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Leukocytosis in penetrating abdominal trauma isolated and associated with osseous and/or thoracic trauma

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KEYWORDS

White blood cell count;
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penetrating trauma;
abdominal trauma;
osseous trauma;
thoracic trauma;
gunshot trauma.

Abstract: *Introduction:* The objective of this study was to determine the level of white blood cells (WBC) in patients with penetrating abdominal trauma isolated (PATI) and associated with osseous and/or thoracic injury (PAT/OT). *Methodology:* This was a retrospective study comparing two groups of abdominal penetrating trauma victims, one with PATI and one with PAT/OT. We examined if level of WBC correlates with PATI group and/or PAT/OT group. We examined the level of WBC as a factor associated with major injury. *Results:* Our study showed a difference in mean WBC between the two groups that was statistically significant ($p=0.01$). A positive relationship between PAT/OT injury was found. *Conclusion:* A significant elevation in WBC in PAT/OT is observed in comparison with PATI and translate a major inflammatory response.

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Introduction

Ciudad Juarez was the most dangerous city in Mexico during years 2008, 2009, 2010 and 2011. In these years, surgeons of The General Hospital of Juarez City (HGCJ) acquired great experience in traumatic patients and begin a research project about this topic in our country (1-6). The evaluation of penetrating trauma (PAT) aims to identify patients in need operation without submitting them to the risks of unnecessary surgical procedures. It is still debated whether the examination is reliable or additional tests should be routinely ordered. Identifying significant injury in the trauma patients with early markers of injury can aid physical exam, history, and other tests in detecting and/or measure severe injury in

penetrating trauma victims. It has been hypothesized that elevation of trauma patient's white blood cells (WBC) count may be a surrogate marker of neuro-humoral activation and be valuable in identifying patients with major injuries (7).

Major injury is associated with a major stress-induced neurohumoral response stimulating the secretion of epinephrine and cortisol. In healthy subjects these stress-induced hormones, epinephrine and cortisol, produce leukocytosis from both bone marrow and splenic sources (7). Leukocytosis is defined as a WBC count greater than 11,000 per mm³ (11×10^9 per L). Approximately 1.6 billion granulocytes per kg of body weight are produced each day, and 50 to 75 percent of these cells

are neutrophils (8). Leukocytosis in trauma/stress is due to neutrophilia, caused by neutrophil margination, and not due to increased marrow production or release of immature cells or bands (9).

During normal circumstances, the estimated life span of WBC is 11 to 16 days (8), but in inflammation states this phenomenon is short-lived, lasting only minutes to hours. Once leucocyte is released into circulation and tissue, it remains the only a few hours, at which time cell death occurs (8). In theory, patients with significant injury should have higher degree of leukocytosis compared to patients with minor injuries. WBC level could serve as an easy-to-obtain marker for serious injury (9). Being unaware of any published study comparing levels of leukocytes in patients with PAT, we planned a study that its objective was to determine the level of WBC in patients with PAT isolated (PATI) and PAT associated with osseous and/or thoracic injury (PAT/OT).

Methodology

This was a retrospective and descriptive (case-control) study. The local institutional review board (IRB) of Autonomous University of Juarez City (UACJ) and The General Hospital of Juarez City (HGCJ) approved this study. Requirement for informed consent was waived by IRB.

This study was conducted at HGCJ, a Second Health Care Level Hospital, in Juarez, Mexico. Entry criteria included patients aged > 14 years and < 65 years; treated

for abdominal gunshot trauma admitted from emergency department (ED) with or without osseous and/or thoracic injury, between April 1, 2008 and December 31, 2010; and that these patients were treated with a therapeutic laparotomy.

Patients excluded from our study were those hemodynamically unstable, non-gunshot abdominal trauma (such as blunt abdominal trauma or stab wound abdominal trauma), lack of WBC count determination on admission, and early or late death by mobility related to trauma.

