



## Penetrating Trauma in Zone II of the Neck

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### Abstract

The neck is a narrow anatomical region with a vast number of vital structures. Depending on the injury mechanism of the trauma, it can be classified as blunt or penetrating. Zone II is the largest and central part of the neck, which affected more than two other zones in neck trauma due to more exposure. In the management of neck trauma, two aspects must be considered: the injury mechanism and the region that is affected. Penetrating neck trauma is the injury that crosses the cutaneous muscle of the neck. The patients who did not have clear signs of visceral or vascular damage (soft signs) use complementary diagnostic methods. Those who present clinical evidence of a vital organ injury (hard signs) should undergo surgery.

**Keywords:** Self-Injury; Roon and Christensen Neck Zones; Penetrating Neck Injury; Neck Zone II

### Abbreviations

Fig.: Figure; A.T.L.S.: Advanced Trauma Life Support; E.C.M.: Sterno-cleidomastoid; A-B-C-D-E: Airway, Breathing, Circulation, Disability, Environment; PTFE: Expanded Polytetrafluoroethylene; Vs.: Versus.

### Introduction

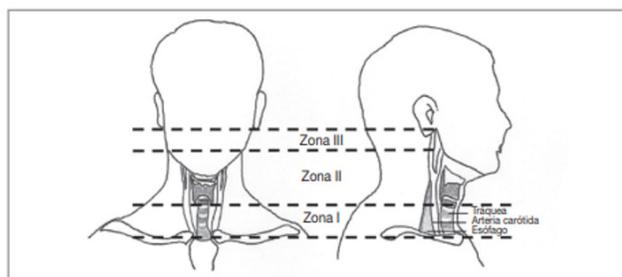
The neck is a narrow anatomical region with a vast number of anatomical structures, such as vascular, respiratory, neurological

and glandular. Neck trauma is important in that the injury to various organs in this area can be life-threatening.

Depending on the injury mechanism, the trauma can be classified as blunt or penetrating.

For the approach of traumatic injuries, the neck is divided into three topographic regions called ZONES: I, II and III, described in 1979 by Roon and Christensen [1]. Zone I: It is the space between the clavicles and the cricoid cartilage. Zone II: Area that extends

from the cricoid cartilage to the angle of the jaw. Zone III: Corresponds to the sector located between the angle of the mandible and the base of the skull (Figure 1).



**Figure 1:** Taken from José Ceballos Esparragón M.<sup>a</sup> Dolores Pérez Díaz surgery of the politraumatized patient 2<sup>nd</sup> ed. ARAN; 2017.

The severity of the injuries caused in each zone of the neck affect morbidity and mortality directly. Depending on the zone of injury, a different approach is considered for evaluation and treatment, especially in vascular injury.

Zone II is the largest and central part of the neck, which affected more than two other zones in neck trauma due to more exposure. Also, exposure to zone II causes easy diagnosis, a simple surgical approach, and low mortality in the injury of this zone. Despite this, the management of penetrating injuries of zone II is very controversial.

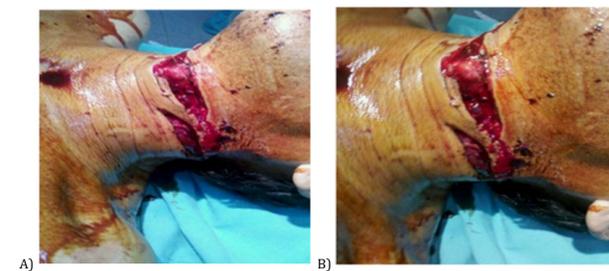
In this writing, we described a clinical case and we focused on the development of penetrating neck trauma in Zone II.

**Materials and Methods**

A 30-year-old male with self-injury in zone II of the neck by a knife, who entered the emergency service of the hospital A.I. de Llano (Corrientes), and underwent initial trauma management and surgical treatment. We sought systematic information on penetrating neck trauma, specifying those that compromise zone II; In Pub Med, SciELO, Google Scholar and textbook databases.

**Case Report**

A 30-year-old male patient brought to the emergency service with self-injury in zone II of the neck by a knife. A.T.L.S. management was start for him. On physical examination, he had two skin lesions, the first one about 10 cm in the center of the neck, and the second one about 6 cm on lateral of the neck. Also, infrahyoid muscles and part of Left E.C.M, windpipe, and left external jugular was exposed. He was taken to the operating room to give surgical management for the lesions. He presented a good evolution in the postoperative period and was discharged from the hospital after 7 days (Figure 2A and 2B).



