Original Article

An Audit of Surgical Neck Explorations for Penetrating Neck Injuries in Northwestern Nigeria: Experience from a Teaching Hospital

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ABSTRACT

Background: Penetrating neck injury is a major trauma mechanism present in about 5%–10% of trauma patients with an estimated mortality of 3%–10%. The management of these injuries is dependent on the anatomical level of injury. **Objectives:** The objective of the study was to document the clinical and operative findings as well as the treatment outcome among our patients who underwent neck exploration for penetrating neck injuries. **Materials and Methods:** A retrospective review of patients who had neck exploration for penetrating neck injury between January 2012 and December 2018 was done. **Results:** Thirty-five patients all of whom had surgical neck exploration were included. The age ranged from 15 to 62 years with a male: female of 7.8:1. The mean age was 30.7 years with standard deviation of ± 12.5 years and the peak age of occurrence of 20–29 years. The mechanism of injury was commonly arrow injury in 9 (25.7%) and suicidal cutthroat in 7 (20%) patients. Thirty-two (91.4%) patients presented with stable vital signs. Zone II neck injuries were most prevalent, seen in 23 (65.7%) patients. Laryngeal injury in 7 (20%) and soft-tissue injury in 7 (20%) of the patients were the most common intraoperative findings. The complication rate of 17.1% with a mortality rate of 2.9% was recorded. There was a statistically significant association between the presence of vascular injury and the development of complications after exploration (Chi-square = 5.666, P = 0.017). It was also a significant positive predictor of complication following neck exploration (odds ratio = 0.017, P = 0.048). **Conclusion:** Male young adults were most involved, commonly from arrow and stab injuries. Although laryngeal and soft-tissue injuries were predominant, vascular injuries were most associated with postoperative complications.

KEYWORDS: *Audit, exploration, neck, penetrating injuries*

INTRODUCTION

Violence has probably always been part of the human experience. Its impact can be seen in various forms, in all parts of the world.[1] Penetrating neck injuries have been a major trauma mechanism, presents in about 5%–10% of trauma patients with an estimated mortality of 3%–10%.[2,3] The causes of penetrating neck trauma could be accidental, homicidal, or suicidal. In a developing country like Nigeria; knives, spears, arrows, and machetes are the most commonly used weapons in cases of penetrating neck injuries, particularly in tribal societies.[4] Indeed, it has been estimated that the arrow has killed more individuals than any other weapon in history.[5] On the contrary, fire guns are the most common cause of penetrating neck injuries in the more advanced societies with attendant higher mortality.[2] However, this mechanism of injury may have recently been on the increase in third world countries as a result of terrorism-related violence.[6] This thus makes

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management of penetrating neck injuries more difficult in our resource-poor setting.

The management of injuries to the neck that penetrate the platysma is dependent on the anatomical level of injury.[7] The neck has been divided into three zones to help in the description and management of neck wounds.[8] Zone I extends from the bottom of the cricoid cartilage to the clavicles and thoracic inlet. Mortality is highest in this zone. Zone II includes the area between the cricoid cartilage and the angle of the mandible. This is the most involved zone and least difficult to manage. Zone III extends to the skull base.[8] Although trauma is not necessarily limited to one zone, Zones III and I are more difficult to expose intraoperatively and require more diagnostic workup.[7] The most common cause of death in all zones is exsanguination.[9-11]

The extent of neck injuries can be underestimated by the location of the wound alone, and extensive injuries, which involve multiple zones, can occur with a seemingly superficial neck wound.[12] While relatively uncommon in comparison to other mechanisms of injury, the potential morbidity of penetrating neck trauma is apparent, given the high density of vital structures confined to a relatively small and poorly protected area.[13-15]

To the best of our knowledge, there had not been an audit of neck explorations on patients with penetrating neck trauma in the study area. Thus, this study aims to document the clinical and operative findings as well as the treatment outcome among patients with penetrating neck injuries that had neck exploration.

MATERIALS AND METHODS

This was a retrospective review of patients who had neck exploration for penetrating neck trauma performed at the Department of Otorhinolaryngology, Aminu Kano Teaching Hospital, Kano, Nigeria, over a 7-year period between January 2012 and December 2018.

