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Selective management of penetrating neck injuries using "no zone" approach

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ABSTRACTS

Introduction: Selective management has been the standard management protocol in penetrating neck injuries (PNIs) since this approach has significantly reduced unnecessary neck exploration. The purpose of this study is to evaluate outcomes of selective management in PNIs using the "no zone" approach, in which the management is guided mainly by clinical signs and symptoms, not the location of the neck wounds.

Materials and methods: A retrospective study was performed in patients treated for PNIs at King Chulalongkorn Memorial Hospital (KCMH) from January 2003 to December 2013. The patients with hard signs of neck injury (i.e., active bleeding, significant haematoma, massive subcutaneous emphysema, and air bubbling through the neck wound) underwent emergency neck exploration. The asymptomatic patients and the patients with soft signs (other symptoms) were considered to be candidates for selective management. Data collection included demographic data, emergency department parameters, details of neck injury, and outcomes in terms of mortality, negative exploration rate, and missed injury rate.

Results: Eighty-six PNI patients were treated at KCMH from 2003 to 2013, 64 of which sustained stab wounds, 12 gunshot wounds, 4 shotgun wounds, and 6 other causes. Thirty-six patients presenting with hard signs underwent immediate neck exploration and there were 2 negative explorations. Twenty-six patients with soft signs underwent selective investigations (including computed tomographic angiography in 21 patients), 5 patients required neck explorations due to positive results of the investigations with one negative exploration. All of the twenty-four asymptomatic patients were managed with close observation, none required subsequent neck exploration. There was no missed injury found in the present study. Successful non-operative management was carried out in 45 patients (52%). The overall negative exploration rate was 7% (3 in 41 patients undergoing neck exploration). Two patients with hard signs died from associated chest injuries (mortality rate 2%).

Conclusion: Selective management of penetrating neck injuries based on physical examination and selective use of investigations (no zone approach) is safe and simple with low negative exploration rate and no missed injury.

Introduction

The neck is an extremely complex anatomical region where several vital structures including blood vessels, aerodigestive tract, spine and spinal cord are confined in a small compact space. Hence, penetration from projectiles or other objects may result in a life-threatening injury. The treatment strategy of penetrating neck injuries (PNIs) acquired from military surgical practice suggested mandatory exploration as a standard treatment to avoid missed injuries [1,2]. However, civilian adoption of mandatory exploration in PNIs resulted in high negative exploration rate (53–56%) [3–5]. Selective management of PNIs, using zones of neck injury to guide investigations and management (a "zone-based" approach), has become a widely accepted treatment strategy in the civilian population since this approach carries very low missed injury rates and highly successful non-operative management (NOM) rates (63–66%) [6–8].

Although zones of neck injury can provide a useful guideline in the management of PNIs, there are some disadvantages related to the use of this zone-based approach including difficulty zoning transcervical or multiple injuries, and poor correlation between the location of neck wounds and internal organ involvement

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[9]. Therefore, recent studies have given more emphasis to the patients' signs and symptoms, rather than the neck zones per se, to dictate further investigation and management [10–12]. This so-called "no zone" approach, using physical examination and computed tomographic angiography (CTA), has greatly simplified the management of PNIs with negligible missed injuries and low negative exploration rates (1–2%) [11–13]. The purpose of the present study is to identify the outcomes of selective management of PNIs, using the "no zone" approach, in terms of negative exploration rate, missed injury rate, and mortality.

Patients and methods

A retrospective study was performed on PNI patients at King Chulalongkorn Memorial Hospital, a 1300-bed university hospital and a level 1 trauma centre in Bangkok, Thailand, from January 2003 to December 2013. The study was approved by our institutional review board. The management of PNIs at our institution is guided mainly by the signs of neck injury. The PNI patients were categorized into 3 groups according to their signs and symptoms. (1) The patients with "hard signs", including signs of vascular injury (i.e., active bleeding and expanding haematoma) and aerodigestive injury (i.e., massive subcutaneous emphysema and air bubbling through the neck wound), were taken directly to the operating room for immediate neck exploration. (2) The patients with "soft signs" (i.e., other signs and symptoms) would undergo selective diagnostic investigation to rule out internal organ injuries. (3) The patients who were "asymptomatic" would undergo close observation and serial physical examination. The selective investigations included esophagoscopy, esophagography, bronchoscopy, and angiography; the use of these modalities was decided individually depending on the clinical suspicion of specific organ injuries in each patient. CTA has become an initial screening tool in PNI patients with soft signs in our institution since 2006. Depending on the CTA findings, the patients would undergo either observation (negative CTA results), or further investigation/operation (positive CTA results).

