

## Penetrating Injuries of the Neck

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### ABSTRACT:

#### BACKGROUND:

Penetrating injuries of the neck are potentially dangerous, causing high rates of morbidity and mortality due to their association with sever bleeding and serious damage to the vital structures in the cervical region.

#### OBJECTIVE:

To know the incidence and distribution of these injuries on the anatomical zones of the neck and the damage of the vital structures in the cervical region and their early surgical management.

#### METHODS:

A prospective study on 52 patients of both civilian and military personnel with penetrating neck injuries attended the casualty department at Alyarmouk hospital over a period of 7 months from June-December 2006.

#### RESULTS:

Fifty patients (96.15%) were males. Twenty four patients (46.15%) were in their third decade. Twenty six patients (50%) were injured by shrapnel of explosives, 23 patients (44.21%) by bullets & 3 patients (5.77%) by unknown objects. Thirty six patients (69.23%) were injured at zone 2, 11 patients (21.15%) at zone 3 & 5 patients (9.62%) at zone 1. Twenty nine patients (55.77%) had laryngeal & tracheal injuries. Thirteen patients (25%) had pharyngeal & esophageal injuries. Four patients (7.7%) had recurrent laryngeal nerve injury. Nine patients (17.3%) had vascular injuries 6 arterial & 3 venous. One patient had vertebral & spinal cord injury. Forty one patients (78.86%) had tracheostomy operations, & 13, (25%) had neck exploration. Six patients (11.54%) treated conservatively. Nine patients (17.3%) have died.

#### CONCLUSION:

Male patients at their middle age were the predominant victims either by shrapnel or by bullets. Zone 2 was most commonly affected followed by zone 3 & zone 1. Laryngo – tracheal, pharyngo – esophageal & vascular structures were mostly involved. Tracheostomy & neck exploration were the main urgent operations performed for them. The high mortality reflected the serious nature of these injuries.

**KEY WORDS:** neck wounds, penetrating injuries.

### INTRODUCTION:

The war and violence in our country caused large number of casualties with injuries at different parts of their bodies. Casualties with dangerous and potentially life threatening Penetrating Neck Injuries (PNIs) were increased and required urgent treatment. In the neck multiple vital structures are vulnerable to injury within a small unprotected anatomical area <sup>(1)</sup>. A successful management of PNIs depends on clear understanding of the anatomy of the neck and the physical properties of penetrating objects <sup>(2)</sup>. There are six systems with important organs related to the neck:-

1. The vascular system includes the innominate, subclavian, axillary, carotid, jugular & vertebral vessels.
2. The respiratory system includes larynx & trachea.
3. The digestive system includes pharynx & esophagus.
4. The nervous system includes spinal cord, brachial plexus, cranial nerves & sympathetic chains.
5. The endocrine system includes thyroid & parathyroid glands.
6. The skeletal system includes the cervical spine <sup>(3)</sup>.

The most common classification of neck anatomy in term of penetrating trauma is to divide its anterior aspect from bellow upwards, into 3 zones:- Fig 1

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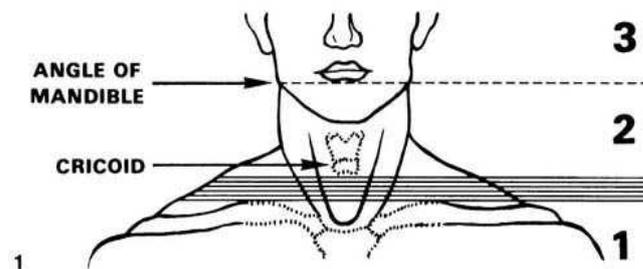
Zone 1; extends from the level of clavicles and sternal notch to the level of cricoid cartilage of larynx; it contains the proximal carotid arteries, subclavian vessels major vessels in the chest; lungs, esophagus, trachea and thoracic duct.

It represents a dangerous area because the vascular structures in this zone are in close proximity to the thorax. The bony thorax and clavicles protect zone 1 from injury. This osseous shield also makes surgical exploration of the root of the neck difficult.

Zone 2; extends from the level of the cricoid cartilage to the angles of the mandible; it contains the carotid arteries, jugular veins, larynx & hypopharynx.

Zone 3; extends from angles of the mandible to the base of the skull, it contains the distal carotid arteries, jugular veins, the salivary glands & nasopharynx.