Study population

This study included all patients who underwent neck exploration for penetrating neck injury at Aminu Kano Teaching Hospital during the period under the study. Patients who had incomplete or missing information were excluded from the study.

Study design

Data were retrieved from the patient's case files collected from the medical records department. The information was entered into a preformed questionnaire. The data entered into the questionnaire included age, sex, tribe, occupation, mechanism of injury, duration of injury before the presentation, site of injury in the neck, side

of injury, patient's clinical status on the first assessment, presence of other injuries, initial first aid intervention before the presentation, initial resuscitation, radiologic evaluation, the urgency of exploration, intraoperative findings, additional procedures, complications, findings on postoperative endoscopy, outcome measures, and follow-up.

Complications were classified as intraoperative, early postoperative (within the first 1 week after surgery), and late postoperative (beyond 2 weeks).

All patients explored were those with hard signs of injury or radiological evidence of significant injuries. All explorations were done under general anesthesia with or without preliminary tracheostomy. Ear, nose, and throat surgeons occasionally in conjunction with cardiothoracic surgeons performed the surgeries. Otorhinolaryngology resident doctors in conjunction with trained nurses carried out postoperative care of the patients. Those who had pharyngeal repair were kept on nasogastric tube feeding for a minimum of 1 week. Tracheostomy decannulation was carried out when the indication had been resolved with satisfactory maintenance of the airway. The first follow-up was done 2 weeks after discharge from the hospital.

Ethical approval

Ethical approval was sought and obtained from the Institutional Ethical Review Committee of Aminu Kano Teaching Hospital.

Statistical analysis

The statistical analysis was done using Statistical Product and Service Solution version 23.0 software (SPSS Inc., Chicago, Illinois, USA). The mean ± standard deviation (SD), median, and ranges were calculated for continuous variables, whereas proportions and frequency tables were used to summarize categorical variables. A Chi-squared test was used to determine P value and to test statistical significance, which was set at $P < 0.05$. Multivariate logistic regression analysis was used to determine predictor variables that predict the occurrence of complications and outcomes.

RESULTS

Of the 48 patients who had neck exploration for penetrating neck injury within the period under review, only 35 fulfilled the inclusion criteria, having complete clinical records. There were 31 (88.6%) males and 4 (11.4%) females, with a male-to-female ratio of 7.8:1. The age ranged from 15 to 62 years, with a mean age of 30.7 and SD of ±12.5 years and a median age of 27 years. The peak age of occurrence was in the age group 20–29 years [Table 1].

Table 1: General characteristic of the study population (*n*=35)	
Variable	**Frequency (%)**
Age group	
10-19	5 (14.3)
20-29	15 (42.9)
30-39	7 (20.0)
40-49	5 (14.3)
60-70	3 (8.6)
Total	35 (100)
Sex	
Male	31 (88.6)
Female	4 (11.4)
Total	35 (100)
Duration before presentation	
Within 24 h	32 (91.4)
1-3 days	1 (2.9)
4-7 days	2 (5.7)
Clinical status on presentation	
Stable	32 (91.4)
Coma	2 (5.7)
Shock	1 (2.9)
Location of injury	
Zone I	7 (20)
Zone II	23 (65.7)
Zone III	3 (8.6)
Multiple zones	2 (5.7)
Site of injury	
Right	8 (22.9)
Left	8 (22.9)
Midline	17 (48.6)
Posterior	2 (5.7)
Type of additional injury	
None	25 (71.3)
Craniofacial	3 (8.6)
Chest	3 (8.6)
Long bone injury	3 (8.6)
Others	1 (2.9)
Initial resuscitation	
None	1 (2.9)
Intravenous fluids	28 (80)
Blood transfusion	4 (11.4)
Tracheostomy	1 (2.9)
Others	1 (2.9)

Figure 1: Clinical presentation among the study population

The most common symptom at presentation was neck pain observed in 16 (45.7%) patients, followed by bleeding from the neck seen among 14 (40%). Dysphagia was the least symptom reported in 2 (5.7%) [Figure 1] patients. Tenderness in the neck followed by profuse bleeding was the most common hard sign noticed among the patients with 4 (11.4%) and 3 (8.6%), respectively. Majority (23 [65.7%]) did not present with any hard sign [Figure 1].

