



## PENETRATING NECK INJURIES IN LIBERIA-A REPORT OF SIX CASES

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### **Abstract:**

Penetrating neck injuries account for 5 % to 10 % of all trauma admissions globally. The management of these injuries is controversial. Due to improvement in imaging modalities selective neck exploration is now accepted as a standard of care in resource rich countries; while mandatory neck exploration remains a viable option for injuries penetrating platysma in limited resource setting. However; mandatory neck exploration poses a challenge to surgeons in low trauma volume centers.

**Objective:** To share our experience and high light challenges.

**Methodology:** Records of 6 patients with penetrating neck injuries managed by our team over the last 6 months (Jan 2017-July 2017), were reviewed for biodata, mechanism of injury, Zones of injury, types of injury, intervention, and outcome.

**Results:** All 6 cases were male with five adults and one child. Three patients sustained intentional knife injuries, while two patients sustained un-intentional sharp objects injuries. Two patients had internal jugular lacerations in zone two of the neck. One child and adult sustained various injuries including parotid and vessels in zone three. One patient had retained foreign body long the trachea-esophageal groove and one patient with tracheal injury. One patient died from exsanguination and the other had threatened airway with tracheostomy on the table.

**Conclusion:** Management of penetrating neck injury in resource limited settings remains a serious challenge. Lack of equipment and surgeon inexperience may lead to poor outcome. Combining both clinical physical assessment and appropriate interpretation of hard and soft signs of neck injury may be helpful in neck exploration decisions.

**Abbreviation-** Bpm: Beats per Minute, CT: Computed Tomography, ER: Emergency Room, ML: milliliter

**Key Terms:** Aerodigestive, Injury, Ligation, Penetrating, Zone

## Introduction

Penetrating neck trauma is responsible for 5% to 10% of all trauma admissions (1). The neck contains a dense concentration of vital structures that are not always easy to assess by physical examination or surgical exploration and poses a serious challenge to surgeons (1,2). Expedient decision making is often required to prevent catastrophic airway, vascular, or neurological sequelae (3). Currently civilian mortality figures are expected at 2–6 % and can be as high as 11 % (3). Most of these cases are associated with vascular injuries (carotid arteries, subclavian vessels) and spinal injuries (5). To standardize reporting, Roon and Christensen divided this region into three cervical anatomic zones, upper zone (zone III), middle zone (zone II), and lower zone (zone I) (6). Zone I includes the area between the sternal notch and clavicles to the cricoid cartilage, zone II extends from the cricoid cartilage to the angle of the mandible, and zone III up to the base of the skull (7). Due to its dimensions, zone II is the most exposed and vulnerable to injuries (7). Nearly 50% - 80% of traumas involve this zone (8). Multidetector CT Angiography is now an integral component of the management of penetrating neck injury but it is lacking in most facilities especially the developing countries as such, clinical assessment must be relied on for decision making. We therefore present a Case series of Six patients with Penetrating Neck Injury to share our clinical experience and outline some the challenges during management.

## Methodology

Over the past 6 months from (January 2017 to July 2017), we managed six cases of Penetrating Neck Injury. The records were retrieved and reviewed for biodata, mechanisms of injury, zones of injury, types of injury, intervention, and outcome. Five of these patients were managed at the John F. Kennedy Medical Center, Liberia's premier Referral Center and one patient at the Saint Joseph Catholic Hospital (also a training center for General Surgery in Liberia). These patients were all seen by a Surgical Resident and a General Surgeon. Four of these patients presented as vascular emergency. Patient with systolic blood pressure below 90mmHg were considered hemodynamically unstable. CT-Angiography could not be done as it is not available in our facility.

## Case 1

A 21-year-old male was brought into the ER conscious and complained of bleeding from stab wound on the right cheek and the neck from a kitchen knife by his nephew following attempted disciplinary action against his nephew from abusing his grandmother. Compressive pressure was applied to the wound using a pad fashioned out of the shirt. No history or loss of consciousness reported.

He arrived conscious and hemodynamically stable. His vital signs were 110/70 mmHg, pulse: 84bpm, and no signs of respiratory compromise. The blood-soaked shirt was replaced with gauze pad for compressive dressing. Two wide bore intravenous cannulas

were inserted with volume of crystalloids infused at 20ml/Kg bolus. Blood was taken for hemoglobin determination, grouping and cross matching. 2 units of packed cells obtained, consent signed, patient was wheeled into theatre for neck exploration. While in theatre, the gauze was replaced with s 16-french foley catheter which was tunneled into the wound depth and balloon inflated with 30 cc of saline.