Zone 2 has the easiest surgical exposure & can be evaluated intraoperatively without preoperative diagnostic tests.<sup>(3)</sup>



**Fig 1 :The three zones of the neck as seen on the front of the neck.  
The shaded area represents the portion some authors consider it zone 1.  
But others label it zone 2. (1)**

The lateral region is defined as the area between the posterior border of sterno- mastoid muscle & the anterior border of the trapezius muscle.

The posterior region is the area between the anterior borders of trapezius muscles.

Knowledge of the physical properties and ballistics of penetrating objects and their location can predict to the risk and helping planning for management.<sup>(4,5)</sup>

Penetrating objects differ in their nature and velocity and accordingly they either cause low energy transfer wounds or high energy transfer wounds.<sup>(6)</sup> Hand guns cause injuries of low energy transfer wounds because they have projectiles with low velocity (90m/sec.). The missile trajectory (Yaw) describes the deflection of projectile around the axis of travel. Most military rifles have a jacket of strong metal usually copper surrounds a lead projectile, and this permits smoother longer flight because of less drag and less aerodynamic compression. (1) The M16 military rifle has a muzzle velocity of (760m/sec.) and has a bullet that is designated to tumble and therefore cause more tissue injury, these types of bullets have high energy transfer also cause temporary cavitations.<sup>(7)</sup>

The explosive pressure that accompanies the bursting of bombs ruptures their casing and

imports a high velocity to the resulting fragments. These fragments have the potential to cause even more devastating injury to the tissues than bullets. They are unstable to flight and may tear through tissue at high speed of tumbling fashion. (1)

Blast injury is considered to be of three types; primary blast injury occurs when the blast wave strikes and compresses the body. The energy is transferred directly from the transmitting medium (i.e. air) to the body surface. Secondary blast injuries occur when flying debris, or collapsed buildings, and other environmental material energized by the explosion strike the body. Tertiary blast injury occurs when casualty's body is thrown against stationary objects by pressure differentials or blast wind.<sup>(8)</sup>

The clinical manifestations of PNIs are related to the severity of the damage of injured structure and the lasting duration of the incidence. On the same victim, multiple signs may appear at the same time. Patients with sever PNIs usually die either immediately or soon afterwards. Patients with moderately severe neck injuries may survive long enough to reach the hospitals and should have a chance to be saved.

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Vascular injuries present with persistent bleeding from injury site, expanding hematoma &/or with hypovolemic shock. Laryngo-tracheal injuries present with difficulty in breathing, cyanosis and surgical emphysema. Pharyngo-esophageal injuries present with dysphagia, hemoptesis and surgical emphysema. Neural injuries presents with paralysis of the affected peripheral nerves, hemiplegia & quadriplegia<sup>(6)</sup>.

Radiological examinations are frequently needed and are essential to identify the site and size of radio opaque objects. Radiography also can identify air shadow within the soft tissue of the neck, tracheal shift, fragmentation of laryngeal cartilages and fractured cervical vertebrae<sup>(7,8)</sup>.

The early management of those victims is usually carried out at casualty units by a team of doctors consist of Anesthetist, ENT, Maxillofacial & Vascular surgeons.

### PATIENTS & METHODS:

A prospective study was carried out on a sample of (52) patients seen at the casualty unit & the department of otolaryngology at Alyarmouk hospital in Baghdad – Iraq, from June – December

2006. Both civilian & military patients were included in this study and subjected to proper history taking and clinical examination of the site of cervical injury, as well as assessment of their circulatory, respiratory & nervous systems. Patients who had minor neck injuries that didn't violet the platysma muscle were excluded. Information were recorded on a questionnaire formula and arranged accordingly. Twenty eight patients had radiological examination in the form of plane X-ray of the neck. Indications for surgical intervention of tracheostomy & wound exploration were; airway obstruction, crepitus, expanding hematoma, and massive bleeding, heamothorax and non expanding heamatoma in the presence of heamodynamic instability and hypovolemic shock.