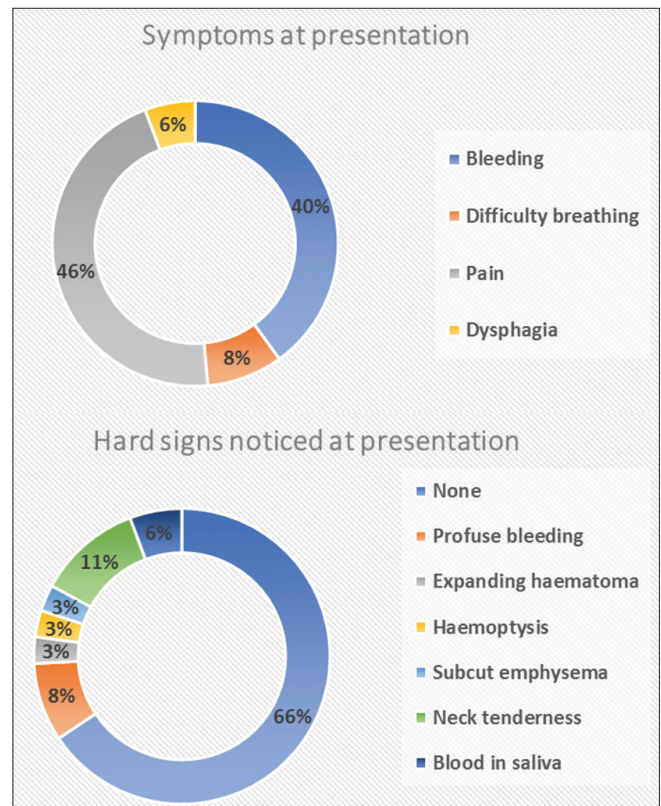Arrow injury was the most common mechanism of neck trauma seen among 9 (25.7%) patients. It was followed by cut throat injuries 7 (20%) due to suicidal attempts. High-velocity injury like gunshot was recorded in only 4 (11.4%) patients. The least mechanism of injury in this study was missing central intravenous cannula (2 [5.7%]) in the neck, necessitating exploration [Figure 2].

Majority (32 [91.4%]) of the patients presented to the hospital within 24 h of the injury, with only 3 (8.6%) presenting afterward. Up to 32 (91.4%) were stable at presentation. Only 1 (2.9%) patient presented in shock. Most of them 20 (57.1%) had initial intervention before presentation to our center [Table 1].

Zone II was the most common location of the injury in 23 (65.7%) patients. Only 2 (5.7%) patients had injury involving multiple zones. In 17 (48.6%) patients, the injury was located in the midline. Injury to the right and left side of the neck was observed in 8 (22.9%) and 8 (22.9%), respectively. Only 10 (29.7%) had other injuries at presentation, with craniofacial (3 [8.6%]), chest (3 [8.6%]), and long bone (3 [8.6%]) injuries been most common. Up to 28 (80%) and 4 (11.4%) patients were resuscitated with intravenous fluid and blood, respectively [Table 1].

The hemoglobin level of the patients on admission was normal in 13 (37.1%) patients. Moderate anemia and severe anemia were observed in 11 (31.4%) and 2 (5.7%), respectively.
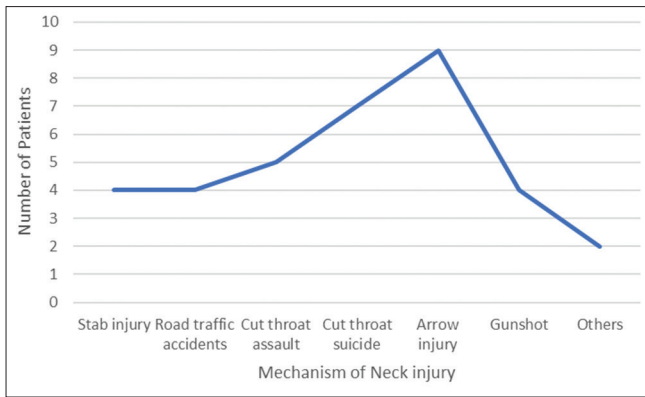
Figure 2: Mechanism of penetrating neck injuries

