Experiences of Penetrating Neck Injuries in a Single Institution

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Abstract

Background: The neck is a particularly critical region to sustain penetrating injuries, due to the close approximation of the trachea, esophagus, blood vessels, and the spinal cord. A penetrating neck injury has the potential for serious morbidity and mortality. The purpose of this study is to evaluate the assessment and management of penetrating neck injuries.

Methods: In this retrospective study, penetrating neck injury patients who were admitted to Eulji University Hospital Trauma Center, between December 2015 and December 2017, were analyzed for epidemiology, mechanism of trauma, injured organ, complications, and mortality.

Results: Thirty-two patients presented with a penetrating neck injury. All patients underwent computed tomographic angiography to evaluate their injuries once vital signs were stabilized.

Among these patients, 27 required surgical treatment. The most commonly injured organ was the trachea. Overall mortality was five, and the main cause of death was bleeding. The mortality was associated with initial systolic blood pressure at the hospital, Glasgow coma scale, transfusion and the abbreviated injury scale of neck.

Conclusion: Meticulous clinical examination as well as early volume resuscitation is essential for treating penetrating neck injury patients. Aggressive fluid therapy during transfer to the hospital will help the patient, even if the damage is severe.

Background

The neck is located between the head and the torso, and contains vital structures, including the trachea, carotid arteries, and spinal cord. While relatively uncommon in comparison to other parts of body, the potential morbidity of penetrating neck trauma is apparent, due to the high density of vital structures confined to a relatively small and poorly protected area [1]. Although penetrating neck injury was estimated to comprise 10% of all trauma patients, the overall mortality rates were estimated between 3% and 6%, most commonly as a result of injury to vascular structures and hemorrhage [2, 3, 4].

Successful management of penetrating neck injuries depends on a clear understanding of the anatomy of the neck [5]. Anatomically, the neck can be divided into three major zones, as presented by Monson et al. in 1969 [6]. These three zones make the initial assessment and management easier, including surgical exploration and hemorrhage control. Zone I extends from the clavicle to the cricoid cartilage, zone II extends from the cricoid cartilage to the mandibular angle, and zone III extends from the mandibular angle to the base of the skull. In zone II, the carotid arteries, jugular veins, larynx, esophagus, trachea, thyroid, and nerves gather. Therefore, damage to zone II is very dangerous [7]. The importance of triage injury from zone to zone has declined in recent years [3, 8].

This study attempts to identify the factors associated with penetrating neck injury and survival, and to characterize the outcome of penetrating neck injury.

Methods

From January 2015 to December 2017, 6183 patients were admitted to Eulji University Hospital Trauma Center for trauma. We exclude the other injuries, such as head, torso, and extremities. We included torso or extremity injury associated with penetrating neck injury. All of these patients were enrolled in this retrospective study. All medical records and operative notes were reviewed.

Descriptive statistics are expressed as mean ± standard deviation unless otherwise specified. Continuous variables were compared using Wilcoxon Signed-rank test. Multiple logistic regression analysis was used to evaluate risk factors for the mortality from injury by estimating the corresponding Odds ratios. All p-values < 0.05 were considered to indicate statistical significance. An unadjusted regression analysis was performed for each systolic blood pressure to determine their ability to predict mortality as an outcome after trauma. The areas under the receiver operating characteristic (AUROC) curves and their corresponding confidence intervals were calculated for these simple regressions. AUROC was utilized as it measures discrimination or the ability of each parameter to accurately predict the outcome of interest, in this case mortality. A conventional classification of AUROC was assumed, suggesting AUROC < 0.60 as poor, 0.70–0.79 as fair, 0.80–0.89 as good, and > 0.90 as excellent discrimination. Statistical analysis was performed using R ver 3.4.1 (Bell lab, Murray Hill, NJ, USA).

Results

Thirty-two patients presented with a penetrating neck injury. The study group comprised 23 men and 9 women with mean age 50.16 years (Table 1). The injury mechanisms included 19 stabbing injuries and 13 blunt injuries. Causes of injuries were accident (19 patients), attempted suicide (10 patients), or homicide (3 patients) (Table 1).