Under general anesthesia and intubation, incision made anterior to the sternocleidomastoid and proximal carotid and internal jugular vein control achieved using pediatrics soft bowel clamps. Distal control was achieved using foley catheter. Injuries to the following structures were confirmed. Internal jugular vein, facial artery, and parotid were all severed. Lateral venorrhaphy was performed and facial artery ligated. Hemostasis controlled and wound closed in layers. Upon extubation, patient started to rebleed on the table and with massive hematoma formation making re-intubation challenging. Hence a surgical airway was established on table and neck wound re-explored. A bleeder was identified on the wound and ligated. Patient was transferred to the general ward and airway discontinued on day two post operatively. He received 2 units of blood and was discharged home with hemoglobin of 10 gm/dl.

### **Case 2**

A 3-year-old male fell on a sharp object while playing at home with his friends and sustained a penetrating injury to the anterolateral surface of the left neck close to angle of the mandible. He presented at the local clinic where he received first aid, wound cleansed and sutured and discharged home. He continued to bleed. He was then taken to Redemption hospital where a figure of eight nylon suture was placed to control bleeding. Hemostasis was achieved and discharged home the same day. While at home, he continued to bleed and was then brought to JFK. On arrival, his pulse was 130bpm, and pale. Punctured wound was confirmed with hematoma and suture in situ, but not actively bleeding. Hemoglobin was 4 gm/Dl. After stabilization and transfusion of 200 ml of packed cells, he was taken to theatre for exploration. The following injuries were confirmed. Parotid was nicked and a branch of the external carotid lacerated. Ligation and wound closure were achieved and child was discharged home on day three with hemoglobin of 9 gm/dl.

### **Case 3**

A 28-year-old male patient was brought into the ER with complain of bleeding from a stab wound in zone two of the right neck. He claimed to have inappropriately touched a female passenger while trying to adjust his sitting position when he was suddenly stabbed on the neck. Compressive pressure was applied and he was rushed to the ER.

He arrived hemodynamically stable with GCS of 15/15. A bleeding wound was confirmed in zone two on the right neck. A purse string suture was placed around the wound for hemostasis. Blood was taken for hemoglobin determination, grouping and cross match.

Two wide bore cannulas inserted and crystalloid infused. After stabilization patient was wheeled into theatre for neck exploration. A lacerated right internal jugular vein was identified at the level of upper part of zone two. It was ligated with vicryl 2/0 and hemostasis achieved, neck wound closed in layers with drain in place. He was also discharged home with hemoglobin of 9 gm/dl.



A

B

**Figure 1. Panel A shows a surgical scar from a zone II injury. Panel B shows a surgical scar from a Zone III injury repair.**

#### Case 4

A 37-year-old male patient a welder was brought into the ER with complain of bleeding and swelling on the anterior aspect of the neck following penetrating injury by a flying metal fragment while welding on along iron. No loss of conscious reported at the site. Examination confirmed a small punctured wound on the anterior aspect of the neck and moderate swelling, but with no active bleeding. He was hemodynamically stable and Hemoglobin of 15g/dl was reported. Anterolateral and anterior posterior cervical X-rays showed a foreign body lodged anterior to the trachea.

He was further optimized with crystalloid, grouped and typed and two units requested to hold. He was explored 48 hours later and the piece of metal removed. Patient was discharged home after 48 hours post operatively.



A

B

C

**Figure 2. Panel A shows patient's recovery after a Zone I foreign body extraction. Panel B shows initial hemorrhage control with purse-string sutures. Panel C shows a tracheal injury from a buffalo horn.**

### Case 5

A 32-year-old male patient was brought into the ER with complain of bleeding from the neck wound. He sustained neck injury after a stabbed by a male acquaintance following an argument. No loss of consciousness reported. Compressive pads were applied and he was rushed to ER. He was hemodynamically stable but bleeding from the neck wound. A purse string suture was placed around the wound to control hemorrhage. Two wide bore cannulas inserted and crystalloid infusion started. Blood collected for hemoglobin determination, grouping and cross matched with 4 units of blood requested. After stabilization, he was taken to theatre. Under general anesthesia endotracheal intubation, neck exploration revealed total transection of the Internal Jugular Vein after removal the clots. Intraoperatively, he exsanguinated complicated by massive air embolus and subsequently died on the table.

### Case 6

A 37-year-old male hunter presented with hoarseness and an anterior neck wound after being pierced by a buffalo horn while hunting at night. There no significant hemorrhage from the wound and no dysphagia or odynophagia.