The study patients were divided into 2 groups: patients with PATI versus patients with PAT/OT. Data were collected on age, sex, time between trauma and hospitalization, drugs/alcohol intoxication, associated osseous/thoracic injuries, intra-abdominal organs injured, pre-operative level of leukocytes, pre-operative level of neutrophilia, pre-operative level of hemoglobin, pre-operative level of hematocrit, and hospital stay.

Data were entered and analyzed using STATA 10 computer program. Continuous data were compared between groups using Chi square test or t-student test. A level of $p < 0.05$ was used to declare statistical significance for all comparisons.

Results

Between April 2008 to December 2010; a total of 480 PAT patients were reviewed. Of these, we studied 186

Table I.
Organs injured by number of patients and percentages.

Organs	PATI	Percentage	PAT/OT	Percentage
Stomach	15	13.8	21	27.3
Duodenum	3	2.7	2	2.6
Small bowel	55	50	33	42.3
Large bowel	55	50	42	54.5
Liver	19	17.4	15	19.5
Spleen	5	4.6	20	26
Kidney	2	1.8	1	1.3
Bladder	7	6.4	2	2.6
Pancreas	0	0	2	2.6
Diaphragm	0	0	22	28.6
Total	161	—	160	—

Table II.
Laboratory variable by groups and statistical difference. Penetrating abdominal trauma isolated (PATI); penetrating abdominal trauma associated with osseous and/or thoracic injury (PAT/OT); white blood cells count (WBC); hemoglobin (Hb).

Laboratory variable	PATI	PAT/OT	Total	<i>p</i>
Leukocytosis (yes/no)	95/14	67/10	162/24	0.977
Mean WBC	14.2	16.4	15.1	0.01
Mean Hb	13.7	12.8	13.3	0.069

patients with inclusion criteria and without exclusion criteria. The mean age was 28.8 years; the median age was 28 years, an age difference from 14 to 60 years (range 46 years). 168 (90.3%) patients were male and 18 (9.7%) patients were female. 109 (59%) patients met criteria for PATI, and 77 (41%) patients were classified as PAT/OT.

The mean time between trauma and hospitalization was 90 minutes (± 66 , range 60 – 420). The mean time between trauma and hospitalization in PATI group was 87 minutes (± 53); in PAT/OT group was 93 minutes (± 82). There was not difference in time between groups ($p=0.284$).

There were 92 (84%) patients with intoxications (alcohol and/or drugs) in PATI group, and there were 60 (78%) patients with intoxication in PAT/OT group. There was not statistical difference between these groups ($p=0.260$). The organ more affected in both groups was large bowel, followed by small bowel. The rest of organs are showed in table 1.

95 (87.2%) patients were leukocytosis in PATI group, whereas 67 (87%) patients were leukocytosis in PAT/OT group. Both groups were leukocytosis in same

level without statistical difference in this comparative (figure 1). The mean WBC for all patients was 15,100 per mm³ ($\pm 4,200$). The mean WBC for PATI group was 14,200 per mm³ ($\pm 3,500$). The mean WBC for PAT/OT group was 16,400 per mm³ ($\pm 4,700$). The difference in WBC values between the two groups was statistically significant (square Chi test (56) = 82.28, $p = 0.01$) (Table 2).

In PAT/OT group, there were 20 (26%) patients with PAT and thoracic injury with a leukocytosis level of 17,400 per mm³ ($\pm 5,165$), 13 (17%) patients with PAT and any arm fracture with leukocytes level of 14,100 per mm³ ($\pm 3,240$), 18 (23.4%) patients with PAT and any leg fracture with a leukocytosis level of 17,100 per mm³ ($\pm 3,600$), 6 (8%) patients with PAT and arm plus leg fracture with a leukocytosis level of 15,300 per mm³ ($\pm 5,500$), 10 (13%) patients with PAT and thoracic plus arms injury with a leukocytosis level of 15,700 per mm³ ($\pm 5,800$), 7 (9%) patients with PAT and thoracic plus leg injury with a leukocytosis level of 17,300 per mm³ ($\pm 5,200$), and 3 (4%) patients with PAT and thoracic plus arm and leg injury with a leukocytosis level of 19,000 per mm³ ($\pm 4,6,200$). There were not statistical