Table 1
Patient characteristics

Characteristics	Value
Age (years)	50.16 ± 18.13
Sex (male:female)	23:9
Alcohol ingestion (no:yes:unknown)	8:9:15
Underlying psychological disease	3
panic disorder	1
anxiety disorder	1
schizophrenia	1
Mechanism of injury (stab wound:blunt)	19:13
Homicidal	3
Suicidal	10
Accidental	19

All patients underwent computed tomographic angiography (CTA) for evaluating injuries, once vital signs were stabilized. Twenty-seven patients required surgical treatment. The damaged structures are listed in Table 2. The most commonly injured organ was the trachea and airway (7 cases) (Table 2). The average Injury Severity Score (ISS) was 6.94, and the average abbreviated injury scale (AIS) of neck was 3.38 (Table 3).

Table 2
Damaged anatomical structures

Damaged Structures	**No.**			
Neck	Airway	7	trachea	4
			pharynx	1
			larynx	1
	Arterial system	2	Carotid artery	2
	Venous system	2	Jugular vein	2
	Spinal cord	1		
	Others		Muscle	10
			Thyroid gland	1
			Hyoid bone	1
			Subcutaneous tissue	10
Associated part	Head	2		
	Chest	3		
	Abdomen	2		
	Vertebrae and Spine	2		
	Pelvis and Extremity	3		

Table 3
Transfer time, vital signs, and Injury Severity Score of the patients

Variables	
Systolic blood pressure in the filed	107.53 ± 47.76 mmHg
Systolic blood pressure at the hospital	101.78 ± 44.70 mmHg
Glasgow coma scale at the hospital	12.16 ± 4.58
Transfusion	6 patients (4 ± 2.53 pints)
Cardiopulmonary resuscitation in the filed	3 patients
Cardiopulmonary resuscitation at the hospital	4 patients
Injury Severity Score	6.94 ± 7.35
Abbreviated Injury Scale (neck)	3.38 ± 2.82
Time to rescue team arrival	45.74 ± 94.36 min
Transfer time to the hospital	37.66 ± 22.17 min

The average time to rescue team arrival in the field was 45.74 min. Mean systolic blood pressure (SBP) in the field was 107.53 mmHg. Three patients received cardiopulmonary resuscitation in the field and during transfer to the hospital (Table 3). The average transfer time to the hospital was 37.66 min. Initial mean SBP at the hospital was 101.78 mmHg, and four patients received cardiopulmonary resuscitation at the hospital (Table 3). The change in SBP is shown in Fig. 1 ($p = 0.451$). Six patients received a transfusion, and the average transfused red blood cells were 4 pints (Table 3). The average Glasgow coma scale (GCS) at the hospital was 12.16 (Table 3).

Twenty-seven patients required surgical treatment, consisting of primary repair and temporary tracheostomy (3 patients) (Table 4). The average hospital stay was 15.67 days (Table 4). There were no complications, such as wound infection, pneumonia, or sepsis. Overall mortality was five patients (15.62%). The causes of mortality were bleeding (3 patients), acute drug intoxication from herbicide (one patient), and spinal cord injury (one patient) (Table 4). The mortality was associated with initial SBP at the hospital, GCS, transfusion, and AIS of neck ($p < 0.05$) (Table 5). Both SBP at the hospital and the field were highly predictive of mortality with AUROC of 1.0 and 0.96, but SBP at the hospital was higher than that of the field (Fig. 2).

Table 4
Patient outcomes

Outcome	Values
Surgical treatment	27/32 (84.38%)
Primary repair	27
Temporary tracheostomy	3
Hospital stay	15.67 ± 20.42 days
Complication	0/27
Wound infection	0
Pneumonia	0
Sepsis	0
Overall Mortality	5/32 (15.62%)
Causes of mortality	
Bleeding	3
Drug intoxication (herbicide)	1
Spinal cord injury	1

Table 5
Effect of transfer time, vital signs, and injury severity scale on outcomes using multiple logistic regression ($p < 0.05$)

Factor	OR	95% CI
Systolic blood pressure in the filed	1.001	0.998–1.005
Systolic blood pressure at the hospital*	0.995	0.993–0.999
Glasgow coma scale at the hospital*	0.965	0.946–0.986
Transfusion*	1.067	1.006–1.132
Time to rescue service arrival	1.000	0.999–1.001
Transfer time to the hospital	0.999	0.996–1.001
Injury Severity Score	1.004	0.990–1.019
Abbreviated Injury Scale (neck)*	0.961	0.931–0.994
OR, Odds Ratio; CI, confidence interval		

Discussion

The neck is a particularly critical region to sustain penetrating injuries, due to the close approximation of the trachea, esophagus, blood vessels, and the spinal cord. In our study, the mortality was associated with initial SBP at the hospital, GCS, transfusion, and AIS of the neck. Early volume resuscitation is considered essential for penetrating neck injury patients. Aggressive fluid therapy, during transfer to the hospital and in the field, would help the patient, even if the damage is severe.

