [16%] patients. The internal carotid artery with the common carotid arteries was injured in 2[8%] patients. The internal carotid artery was injured in 1[4%] patient. The external carotid artery was injured in 1 patient. The common, internal and external carotid arteries were found injured in 1[4%] patient. The subclavian were injured in 1 [4%]. Vertebral arteries were injured in 2[8%] patients.

The venous lesion was mainly to the internal jugular vein in 10 patients [40%]. 4 patients were injured at the external jugular vein.

Most of the neck vascular injuries were on the right side 17 patients [68%]. The cause of the vascular lesion was penetrating injuries by a gunshot, a knife, a sharp rod or iatrogenic during insertion of a permcath for hemodialysis. Other injuries (7 patients [28%]) were associated with road traffic accidents, fall from a height or falling heavy objects on the neck and shoulder.

Primary repair was done for 2 arterial injuries and 2 venous injuries.

The rest of the arterial injury was revascularised by a venous interposition conduit in 6 patients [24%], while legation done in 3 patients (2 patients with external carotid injury and one patient with a vertebral artery lesion).

The remnant of the venous injury (12 patients [48%]) was managed by legation.

Associated injuries were seen in 8 patients [32%]. They were in the form of head trauma, bone fractures, nerve injuries, rib fractures and esophageal injuries.

Patients' morbidity was mainly from the associated injuries. There was no postoperative bleeding, hematoma, thrombosis or infection for the entire patient dealt for their vascular injuries.

Mortality was seen in 1 patient [4%], he was died at the 12$^{th}$ post operative day, he was multiple trauma patient, fall from a height with head fracture, left transverses cervical spine fracture, left vertebral artery injury, fracture ribs with lung contusion. The cause of death was considered due to ARDS.

Routine follow up of the patients in the outpatient clinics. Duplex scan done for all the patients with whom arterial repair and revascularization was done after 3 months. It showed patency of the arterial flow.