**Figure 2**

**Discussion and Conclusion**

The first described case of surgery for penetrating neck trauma is on papyrus by E. Smith [2]. In 1552 Ambroise Paré ligation of the primitive chaotid artery and internal jugular vein in a wounded soldier, he did not die but was left with serious neurological sequelae [3]. The conduct of operating neck trauma in the I<sup>o</sup>, II<sup>o</sup> W.W. and in the wars in Korea and Vietnam they decreased mortality by 7%. Exploration early and systematic injuries that penetrate the musculocutaneous neck, it was installed as a valid treatment alternative [4]. Due to the large number of negative examinations (around 50%) that were obtained by this approach, a conservative management is chosen, the selected cases are operated according to the physical examination, results of complementary studies that demonstrates the degree of injury to the patient [5-7].

From the anatomical point of view the different organs related to different systems are housed in Zone II of the neck such as skin from cutaneous, esophagus from the digestive system, part of the

pharynx and larynx from the respiratory system, middle part and bifurcation of the carotids, internal and external jugular veins, vertebral vessels from the circulatory system, thyroid and parathyroid from the endocrine system, spinal cord and its emerging nerves, vagus, recurrent laryngeal nerves and cervical sympathetic chain from the nervous system, cutaneous muscle of the neck and the superficial fascia. Sternocleidomastoid with deep cervical fascia and its vascular and airway laminae, infrahyoid, spinal and trapezius with peri-vertebral fascia, and segment of the vertebral column from the musculoskeletal system [8].

Neck trauma is a frequent cause of consultation in emergency services. The initial management of a neck injury is the same as other traumatic injuries, according to the guidelines of the A.T.L.S. (A B C D E). In the management of neck injury, the mechanism and the zone of injury must be considered.

Penetrating neck trauma is defined as any injury that crosses the cutaneous muscle of the neck. Penetrating injuries of the neck are more frequent than blunt ones. They represent approximately 40% of all cervical injuries and have an overall mortality of around 9% [8,9].

Penetrating injuries can be caused by sharp weapons, or by fire-arm projectiles. Sharps injuries, included cutting, stabbing or combined, that is 60% of all penetrating neck injuries. In this type, the injury is limited to the path of penetration of the sharp object, and the damage is minimal in the adjacent tissues. Projectile wounds caused 40% of all penetrating neck injuries. Severity and extension injury depending on the speed and size of the projectile, and also the distance from which the projectile comes. The dissipated energy, and the fragments that are detached from it when impacting the body, caused the collateral injury. Therefore, projectile wounds make wider and more intense injuries than sharps injuries [10].

The surgical exploration of penetrating neck injuries of zone II, its origin in the experience in the handling of these injuries during the military campaigns that had the purpose of reducing the morbidity and mortality of these. Surgical exploration is still used in cases with signs and symptoms of significant injury to the vital structures.

Approaches to neck injuries are considered hard and soft signs. Signs are classified as hard or soft, based on evidence of serious

injury. Hard signs are associated with vital organs injury. They including severe dyspnea, blowing the wound, and abundant hemoptysis in Laryngotracheal injury, Saliva or food leakage from the wound and Bright bleeding from the mouth in the absence of other injuries in Pharyngoesophageal injury, active bleeding, Expansive hematoma, murmur or thrill, weak or nondetectable distal pulses, sensory disorder or neurologic deficit, and hypotension or shock in vascular injury. Soft signs are included Subcutaneous emphysema, dysphonia, hemoptysis in laryngotracheal injury, Subcutaneous emphysema, Dysphonia, hematemesi, odynophagia, dysphagia in pharyngoesophageal injury, Stable bruise, Light bleeding, Proximal wounds, and Response to resuscitation in vascular injury [11,12] (Table 1).

	Hard signs	Soft signs
Laryngotracheal	Severe dyspnea	Subcutaneous emphysema
	Blowing wound	Dysphonia
	Abundant hemoptysis	Hemoptysis
Pharyngoesophageal	Saliva or food leakage from the wound	Subcutaneous emphysema
	Bright bleeding from the mouth in the absence of other injury	Dysphonia
		Dysphagia
		Odynophagia
	Hematemesi	
Vascular	Active bleeding	Stable bruise
	Expansive or pulsatile hematoma	Mild bleeding
	Murmur or thrill	Proximal wounds
	Sensory disorder or neurologic deficit	Response to resuscitation
	Weak or nondetectable distal pulses	
	Hypotension or shock	