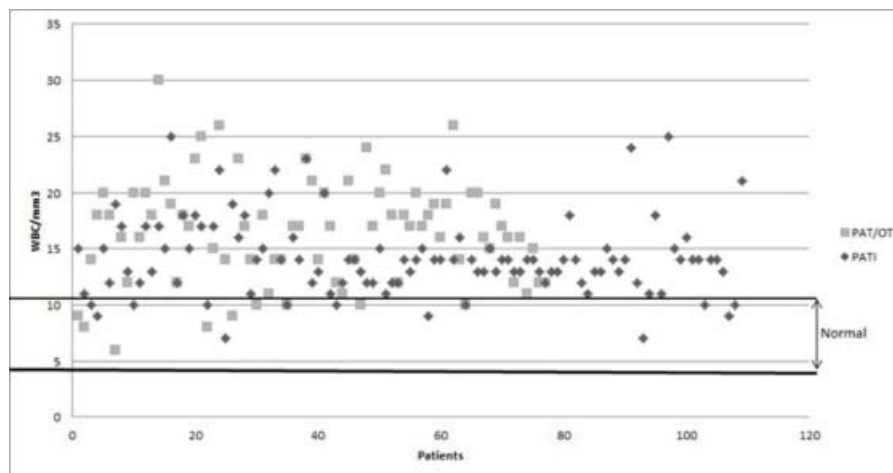


Figure 1. White blood cells (WBC) count distributed by patients and group (penetrating abdominal trauma isolated (PATI) and penetrating abdominal trauma associated with osseous and/or thoracic injury (PAT/OT)). Black lines signaling normal range.

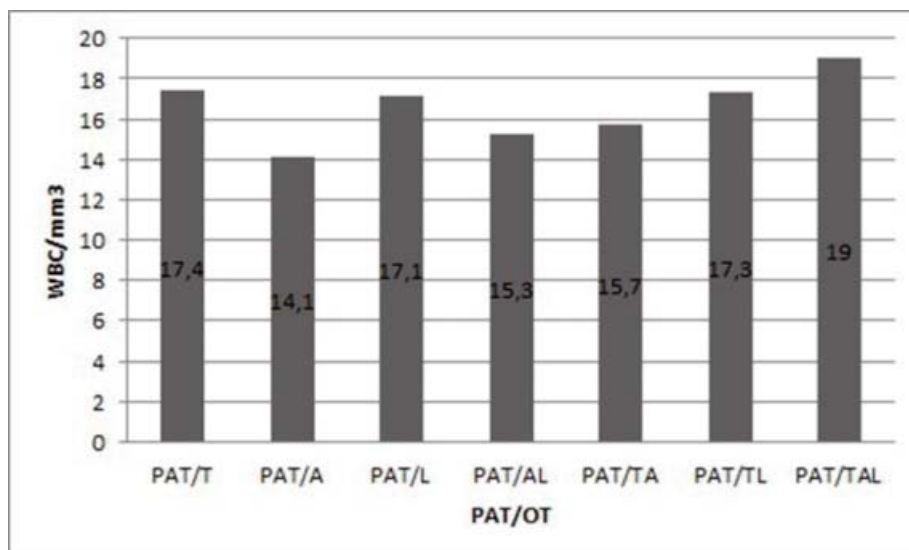


Figure 2. White blood cell (WBC) count mean in penetrating abdominal trauma (PAT) associated with osseous and/or thoracic (PAT/OT) injury separated by regions. PAT/T: thoracic injury; PAT/A: arm injury; PAT/L: leg injury; PAT/AL: arm plus leg injury; PAT/TA: thoracic plus arm injury; PAT/TL: thoracic plus leg injury; PAT/TAL: thoracic plus arm plus leg injury.

differences between these groups and its leukocytosis level (chi square = 210,45; $p = 0.594$) (figure 2).