### RESULTS:

Age incidence:

Three patients were at 10 – 19 years of age, 24 patients were at 20 – 29 years of age, 9 patients were at 30 – 39 years of age, 10 patients were at 40 – 49 years of age, 5 patients were at 50 – 59 years of age & 1 patient was above 60 years of age. Fig. 1

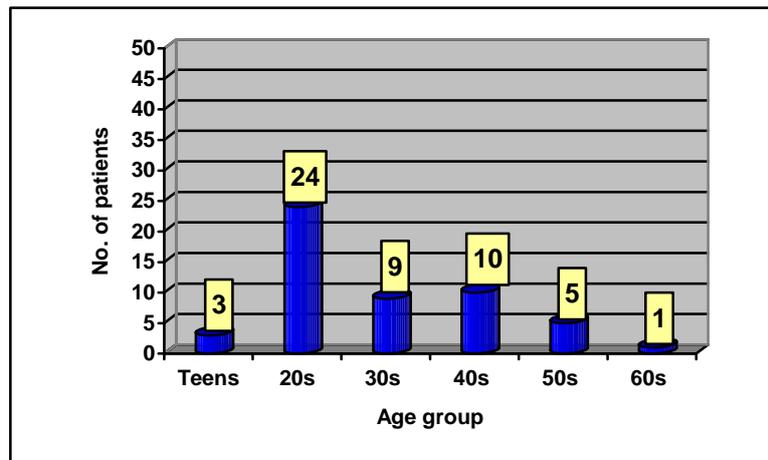


Fig. 1

Table 1:

Age group	No. of patient	%
10 - 19 years	3	5.77 %
20 – 29	24	46.15 %
30 – 39	9	17.3 %
40 – 49	10	19.35 %
50 – 59	5	9.6 %
60 – 69	1	1.96 %
20 - 49 years	43	82.7 % Highest Incidence

### Gender incidence:-

Fifty patients were males & 2 patients were females.

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**Table: 2**

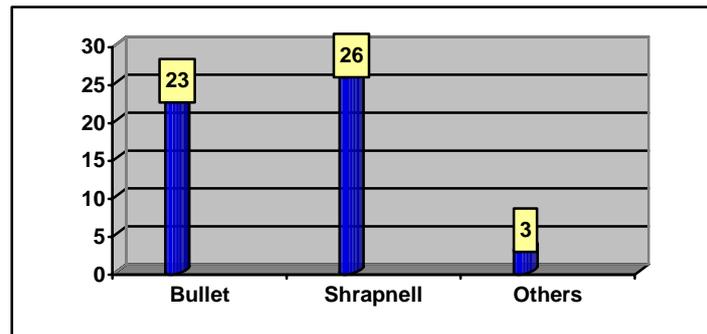
Gender	No. of patients	%
Male	50	96.15 %
Female	2	3.85 %

### Causes of injury:

Most of our patients 26 (50%) were injured by explosions

Patients injured by bullets were 23 (44.23%). Rifle bullets 21 patients and 2 patients hand gun bullets.

Patients injured by unknown objects were 3 (5.77%). Fig 2



**Fig. 2**

**Table 3: Causes of injuries**

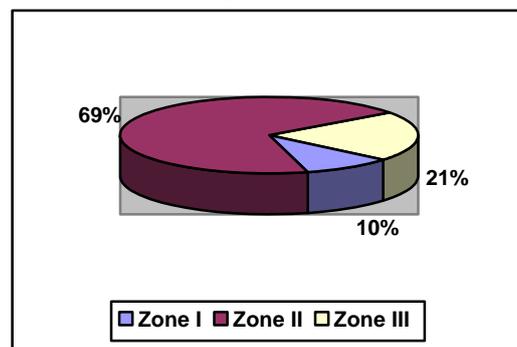
Cause	No. of patients	%
Bullets	23	44.23 %
Shrapnel	26	50 %
Others	3	5.77 %

Distribution of injuries according to the anatomical zones:

Patients injured in zone 1 were 5 (9.62%).

Patients injured in zone 2 were 36 (69.23%).

Patients injured in zone 3 were 11 (21.15%). Fig 3.



**Fig. 3**

**Table 4:**

Zonal distribution

Zone	No. of patients	%
Zone 1	5	9.62 %
Zone 2	36	69.23 %
Zone 3	11	21.15 %

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### Distribution of visceral injuries:

Twenty nine patients (55.77%) had tracheal and laryngeal injuries, manifested themselves with airway obstruction.

Thirteen patients (25%) had pharyngeal and esophageal injuries.

Four patients (7.7%) had recurrent laryngeal nerve injuries, presented with hoarseness of voice and confirmed by fiber optic endoscopic examination.