**Table 1:** Hard and soft signs based on the injured system.

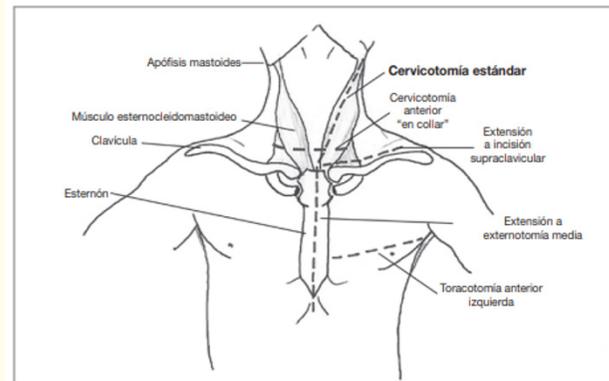
There is no disagreement about the management of a patient with vital organs injury, and all of them have to undergo exploration. But, 40% of patients with neck injuries have hemodynamic stability, without signs or symptoms that indicate injury to a vital structure [13,14]. Due to the high percentage of negative surgical

explorations and the high economic cost of explorations, the exploration in patients without vital organs injury was changed towards conservative management, at the beginning of the 20<sup>th</sup> century [5-7]. But studies showed the exploratory approach had lower mortality than the observational strategy. Neck surgical exploration under local anaesthesia was suggested as an alternative strategy to the decreased economic cost. But exploration under local anaesthesia is not being able to repeat the results obtained with general anaesthesia. Also, it caused many complications such as bruising or inadvertent injuries [17,18].

Another suggested strategy for patients with hemodynamic stability, without signs or symptoms of vital structure, especially those who do not have clear signs of visceral or vascular damage and soft signs, was complementary studies. These studies such as cervical spine radiography, ultrasound, Doppler ultrasound, computed tomography, angiography, bronchoscopy and esophagoscopy was viable and useful, in addition to the initial examination [14]. Several studies showed esophagogram and esophagoscopy had about 90% and 86% accuracy respectively. The accuracy of laryngoscopy, bronchoscopy and arteriography 100% was reported [19,20]. This approach caused too much attention to be paid to complementary studies and the physical examination to be considered unreliable. But recent studies do not show results. One study showed that there is no statistically significant difference between the sensitivity of the physical examination and angiography in significant vascular lesions. In another study, a total of 145 patients was evaluated. According to results, 21% were taken to the operating room without conducting complementary studies, but with an obvious clinical sign of severe injury. Only 10% of explorations that guided by the physical examination was false positive, and the rest of the patients with signs of evident lesions required surgery. Also, it was reported that patients with positive angiography had symptoms of vascular injury, or those with vascular, airway, or digestive injury in contrast tomographic studies, were also evident on physical examination [21-24].

### Surgical technique

Cervicotomy by the anterior edge of the sternocleidomastoid is chosen in surgical approach for Zone II neck injury. This allows the incision to expand to median sternotomy if it is necessary. If there is a contralateral injury, it can expand to the "collar" (necklace) incision [25] (Figure 3).



**Figure 3:** Taken from José Ceballos Esparragón M. <sup>a</sup> Dolores Pérez Díaz surgery of the politraumatized patient 2<sup>nd</sup> ed. ARAN; 2017.

Vascular lesions are most frequently in zone II neck injury. Internal Jugular Injury is the most common vascular injury. It can cause expansive hematomas that follow by compression of the airway and suffocation. The treatment of Internal Jugular Injury is surgical repair or ligation if repair isn't possible.

The Common Carotid arteries injury caused higher mortality compared with other vascular injuries. The repair of Common and Internal Carotid has to be aimed at maintaining distal flow to preserve neurological functions and inhibit bleeding [26]. When there is a complete section of the artery and the gap is less than 1 cm, the ends can be mobilized to perform a primary anastomosis, avoiding that the sutures remain under tension. When the gap is greater than 1 cm, it should be repaired with a vascular prosthesis (PTFE or Dacron) or autologous by venous transposition (saphenous vein). The external carotid can be ligated when the surgical repair is not possible, ligation does not present greater risks [27,28].

Due to deep location, and protection by muscular and bone structures, vertebral artery injury is relatively rare. In most cases, patients with vertebral artery injury do not reach the hospital alive. In injuries of the Vertebral Arteries, open surgery is a great challenge even for well-trained surgeons, it is just considered for unstable patients with active bleeding or when endovascular treat-

ment is not available. When the patient is stable, angiographic embolization is performed if there is interventional radiology [29,30].

Injuries to the trachea or larynx are repaired with separate stitches of resorbable material (Vicryl) that protects the airway from granulomas formation and stenosis. Management of esophageal lesions is depending on the severity of the injury. For mild injury defunctionalization of the esophagus and other surgical repair is done to avoid the formation of fistulas [30,31].

### Remember

The exploration of penetrating neck wounds in emergencies should be limited to verifying to penetrate the cutaneous muscle of the neck. In no case should clots be removed or an attempt should be made to establish the path of the wound using blind exploration, either digital or instrumental. If an impaled object is found, it should be fixed and not removed until the controlled situation is found in the operating room [15,16].

In general, it should be decided according to the patient's condition and type of injury that conservative treatment or surgical manganate is appropriate to choose. Physical examination is very important and complementary studies can't replace it. The role of physical examination is very important in life-threatening injuries, with the advantage of being carried out immediately without delay. It helps to start the necessary surgical procedures without delay.

### Conflict of Interest

The authors declare no conflict of Interest.

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