**Fig. 1:** Penetrating neck injury vascular injuries in the neck decision making

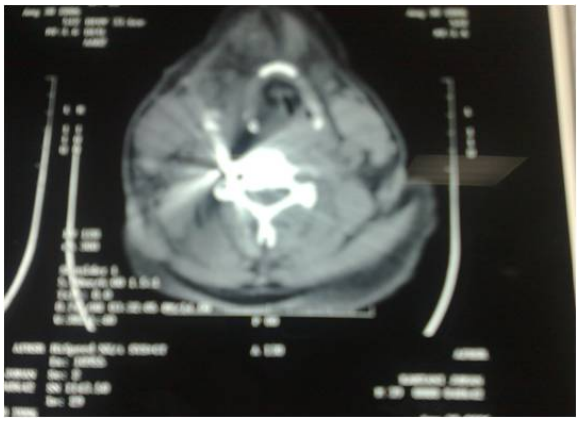

**Fig. 2:** CTA neck with bullet injury to carotid artery Vascular

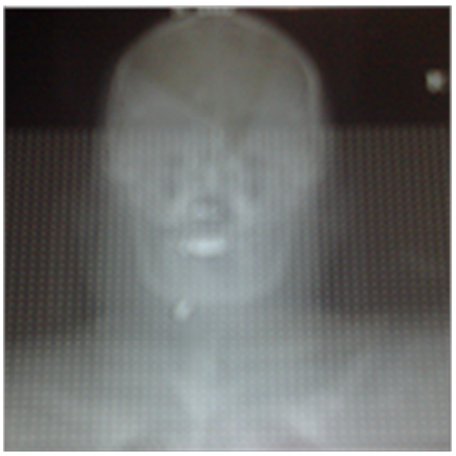

**Fig. 3:** CT neck bullet inury in the neck vascular injury of the neck decision making

**Fig. 4:** Ruptured carotid artery pseudoaneursm post trail of jug. cathter insertion

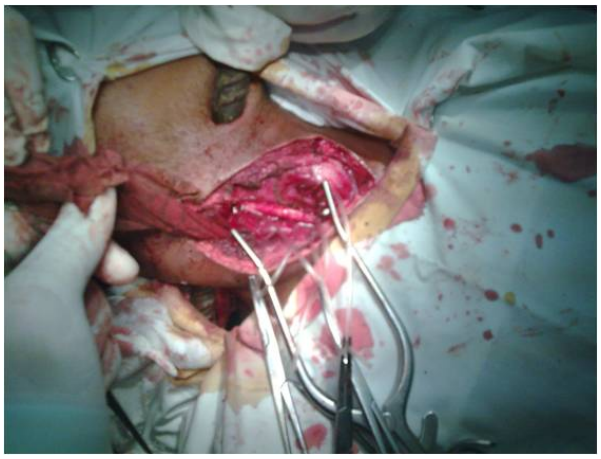

**Fig. 5:** Exploration of right carotid artery with penetrating trauma vascular injuries of the neck Decision Making

**Fig. 6:** Leaking Carotid artery pseudoaneurysm explored vascular injuries of the neck Decision Making

**Fig.7:** Postoperative repair of carotid artery injury vascular injuries of the neck Decision Making.

**4. Discussion:**

Neck injuries can be some of the most overwhelming and dramatic scenarios we'll see during our career. Thorough knowledge of the anatomy of the neck, physical assessment, and current recommendations for diagnostic and therapeutic interventions are necessary for appropriate management. Expeditious decision making often is required to prevent catastrophic airway, vascular, or neurologic sequelae [1-2,8] .

A large number of studies since the 1970's have attempted to determine the reliability of the physical exam in screening patients who should undergo further evaluation and treatment for penetrating neck injuries. Mandatory neck exploration for penetrating neck wounds was often found to lead to a negative exploration rate in excess of 50%. A review of the literature published in 1994 by McConnell *et al.* [9] compares several studies that use physical exam to screen patients. The review notes that in those studies in which asymptomatic patients were placed in observation groups (serial q6 hour exams by a physician), the rate of negative neck exploration was low, while the rate of false negatives was negligible.

As carotid artery injuries can create very serious mortality and morbidity, these injuries should be intervened immediately and should be followed seriously during the postoperative period. Although arterial Doppler ultrasonography can provide useful information in these kinds of injuries standard method is conventional angiography of aorta and its branches [10]. However, patients who do not have a stable condition, who have hematoma and serious bleeding should be immediately taken into surgery [11]. As these patients who have been immediately taken into surgery are from the young group, arterial wholeness, which will be provided without losing time during the surgery, will give satisfying results. Besides, it is useful pointing out the importance of duration of time between the injury and operation time. We think that the less the duration of this period is the more the results will be better.

When the vascular injuries at the neck area are as a result of cutter equipments, injury along the cut line could take place; at the injuries with high energy guns the injuries could take place with the blast effect. In the blunt vascular injuries not having surface occurrence of the injury makes examination and treatment harder. In these kinds of blunt traumas, it should be considered that there could be a probability of having neck and spinal injuries [12].

In cervical injuries, it will be helpful to investigate the neck area in three parts. Manson and all have made this discrimination: Zone 1; Base of the neck that is 1 cm above and under of Clavicle and thoracic area. Zone 2; Area that is between 1 cm

above Clavicle and mandibular angle. Zone 3; Area between base of the skull and mandibular angle [13].

At the injuries that are round the neck area, routine surgical exploration is performed in some medical centers and some surgeons prefer elective surgery with arteriography. According to our view, the most appropriate method is applying surgical exploration without further investigation for cases that have active bleeding and applying elective surgery after further investigation for cases that have stable condition

In patients with penetrating trauma in zone I or II who have sufficient clinical evidence of a vascular injur)' and are hemodynamically unstable, an immediate oblique incision along the anterior border of the sternocleidomastoid muscle should be performed [14].