Data collection included demographic data, emergency department (ED) parameters (vital signs, trauma scores, hematocrit, and base deficit), signs of neck injury, details of neck injury, types of management, and outcomes in terms of blood component transfusions, complications, intensive care unit (ICU) days, ventilator days, length of stay, negative exploration rate, missed injury rate, and mortality. Zones of neck injury were recorded according to Roon and Christensen's [4] modification (i.e., zone I – the base of the neck to the cricoid cartilage, zone II – the cricoid cartilage to the angle of the mandible, and zone III – area cephalad to the angle of the mandible). Statistical analysis was done by the Windows SPSS programme version 17.0 with the statistical significance set at $p < 0.05$. Univariate analysis was performed with the Chi-squared test for comparison of categorical variables, and the Analysis of Variance (ANOVA) for comparison of continuous variables. The non-parametric Kruskal–Wallis test was used for comparison of variables that were clearly non-normally distributed (i.e., Glasgow Coma Scale (GCS), injury severity scores (ISS), revised trauma score (RTS), blood transfusions, ICU days, ventilator days, and length of stay).

Results

From January 2003 to December 2013, 86 patients with PNIs admitted to the authors' institution were identified (77 males and 9 females, with the mean age of 27.1 years). Stab wounds were the most common mechanism, accounted for 74% of the patients, followed by gunshot wounds (14%), shotgun wounds (5%), and other mechanisms (7%). Thirty-six patients presenting with hard signs (hard sign group) underwent emergency neck exploration. Twenty-six patients presenting with soft signs (soft sign group) were hemodynamically stable and underwent selective investigation. The remaining 24 asymptomatic patients (asymptomatic group) were admitted for close observation and serial physical examination. The demographic data and ED parameters are shown in Table 1. The patients in the hard sign group had significantly higher ISS and lower RTS than the other 2 groups. The management of PNIs and the details of the signs of neck injury are demonstrated in Fig. 1.

The zones of neck injury are shown in Table 2. Zone II (65%) was the most commonly injured area, followed by zone I (16%) and zone III (13%). Five patients (6%) had multiple injuries to the neck and could not be classified into just one zone. Eighteen patients

Table 1
Demographic data and emergency department (ED) parameters.

	Total (n = 86)	Hard sign group (n = 36)	Soft sign group (n = 26)	Asymptomatic group (n = 24)	p value
Sex					
Male	77 (90%)	34 (94%)	24 (92%)	19 (79%)	0.143
Female	9 (10%)	2 (6%)	2 (8%)	5 (21%)	
Age	28.9 (10.8)	26.8 (9.1)	28.3 (10.1)	32.7 (13.0)	0.105
Mean (SD)					
Mechanism					
Stab wound	64 (74%)	33 (92%)	13 (50%)	18 (75%)	**0.001**
Gunshot wound	12 (14%)	2 (5%)	9 (35%)	1 (4%)	
Shotgun wound	4 (5%)	0	3 (11%)	1 (4%)	
Other	6 (7%)	1 (3%)	1 (4%)	4 (17%)	
ED parameters					
Mean (SD)					
SBP	121.0 (24.0)	116.4 (28.6)	125.7 (18.9)	124.0 (20.9)	0.253
PR	90.0 (21.0)	87.8 (22.4)	89.2 (21.6)	94.3 (18.4)	0.496
RR	20.1 (3.4)	19.4 (4.8)	20.2 (1.0)	21.1 (1.9)	0.158
GCS*	13.9 (2.5)	13.5 (2.8)	13.5 (2.9)	14.8 (0.6)	0.132
ISS (median (IQR))	9 (5–16)	13 (9–18)	9 (9–14)	5 (5–8)	**<0.001**
RTS*	7.5 (1.1)	7.3 (1.4)	7.5 (1.1)	7.8 (0.2)	**0.009**
TRISS	96.0 (14.0)	95.0 (16.0)	94.7 (17.2)	98.9 (0.8)	0.500
Hematocrit	39.1 (6.3)	37.8 (7.7)	39.9 (5.6)	40.0 (4.4)	0.312

SBP = systolic blood pressure, PR = pulse rate, RR= respiratory rate, GCS = Glasgow Coma Scale, ISS = Injury Severity Score, RTS = Revised Trauma Score, TRISS = Trauma and Injury Severity Score, IQR = inter-quartile range

* The means and standard deviations (SD) are shown for these variables because the medians were uninformative. Nevertheless, non-parametric tests were applied for a significance test.

The bold value in the table is meant to highlight the significant values ($p < 0.05$).