The mean of hemoglobin level was 13.7gr/dL (± 2.4) in PATI group, the mean of hemoglobin level was 12.8gr/dL (± 2.1) in PAT/OT. There was not a statistical difference in this variable between the groups ($p=0.069$).

The mean of hospital stay was 9.5 days (± 10 , range 2 - 76); the mean of hospital stay for PATI was 8.2 days (± 7) and the mean of hospital stay for PAT/OT was 11.6 days (± 13). There was statistical difference in hospital stay between these groups ($p=0.039$).

Discussion

The purpose of this study was to measure pre-operative levels of leukocytosis in patients with PATI and PAT/OT underwent to exploratory laparotomy and observe if the PAT and associated injured in extremities and/or thorax have a major inflammatory response and translate in a major leukocytosis.

Diverse Mexican (10,11,12,13) and international (15,16) studies showed that productive age is the most affected population, (males predominant) this concordat with our results. The time between injury and hospitalization, we considered that is rational (mean 90 minutes), we do not have a similar studies to compare this mean, except an anterior study published for us (1), in that article the mean time between injury and hospitalization was 55 minutes, but these patients was underwent to damage control surgery, may be this reason was the capable of a minor time.

Intoxication does not play an important role in both groups, and this was reflects in a non-statistical difference between these variables. This was appreciated in anterior study (3), that no found relationship between alterations of conscience by drugs and/or alcohol and incidence of non-therapeutic laparotomy.

Digestive tract is the most affected organ in penetrating abdominal trauma (13,16). Although several studies (17,18,19) inform that large bowel is the second most injured organ in penetrating trauma, in this study this organ was first in frequency, followed by small bowel (first in several studies).

Both groups had inflammatory response, because both groups had leukocytosis, and does not statistical difference. But we observed a major leukocytosis in PAT/OT group; this difference was statistical significance in favor to this group. Several studies have described a significant higher WBC counts in their most severely injured trauma patients (7,9). We think that a major leukocytosis reflects more severe trauma that afflicts the osseous and/or thoracic trauma associated patients. This was logical, but not was measured before.

An elevation of WBC typically reflects the normal response of bone marrow to an infectious or inflammatory process. In case of trauma stimuli, leukocytosis is the appropriate response of bone marrow to these external stimuli (8). The metabolic responses to injury and critical illness include hypermetabolism, accelerated skeletal muscle protein breakdown, glucose intolerance, and insulin resistance (20).

In moderate and severe leukocytosis, the majority of cells are neutrophils. Neutrophilia may be caused by increased release from marrow stores, increased production, extended survival or demargination within the blood vessels (21).it is considered a non-specific measure of inflammation, being associated with bacterial and fungal infection, neoplasms, trauma, myocardial ischaemia, and with almost any medical condition that causes stress (21).

The integral evaluation of PAT aims to identify patients in need of treatment (surgical or non-surgical), and laboratory parameters like a severe leukocytosis may be a surrogate marker for organ/region injured as-

sociated with other lesions that may be unsuspected. The differences in leukocytosis between the sub-groups of PAT/OT group were no statistical significance. The mean of hemoglobin was no difference between groups.

The hospital stay was more prolonged in patients with associated trauma, this was logical, because, these patients suffered fractures and/or hemothorax/pneumothorax and these injuries were treated specifically.

Conclusion

Today, the complete blood cell count is the most widely ordered medical investigation in both ambulatory and hospitalized patients and remains like the cornerstone of clinical medicine (22). However, despite great advances in the understanding of immune system made in recent decades, little progress has been made regarding the clinical significance of leukocytosis in trauma patients. Our finding in PATI and PAT/OT patients support the findings of previous studies: higher WBC counts are finding in patients with major injuries. A significant elevation in WBC in PAT/OT patients is a phenomenon awaited, and suggests severe injury and a major inflammatory response.

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