The initial evaluation of a trauma patient begins with the “ABC’s” of trauma management: establish a secure airway, breathing/respiration, and volume resuscitation [3, 8, 9]. For our study, the mortality was associated with initial SBP at the hospital, GCS, and transfusion (Table 5). When SBP is low, transfusion is performed and the GCS would be low. The GCS was developed for monitoring postoperative craniotomy patients, and was subsequently applied as a means for overall physiological derangement in trauma field. Therefore, SBP is considered to be the most important factor. Additionally, the main cause of mortality was hypovolemia due to bleeding. Therefore, volume resuscitation is as important as airway management and respiration. The combined use of SBP and motor GCS is effective at predicting patient survival [10].

As the ISS is a severity scale derived from the anatomical based scale, the ISS is the sum of the squares of the highest AIS in each of the three most severely injured ISS body regions. So, both AIS and ISS do not reflect the physiologic state of traumatic victims. However, in this study, mortality is related to AIS of the neck.

The platysma is a thin muscular sheet, which surrounds the superficial fascia of the neck. It determines whether a penetrating wound of the neck is superficial or deep [11]. The potential for injury to a vital organ exists when this structure is penetrated. If the platysma is penetrated in the initial survey, an active surgical intervention is required [11]. The standard management is immediate surgical exploration for patients who present with signs and symptoms of shock and continuous hemorrhage from the neck wound [3]. However, all patients with active bleeding, expanding hematoma, shock, massive subcutaneous emphysema, or significant airway compromise are admitted directly to the operating room and are surgically explored, regardless of the zone of injury [3, 8]. Also, particular importance should be placed on the airway, because bleeding within the tight compartmentalized spaces of the neck may appear quiescent externally, yet cause progressive airway compromise and eventual complete obstruction [8]. In this study, 22 patients presented with platysma penetration; significant airway or vascular injury was found in 11 patients (Table 2). Mandatory surgical exploration was once warranted, if platysma penetration was present. Today, mandatory surgical exploration for all injuries that penetrate the platysma is no longer practiced [3]. Nonetheless, mandatory exploration of all neck wounds may be the best policy in an environment in which routine serial examinations are not possible [5].

CTA is generally considered the initial diagnostic method to evaluate the injured organs in penetrating neck trauma [3]. Comprehensive physical examination with CTA is adequate for identifying and excluding vascular and aerodigestive injury due to penetrating neck trauma [12]. In this study, all patients with stable vital signs were taken for a CTA. We determined the surgical strategy from this CTA. As the accuracy of the CTA increases, with careful clinical evaluation to diagnose critical structures damage, surgical intervention or observation is performed safely and carefully [1]. In a trauma center with experienced staff, the frequency of operations for penetrating neck wounds without structural injuries can be minimized by selective neck exploration [13, 14].

In this study, 6183 patients visited our hospital over a three year period. Thirty-two patients presented with penetrating neck injury. Five patients died. Although penetrating neck injury was estimated as 10% of all trauma patients, the overall mortality rates were estimated at between 3–6%, most commonly as a result of injury to vascular structures, causing hemorrhage [2, 3, 4]. The results of this study seem to be similar to those of previous studies. There are many important structures in the neck. Therefore, it seems that the AIS of the neck is more related to damage than the ISS. And early "ABC's" is very important. The neck is a particularly critical region to sustain penetrating injuries, due to the close approximation of the trachea, esophagus, blood vessels, and the spinal cord.

Conclusions

The assessment and management of penetrating neck injury remains controversial. In this study, we conclude that not only meticulous clinical examination, but also early volume resuscitation, are essential for penetrating neck injury patients. The most important lesion is early "ABC's."