Majority of the patients (17 [53.1%]) had no radiological investigation before exploration. Among the other patients, X-ray was the most commonly requested radiological investigation seen in 12 (37.5%) patients.

Up to 27 (77.1%) had immediate neck exploration at presentation, and laryngeal 7 (20%) and soft-tissue injuries 7 (20%) were the most common intraoperative findings. Vascular and neurological injuries were noted in 3 (8.6%) and 2 (5.7%) patients, respectively. Seventeen (48.6%) patients had tracheostomy as an additional procedure. However, 17 (48.6%) did not require any additional procedures [Table 2].

Complications were encountered in only 6 (17.1%) patients, some of which include vocal cord paralysis (1 [2.9%]), stroke (1 [2.9%]), and pharyngocutaneous fistula (1 [2.9%]). In the majority of the patients (21 [60%]), postoperative endoscopy was not conducted. Among the patients who had postoperative endoscopy, laryngeal edema was observed in 2 (5.7%). Other findings were laryngeal stenosis (1 [2.9%]) and vocal cord palsy (1 [2.9%]) [Table 2].

Majority of the patients (15 [42.9%]) spent between 8 and 28 days on admission after neck exploration. However, 2 (5.7%) patients spent between 1 and 3 days only on admission. Mean ± SD for the length of hospital stay was 16.5 days ± 16.9 days. Of all the patients managed, 32 (91.4%) were discharged and 2 (5.7%) left against medical advice. We recorded only 1 (2.9%) case of mortality. Among the patients discharged, majority (23 [65.7%]) were subsequently lost to follow-up. Only 8 (22.9%) had completed follow-up [Table 2].

Pearson's correlation analysis showed a significant association between type of organ injured and the development of complications (Chi-square = 5.666, $P = 0.017$). There was, however, a weak association between the location of the injury and the development of complication (Chi-square = 3.370, $P = 0.066$) [Table 3].

Table 2: Intra- and postoperative findings among the study population (*n*=35)

Variable	Number of patients (%)
Intraoperative findings	
Pharyngeal injury	6 (17.1)
Laryngeal injury	7 (20)
Esophageal injury	2 (5.7)
Tracheal injury	2 (5.7)
Vascular injury	3 (8.6)
Neurological injury	2 (5.7)
Soft-tissue injury	7 (20)
Others	6 (16.2)
Additional procedure	
None	17 (48.6)
Tracheostomy	17 (48.6)
Others	1 (2.9)
Types of complication	
None	29 (82.9)
Neck stiffness	1 (3.6)
Vocal cord paralysis	1 (3.6)
Stroke	1 (3.6)
Pharyngocutaneous fistula	1 (3.6)
Tracheocutaneous fistula	1 (3.6)
Quadriplegia	1 (3.6)
Endoscopic findings	
None	21 (60.0)
Normal	9 (25.7)
Laryngeal edema	2 (5.7)
Stenosis	1 (2.9)
Vocal cord palsy	1 (2.9)
Pooling of saliva	1 (2.9)
Length of hospital stay (days)	
1-3	2 (5.7)
4-7	10 (28.6)
8-28	15 (42.9)
>28	8 (22.9)
Follow-up	
Still on	4 (11.4)
Lost to follow-up	23 (65.7)
Complete	8 (22.9)

Mean±SD=16.5 days±16.9, Range=2–81 days. SD: Standard deviation

Multiple logistic regression analysis revealed that vascular injury is a positive predictor of poor outcome among patients who had neck exploration (odds ratio = 0.071, $P = 0.048$) [Table 4].