He was brought in hemodynamically stable and fully conscious. There was an anterolateral neck laceration below the cricoid cartilage with a puncture wound extending deep into the trachea. Crepitus was palpated along the anterior triangle of the neck. He was diagnosed of penetrating neck injury with tracheal injury. He underwent primary tracheal repair with 2.0 vicryl followed by delayed primary wound closure. His recovery was unremarkable.

### Results

Case Series	Age	Sex
Case 1	21 years	male
Case 2	3 years	male
Case 3	28 years	male
Case 4	37 years	male
Case 5	32 years	male
Case 6	37 years	male

**Table 1.0 Demography:** A total of six patients were reviewed in this study for penetrating neck injury. All patients in the case series were male involving five adults and a child.

Cases	Mode of Injury	Mechanism of Injury	Zones of the Neck	Vascular Injury	Other Injuries
Case 1	Intentional	Knife	Zone III	Internal Jugular vein, Facial artery	Parotid
Case 2	unintentional	Broken glass	Zone III	Branch of external carotid artery	Parotid
Case 3	Intentional	Knife	Zone II	Internal Jugular vein	
Case 4	unintentional	Metal Projectile	Zone I		Foreign body anterior to trachea
Case 5	Intentional	Knife	Zone II	Internal Jugular Vein	
Case 6	Unintentional	Buffalo Horn	Zone II		Tracheal injury

**Table 2.0 Categories of Injury:** All three of the Knife injury were intentional injuries. All other injuries including those sustained from a broken glass, metal projectile and buffalo horn were unintentional. About three of the penetrating neck injury were in Zone II of the neck while two were Zone III injuries. Two patients sustained multiple Zone III injury; one involving the internal jugular vein, facial artery and parotid gland while the other had injuries of the external carotid and the parotid gland. One patient had an isolated jugular venous injury in zone II. One patient sustained a zone II tracheal injury while another had a foreign body lodged anterior to the trachea in zone I of the neck.

Case series	Management Approach	Outcome	Complications
Case 1	Venorrhaphy, ligation and tracheostomy	Recovered	Facial palsy
Case 2	Ligation of branch of external carotid artery	Recovered	
Case 3	Ligation of internal Jugular vein	Recovered	
Case 4	Neck Exploration and Foreign body removal	Recovered	
Case 5	Neck Exploration	On-table Exsanguination	Died
Case 6	Primary tracheal repair	Recovered	

**Table 3.0 Management and Outcome:** All the patients underwent neck exploration. All the arterial injuries were controlled by ligation. The jugular venous injuries were repaired both with lateral venorrhaphy and ligation. One patient with rebleed and neck hematoma required a tracheostomy for airway control. A neck exploration for foreign body removal and primary tracheal repair were required for the other patients. There was a single death from on-table exsanguination and air embolism.

### Discussion

Neck injuries that extend beyond the platysma are considered penetrating (7). Penetrating injuries of the neck can be classified according to the anatomical level of the injury (10). Zone I is defined as the region between the clavicles, sternal notch and the level of the cricoid cartilage, zone II lies between the cricoid and the angle of the mandible, and zone III comprises the area between the angle of mandible and the skull base (11). The assessment and surgical management of injuries in zones I and III are complicated by the proximity of the thoracic cavity and skull base region, respectively (11). Most of penetrating injuries occur in zone II where the major structures are relatively more accessible surgically (10, 11).

The Advanced Trauma Life Support approach to significant injury emphasizes a systematic approach to the assessment and management of any form of significant trauma (12) but the need to prioritize the management of significant hemorrhage is especially appropriate in the context of penetrating neck trauma, given that exsanguination accounts for 50% of the mortality from such injuries (11). Careful physical examination has been shown to be safe and reliable in predicting the need for surgical exploration or further diagnostic investigations (9). Clinical findings are usually classified as “hard” or “soft” (15). Hard signs are indicative of major vascular or aerodigestive tract injury and include active bleeding, hemodynamic instability,

expanding or pulsatile hematoma, bruit/thrill, pulse deficit, central neurologic deficit/evolving stroke, refractory shock, massive subcutaneous emphysema and significant airway compromise (15). Soft signs include venous oozing, non-expanding or non-pulsatile hematoma, minor hemoptysis, dysphonia, dysphagia, air bubbling through wound, and mild emphysema (15).

Patients with hard signs require immediate surgical intervention while patients with soft signs may require further investigations to confirm the need for surgical exploration or not. Asymptomatic hemodynamically stable patients often just require careful observation. A retrospective study in Nigeria showed that major vascular injuries were associated with overt signs including severe bleeding, expanding hematoma, loss of carotid pulsation and neurological deficit therefore, neck exploration was performed in these patients without further diagnostic evaluation (9). Physical signs as a basis of detecting significant injury had a sensitivity of 97.2% and specificity of 87.4%. (9). In the most recent prospective, multicenter study, evaluating 453 patients over 31 months, all 189 patients without physical examination findings of vascular or aerodigestive tract injury were observed and discharged without a missed injury (mean, 2.6-day follow-up) (18).