Limitations

First, the single-center retrospective design of this study is its major limitation. Second, this retrospective study consisted of patients with airway injury or vascular injury. Therefore, this study group was heterogenous. Further studies for specific injury, such as vascular injury or airway injury, seem to be necessary. Lastly, the number of patients was only 32, further studies with a larger population would be helpful. However, our data might prove to be meaningful for the prevention of death from penetrating neck injury.

Declarations

Ethics approval and consent to participate

This study was approved by Eulji University Hospital ethics committee.

Consent for publication

Not applicable

Availability of data and materials

Not applicable

Competing interests

The authors have no conflict of interest to declare.

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Authors Contribution

DN; study design, data collection, analysis & interpretation, writing

JHC; critical revision

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Figures

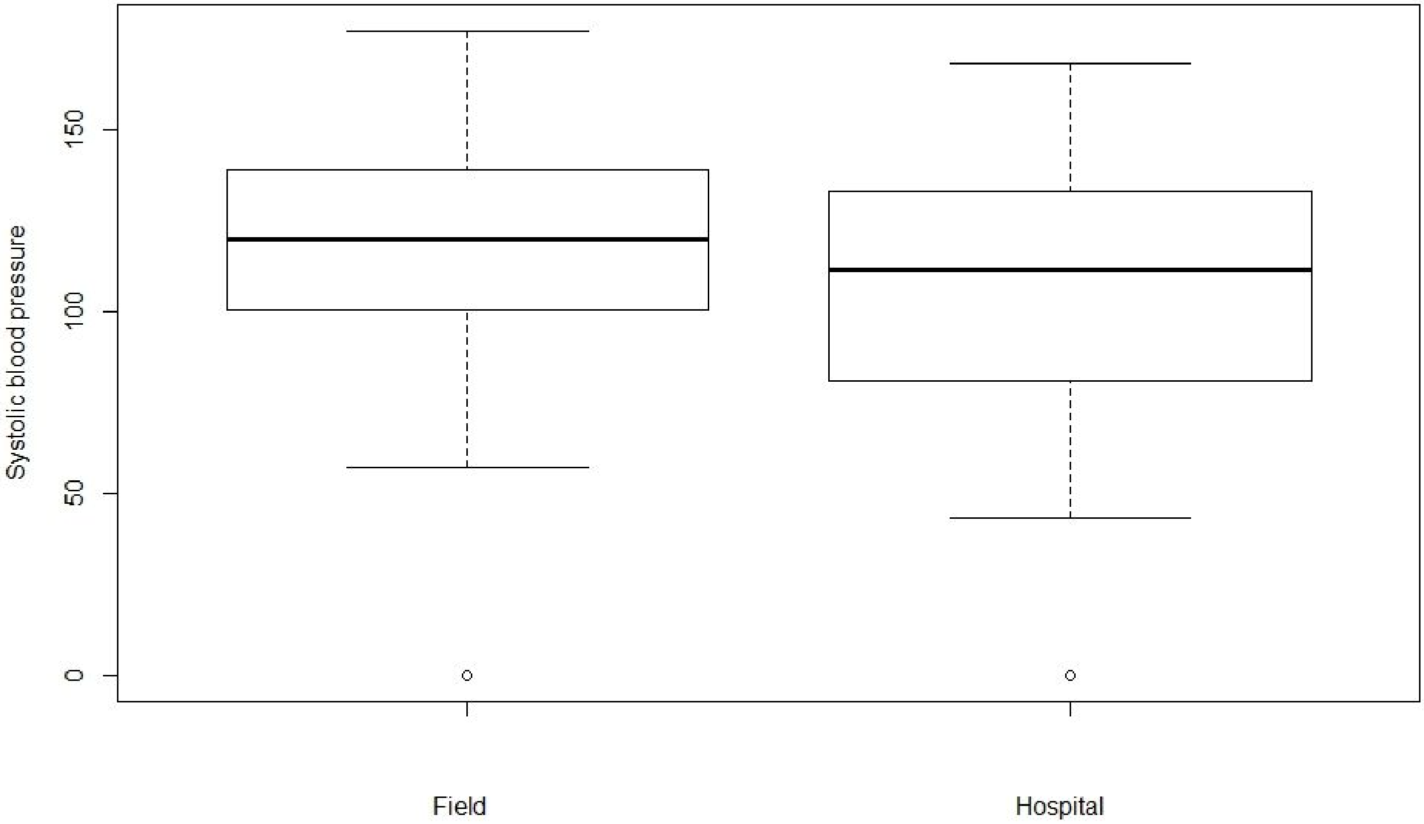

Figure 1

Comparison systolic blood pressure between in the field and the hospital (p = 0.451)