DISCUSSION

Penetrating neck injuries are often associated with great anxieties in the emergency rooms of most hospitals and pose a major challenge to surgeons. Significant morbidity often anticipated because of the large number of vital structures contained in a confined region.

Table 3: Factors affecting outcome among the patients who had neck exploration

Variable	Absence of complication	Presence of complication	χ^2	P
Patient age (years)				
<18	5	0	1.207	0.272
≥18	24	6		
Duration before presentation (h)				
Within 24	26	6	0.679	0.41
After 24	3	0		
Location of the injury				
Zone II	21	2	3.370	0.066
Other zones	8	4		
Urgency of intervention				
Immediate	22	5	0.157	0.682
Delayed	7	1		
Mechanism of injury				
Low velocity	26	5	0.296	0.658
High velocity	3	1		
Injured structure				
Vascular	1	2	5.666	0.017
Nonvascular	28	4		
Admission hemoglobin				
Anemia	19	3	0.513	0.474
Normal	10	3		

Significance is $P<0.05$

Table 4: Determinants of outcome in patients who had neck exploration

Predictor	OR	90% CI	P
Location of injury			
Other zones	Referent		
Zone II	5.250	0.799-34.495	0.084
Mechanism of injury			
Low velocity	Referent		
High velocity	1.733	0.148-20.232	0.661
Admission hemoglobin			
Anemia	Referent		
Normal	1.900	0.322-11.200	0.478
Urgency of exploration			
Immediate	Referent		
Delayed	0.629	0.062-6.328	0.694
Injured structure			
Vascular	Referent		
Nonvascular	0.071	0.005-0.980	0.048

Significance is $P<0.05$. OR: Odds ratio, CI: Confidence interval

The young adult male predominance in our retrospectively reviewed series is comparable to findings by several other reviews worldwide.[2,11,13,14,16-24] However, in slight contrast, Seok and Cho[25] reported a higher median age of 54.3 years, while Hundersmarck *et al.*[26] reported a median age of 40 years. These injuries are common in this age group and gender because they constitute the most active part of most societies and are more likely to be exposed to violence and accidents.

Profuse bleeding was the most frequently reported hard sign of penetrating neck injury in related studies.[2,11,16,21] Our study showed a contrary finding. This could be due to the relatively lower vascular injuries seen among our patients.

Stab injury from knives or related objects is the most predominantly reported mechanism of injury worldwide.[13,14,16-18,21,27] This is closely followed by gunshot.[2,24] However, on the contrary, arrow injuries predominate in our cohort of patients. Frequent farmer-herder clashes in communities within and surrounding the study area could explain such. In addition, suicidal cutthroat closely follows arrow injuries in our series. Similarly, several other authors worldwide variously reported deliberate self-harm as a common mechanism of penetrating neck injury.[18-20,23] The rampant drug abuse and consequent drug-associated psychiatric illnesses in addition to the predominant harsh socio-economic condition among the youths might be responsible.[28,29]

Early presentation to the hospital was a common finding among our patients. This is similarly reported by other studies in sub-Saharan Africa.[17,20] Gilyoma *et al.*[20] in Tanzania reported that none of their patients had prehospital resuscitation. In contrast, majority of our patients had some form of prehospital care at a facility before the presentation. Only 2.9% of our patients presented in shock similar to 3% reported by Texeira

et al.,[16] while Gilyoma *et al.*[20] reported up to 22.4% of their patients with shock on presentation. Prehospital care received by our patients might have helped prevent presentation in shock. Moreover, most of our patients were hemodynamically stable on presentation, as it is reported by several other authors.[2,11,21,26]

Zone II, being the most exposed part of the neck, is the most affected by injuries in our series, as it is reported similarly by most authors worldwide.[2,11,13,14,16-23,26] The midline of the neck is the most affected side among our patients. A similar finding was reported by de Régloix *et al.*[18] in France. On the contrary, Nasr *et al.*[2] in Brazil and Ahmed[17] in Zaria, Nigeria, found the left side as the most common among their patients. Cutthroat either homicidal or suicidal took prominence in our series and is often associated with centrally placed incisions.