In patients with a gunshot wound in zone II with a stable hematoma, an unknown level of a carotid-jugular arteriovenous damage, loss of the carotid pulse without a neurologic deficit, or proximity to the vertebral artery, diagnostic tests are indicated.15 Current diagnostic options include duplex ultrasound, digital subtraction arteriography, computed tomography (CT) angiography, and magnetic resonance angiography. In most centers, arteriography remains the gold standard in evaluating possible injuries to the carotid arteries.15 Duplex scanning has its technical hmitations for zone I and III or cervical wounds with large, soft tissue defects. CT angiography can be used as a noninvasive alternative to conventional arteriography.' A potential disadvantage is the degradation of image quality from the artifacts produced by metallic fragments embedded in the soft tissue [16]. .

For many types of penetrating injuries, the absence of hard signs reliably excludes surgically significant vascular injury. Prospective protocols demonstrate this for proximity injuries of the extremities by both short- and long-term follow-up[17]. Studies that examine penetrating trauma to all zones of the neck show consistently that zone 3 injuries are the least likely to occur and the most difficult to treat surgically [18-20].

The availability and accuracy of angiography in most institutions since the 1970s have brought about the concept of "selective management," which has become standard in some trauma centers for hemodynamically stable patients [21-22]. This approach results in many negative angiograms, as well as positive studies that are not surgically significant [23-25]

Surgical options for treatment of carotid artery injury include ligation or resection of the injured part of the artery with either primary repair or interposition grafting. Flow through the common carotid artery

References Liekweg and Greenfield [25] recommended a reconstruction of the injured vessel in a review of 170 patients with isolated injury to the internal carotid artery or common carotid artery with normal neurologic examinations before surgery. After revascularization, 5% of the patients had neurologic deficit versus 339f in patients where the injured carotid artery was ligated ($P < 0.002$). Ramadan *et al.*,[26] reported an even more pronounced difference in neurologic deficit after vascular repair compared with ligation in neurologic asymptomatic patients (8% vs 50%, $P < 0.05$). Other reports concluded that restoration should always be performed in the case of neurologically asymptomatic patients[27]. The most important complication of a ligated internal carotid artery or an untreated internal carotid artery occlusion is that it may develop embolic symptoms from the residual proximal internal carotid artery stump or distal tail.[14] We believe ligation should be reserved (1) for patients with prolonged coma with a Glasgow Coma Scale of less than 8 for more than 4 to 6 hours, (2) for technical reasons where surgical revascularization or endovascular repair is not possible, and (3) for injuries to the extemal carotid artery and its hranches[28].

As a nonsurgical treatment, watchful waiting is the last option. Some authors recommend systemic heparinization for asymptomatic patients with gunshot lesions to the neck with a proven occlusion of the carotid artery and no injuries to the brain or to othersites of the body [29] . This recommendation is partly based on available data from patients with blunt carotid injuries with similar injuries lo the carotid wall in which heparinization has been found to be associated with improvements in neurologic outcome and survival. However, the safety and efficacy of anticoagulants in the management of stroke after carotidinjury has not been demonstrated [30] .

**5. Conclusion:**

Knowledge of the anatomy of the neck, physical assessment, and current recommendations for diagnostic and therapeutic interventions are necessary for appropriate management. Expeditious decision making often is required to prevent catastrophic airway, vascular, or neurologic sequelae

Ustable patients condition, who have hematoma and serious bleeding should be immediately taken into surgery. The need of multidisciplinary approaches should not be forgotten.

When vascular injury is suspected in stable patients, they can be taken under elective surgery

after routine examinations and arterial and venous Doppler ultrasonography and CTA. Arterial or venous reconstruction provides the best outcome for most of the patients with vascular injuries in the neck.

**Correspondence author**
Abdullah Musleh
Department of Otolaryngology, Head and Neck Surgery, Armed Forces Hospital, South Region, Saudi Arabia
shahrani99@hotmail.com

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