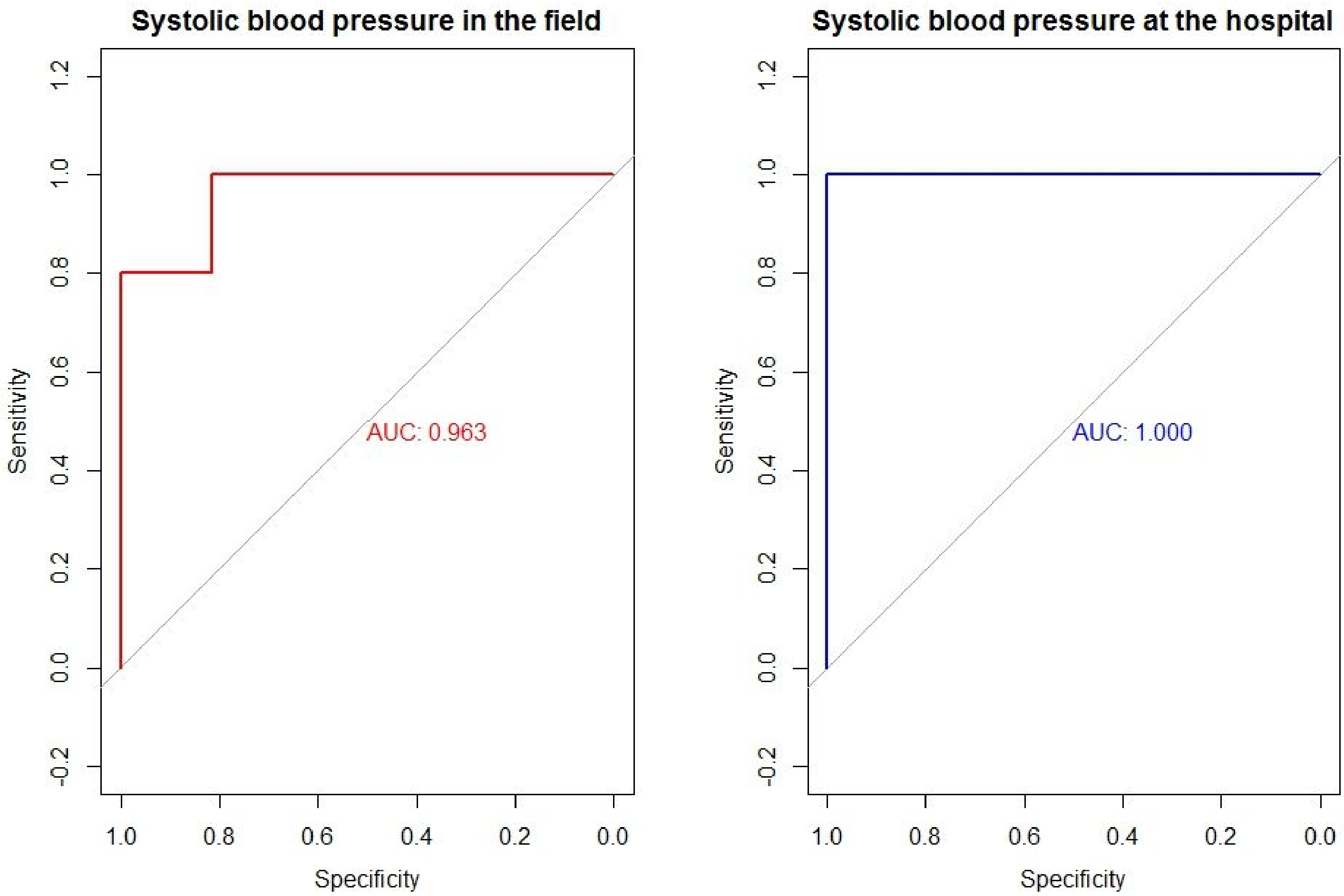

Figure 2

Area under receiver operating characteristic curve (AUROC) for the simple regression analysis to predict mortality (AUC, area under the curve)