The occurrence of additional nonneck injuries among our patients is comparable to findings in other series worldwide.[2,17,22,24] Moreover, Madsen *et al.*[27] in South Africa reported up to 60% of their patients having additional injuries, while Mahmoodie *et al.*[13] in Iran reported only 11.98% of their patients with additional injuries. In most studies including ours, the chest is a common region for additional injuries.

Preoperative blood transfusion was not a common practice among our patients who had neck exploration for penetrating neck injury. On the contrary, Gilyoma *et al.*[20] in Tanzania reported a much higher figure of 45.9% in their series. Majority of the patients in our series had mild-to-moderate anemia preoperatively. This is comparable to findings by Hundersmarck *et al.*[26] in the Netherlands.

Majority of our patients did not undergo any radiological investigation before exploration. This is similar to what was reported in Zaria, Nigeria.[17] However, Nason *et al.*[22] in Canada reported that only 30.8% of the patients in their series were explored without undergoing any radiological investigation. These investigations are often not readily affordable in resource-poor settings with minimal insurance coverage like ours. Most of the patients reviewed in our study had immediate neck exploration, with only 22.9% having selective (delayed) surgery. This is in agreement with findings of 60% immediate exploration by Nasr *et al.*[2] in Brazil. However, Ahmed[17] in Zaria, Nigeria, and Texeira *et al.*[16] in Brazil reported contrary findings of delayed exploration in the majority of their patients. This is so in our center because most of our patients present with arrow impalement or cutthroat that will require immediate surgery.

Laryngeal and soft-tissue injuries were the most common intraoperative findings among our patients. Chappidi and Chilukuri[19] in India reported similar findings in their study. Furthermore, many other authors reported either laryngeal or soft tissue as the most common intraoperative finding in their studies.[11,14,19,20] However, the literature search showed that the majority of authors reported vascular injuries as the most common.[2,17,21,24-27] The predominance of high-velocity injuries in those studies might have accounted for their findings.

Tracheostomy was done in addition to neck exploration in almost half of our patients. This is similar to findings in other related studies.[2,20,23] However, Diaz-Martinez *et al.*[24] in Columbia reported that only 2.2% of their patients had a tracheostomy. Complication rates in our cohort of patients are similar to reported rates in other studies worldwide.[13,23,28] Up to 40% of our patients underwent postoperative flexible nasopharyngoscopic evaluation as similarly reported by Kasbekar *et al.*[14] in the United Kingdom.

Majority of our patients stayed beyond a week on the hospital bed after neck exploration. This is comparable to findings by other authors.[18,20,21] On the contrary, some authors reported lower hospital stay.[11,17,22] Different study designs, sample size, and institutional protocols might have accounted for the differences.

More than 90% of the patients in our series were successfully discharged home, as similarly reported by other authors.[20,21] Gilyoma *et al.*[20] reported that 6.8% of their patients left against medical advice, as was similarly found in our study. The mortality rate in our series agrees with other reports worldwide.[2,13,16,17,22,24,27,30] However, other authors reported higher mortality rates of between 7% and 20.51%.[11,18,20,21,25,26] Our relatively lower occurrence of vascular injury might explain our low rates.

Majority of our discharged patients never turned up for follow–up, as was similarly reported by Gilyoma *et al.*[20] in Northwestern Tanzania. Low level of education and low socioeconomic status of the patients might be the reason.

Vascular injury, even though uncommon in this study, was found to be associated with the development of postoperative complications among our patients. In addition, a weak association was found between the anatomical zone of injury and development of a complication. Gilyoma *et al.*[20] reported anatomic zone and delayed presentation to be significantly associated with development of complications.

CONCLUSION

Penetrating neck trauma is most common among young male adults mostly with laryngotracheal injuries from

arrow impalement or homicidal/suicidal cutthroat. Vascular injury, though uncommon, was shown to be a positive predictor of occurrence of complications. Provision of adequate health-care facilities and further training and re-training of surgeons on the management of vascular injuries will help to improve the outcome of treatments in these patients.

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Conflicts of interest
There are no conflicts of interest.

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