Nine patients (17.3%) presented with vascular injuries, 6 of them had arterial injuries: common carotid in 2, external carotid in 2, inferior thyroid in 2, external in 1, lingual in 1, and 3 of them had injuries to external & internal jugular veins. They presented with expanding hematoma, persistent bleeding and hypovolemic shock.

One patient (1.96%) had fracture cervical vertebra, presented with quadriplegia and respiratory distress and died soon afterward. Fig. 4

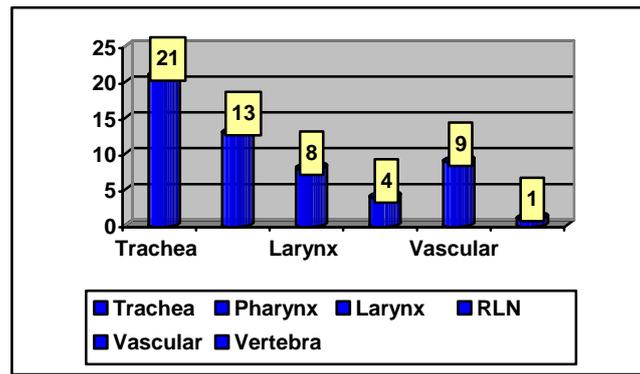


Fig: 4

Table :5

Distribution of visceral injuries:

Anatomical structure	No. of patients	%
Larynx & trachea	29	55.77 %
Pharynx & esophagus	13	25 %
Recurrent laryngeal nerve	4	7.7 %
Vascular	9	17.3 %
Vertebra	1	1.96 %

### X ray examination:

Neck X ray examinations were done for 28 patients, the findings were;

Foreign bodies in 15 patients had either as multiple pieces of shrapnel or bullet.

Surgical emphysema was found in 11 patients and tracheal deviation was found in 2 patients. Fig 5

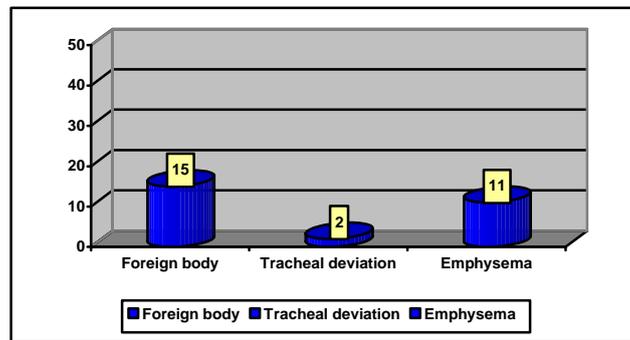


Fig: 5

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### Surgical intervention and management:

Tracheostomy was performed for 41 patients (78.83 %) and neck exploration for 13 patients (25 %).

Six patients (11.53 %) admitted to the ward for observation and treated conservatively without surgical intervention. Fig 6

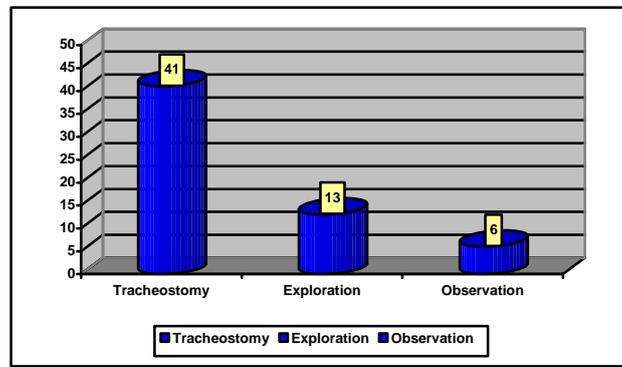


Fig. 6

Table 6:

Early management	No. of patients	%
Tracheostomy	41	78.83 %
Neck exploration	13	25 %
Conservative	6	11.53 %

### Mortality:

Nine patients (17.3 %) had died due to the severity of their injuries

### DISCUSSION:

Unfortunately, the war & violence in our country has increased the incidence of penetrating neck injuries (PNIs), so that in a single general hospital & within a relatively short period of seven months, it was possible to evaluate 52 victims with serious life threatening neck injuries of both civilians & military personnel. Patients involved in this study had serious injuries and some of them developed complications.

They were mostly young men, 50 patients were males & 2 patients were females. The average age was 32.1 years. In a similar study by Jeffrey<sup>(9)</sup> et al the average age was 36.4 & in Agnood<sup>(8)</sup> et al. the average age was 29.6. This is consistent with general trauma patients in that most of them were young men.