Military experience in World War II resulted in the adoption of a policy of mandatory neck exploration for any injury that was found to breach the platysma but this practice is now obsolete (11). Given the controversies about the management of PNI, limited evidence base, and variability in resources and experience, decisions about whether to use a selective, zone-based management approach or a no-zone approach will vary by local expertise and resources and are likely to remain institution-specific for the time being (13). No-zone algorithms are based on patient stability and the presence of soft versus hard signs of injury, regardless of injury location whereas zone-driven approaches are based on the location of the external wound (13).

Indeed, the shift away from management dictated by wound location and depth to a “no zone,” image-based approach has been driven primarily by CT Angiography (11, 14). Because of difficulty in surgical exposure, selective management is frequently chosen for injuries in zones I and III if the patient is stable and has no obvious injuries (3). Operative exposure for penetrating neck injuries with “hard signs” or hemodynamic instability are determined by the anatomic zone of injury. Most penetrating neck injuries can be approached via an anterior sternocleidomastoid incision (6). Zone I neck injuries may require a median sternotomy with extension to an anterior sternocleidomastoid incision or supraclavicular incision with or without clavicular head resection (18). For Zone II transcervical injuries, a transverse cervical collar incision may provide access to both sides of the neck, with the potential to extend along the anterior sternocleidomastoid muscle (18). Zone III represents a difficult anatomic zone of injury for distal vascular control as such subluxation, dislocation, or resection of the mandible may be necessary to gain operative vascular control (18).

Endovascular techniques have become a useful adjunct and an addition to the armamentarium available for the management of the acutely injured patient (18). Prior to any surgical or radiological intervention on an injured cervical artery, temporary control of hemorrhage should ideally be achieved (11). If simple external compression is ineffective, 18- or 20-gauge Foley catheter into a bleeding neck wound along the path of the wound tract or the more superficial neck wound can be packed or closed with sutures (11). Failure of this intervention to control bleeding requires immediate operative exploration (11).

When a common or internal carotid artery injury is identified during a neck exploration, the consensus from the literature is that repair of the artery is generally preferable to ligation, irrespective of whether a preoperative focal neurological deficit was present or not (16). Ligation of an injured carotid artery is only indicated in patients with preoperative coma (Glasgow Coma Scale score <8), who are likely to have an adverse outcome with either revascularization or ligation (11). Most of the isolated jugular venous injuries are believed to be unrecognized – it is claimed that this low-pressure system usually tamponades or occludes without a major hemorrhage (19). In the event of significant hemorrhage from an injury to the jugular venous system or discovery of a jugular venous injury at neck exploration, the consensus is that ligation of the affected vein can be performed without fear of complication (19). The exception to this general rule would be the rare occasions when the internal jugular venous system sustains bilateral injuries. In this situation, an attempt to repair one vein should be undertaken if possible to minimize the risk of subsequent cerebral venous hypertension and edema (19).

A high index of suspicion is needed for pharyngoesophageal injury. Odynophagia, hematemesis, subcutaneous emphysema, or pre-vertebral air on a lateral neck X-ray requires further investigation. Direct pharyngo-esophagoscopy flexible or rigid has a high sensitivity with respect to detecting injuries and contrast swallows are potentially less sensitive than esophagoscopy but provide information about the size of pharyngoesophageal leaks, which can in turn influence management (11). Patients with suspected or proven pharyngoesophageal injuries should receive intravenous antibiotics and be provided with nutrition via nonoral routes (nasogastric or total parenteral) (11). Small, contained pharyngo-oesophageal leaks can be treated with conservative measures alone. Significant pharyngo-oesophageal injuries require urgent surgical exploration and repair (11).

### **Conclusion**

The management of a penetrating neck injury is challenging in resource limited settings. Careful physical examination employing the hard and soft sign of vascular and aerodigestive injury has been shown to be safe and reliable in predicting the need for surgical exploration or further diagnostic investigations. A good clinical assessment of zone based injuries and emergent surgical response can ameliorate exsanguination from major vascular injuries and prevent aerodigestive complications. Ligation of a unilateral



jugular venous injury has proven to safe and should be done in settings of massive jugular venous hemorrhage. The need for expertise in vascular surgery in these settings cannot be understated.

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### **Consent**

A written informed consent was acquired from for each patient and other relevant information were retrieved from the chart.

### **Conflict of Interest**

The authors declare no conflict of interest regarding this publication.

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