In our study 26 patients (50%) were injured by shrapnel & 23 patients (44.23 %) by ordinary bullets.

Large shrapnel usually have large entrance with loss of skin surrounded by black burned spots. The underlying soft tissue is burned, damaged & lost with cavity formation. These wounds are usually unassociated with hematoma formation. Those patients frequently needed urgent tracheostomy, wound exploration, debridment with ligation of

bleeding vessels & repair of the injured structures. While small shrapnel penetrate the skin & platysma causing minimal soft tissue damage with or without hematoma formation & it remain within the tissue. The management of those patients is mostly conservative & the shrapnel may need to be removed later by exploration.

Bullets usually have small entrance & larger exit, frequently associated with hematoma formation, surgical emphysema & soft tissue swelling causing airway obstruction which needs either tracheostomy or intubation.

Blast injury, was studied in detail by Michael<sup>(10)</sup> et al. in 2005, which produces shell fragments at a high speed of tumbling fashion cause more devastating injury to the tissue than bullets.

The most common site of PNIs was in zone 2, 36 patients (69.23%), followed by zone 3, 11 patients (21.15 %) & in zone 1, 5 patients (9.62 %) which is near to other studies by Jeffrey<sup>(9)</sup> (68%) & Shearer's<sup>(12)</sup> (71%). While in Apefflstadt's<sup>(14)</sup> (50%). Obied's<sup>(13)</sup> gave a range of (60-70%) of injuries affecting zone 2.

This can be explained that injuries in zones 3 & 1 are more dangerous & may be fatal due to their association with maxillofacial & head injuries in

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zone 3 & with thoracic & major vascular injuries in zone 1. In such conditions those patients were either referred to other departments for treatment or were sent to mortuary if they were dead.

The frequency of involved viscera in PNIs is proportional to their size & location. Approach was predicted on clinical suspicion of vascular or visceral injuries. Our study shows laryngeal and tracheal injuries was (55.77 %), pharyngeal was (25%), recurrent laryngeal nerve (7.7%) & vascular was (17.3%), Jeffry's<sup>(9)</sup> showed tracheal & laryngeal (69%) pharyngeal & esophageal (38%), recurrent laryngeal nerve (13%) & vascular injuries in (17.5%). While McConnell's<sup>(15)</sup> showed tracheal & laryngeal involvement (10%), pharyngeal & esophageal involvement (50%) & vascular injuries in (23.7%). Fogelman<sup>(16)</sup> has reported pharyngeal & esophageal involvement in (12%).

Tracheostomy was performed for 41 patients (78.86 %), and neck exploration on 13 patients (25%); Jeffry<sup>(9)</sup> in a study of 16 patients with penetrating neck injuries found that the larynx was injured in 11 patients (69%) and tracheostomy was performed for 8 patients (50%), neck exploration was done on 13 patients (81%). Shelly<sup>(17)</sup>, Apffelstadt's,<sup>(14)</sup> McConnell's,<sup>(15)</sup> Room's & Christensen's<sup>(18)</sup> reported that neck exploration was in a range of (37%- 100%). The entrance of wound in the neck can be misleading & give no indication of projectiles trajectory through tissue.

Fragmentary ballistic munitions play a larger role in neck injuries and often associated with higher mortalities of injuries by shrapnel.<sup>(9)</sup>

Our mortality rate was (17.3%), in Jeffry's et al report it was (13%) & in other reports by Fogelman MJ et al, Minard JG & Kudsek it ranged between (0 – 20%). This high mortality reflects the serious nature of these injuries and may also be related to our selection of patients with clinical evidences of vascular and visceral injuries. Associated severe maxillofacial & thoracic traumas also contributed to this high mortality.

### CONCLUSION:

PNIs mainly affect young men mostly at zone 2, followed by zone 3 & zone 1 caused mostly by shrapnel & bullets. Shrapnel causes more severe damage than bullets. Several cervical viscera were involved at the same time. The entrance of wound in the neck can be misleading & gave no indication of projectiles trajectory through tissue. Laryngo-tracheal & pharyngeal injuries were more common than vascular injuries. Tracheostomy & neck exploration were the most frequent early surgical

interventions required for them. Mortality was quite high reflecting the serious nature of these injuries.

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