ORIGINAL ARTICLE

Abdominal gunshot wounds: evaluating the role of computed tomography in surgical timing and decision-making

Muhammed İkbal Akın,[1] Alisina Bulut,[2] Muhammer Ergenç,[2] Tevfik Kıvılcım Uprak,[2] Ömer Günal,[2] Şevket Cumhur Yeğen[2]

[1]Department of Gastroenterology Surgery, Koşuyolu High Specialization Education and Research Hospital, Istanbul-*Türkiye*
[2]Department of General Surgery, Marmara University School of Medicine, Istanbul-*Türkiye*

ABSTRACT

BACKGROUND: Abdominal gunshot wounds contribute significantly to trauma-related morbidity and mortality. Computed tomography (CT) can provide valuable diagnostic information but may potentially delay definitive treatment. This study aimed to evaluate the role of abdominal CT in surgical decision-making and timing among patients with abdominal gunshot injuries.

METHODS: We retrospectively analyzed patients with abdominal gunshot wounds treated at a tertiary university hospital between January 2013 and January 2023. Collected data included demographic characteristics, physiological parameters, trauma scores, CT findings, time intervals (from admission to CT and to surgery), and clinical outcomes. Patients were classified as hemodynamically stable or unstable based on admission parameters and their response to resuscitation. The two groups were compared.

RESULTS: A total of 74 patients were included (94.5% male; median age, 32 years). Of these, 47 (63.5%) were hemodynamically stable at presentation, while 27 (36.5%) were unstable. Abdominal CT was performed in 67 patients (90.5%), with a median time of 28 minutes from admission. The median time to CT was similar between stable (28 minutes) and unstable (30 minutes) patients (p=0.934). Based on CT findings, nonoperative management was feasible in 10 patients (13.5%). Among the unstable group, CT was performed in 7 of 11 nonresponders, of whom six (54.5%) died. Among patients who underwent surgery, the mean time to operation was significantly shorter in unstable patients compared to stable patients (60.4±36.7 vs. 93.2±76.6 minutes; p=0.034). The perioperative mortality rate was 9.3%, with all deaths occurring in hemodynamically unstable nonresponders.

CONCLUSION: Abdominal CT can aid surgical planning without causing significant delays in definitive treatment, even in initially unstable patients who respond to resuscitation. CT findings may support nonoperative management in selected cases and guide targeted surgical interventions in patients requiring operative treatment. However, these findings apply to carefully selected patients and should be interpreted cautiously, as this study does not establish the safety of CT in unselected hemodynamically unstable patients. The proximity of the CT scanner to the resuscitation area facilitated rapid imaging; therefore, the findings may not be generalizable to institutions with remotely located CT facilities.

Keywords: Abdominal gunshot wounds; computed tomography (CT); surgical decision-making; trauma management; hemodynamic instability; time factors.

Cite this article as: Akın Mİ, Bulut A, Ergenç M, Uprak TK, Günal Ö, Yeğen ŞC. Abdominal gunshot wounds: Evaluating the role of computed tomography in surgical timing and decision-making. Ulus Travma Acil Cerrahi Derg 2026;32:259-269.

Address for correspondence: Muhammed İkbal Akın
Department of Gastroenterology Surgery, Koşuyolu High Specialization Education and Research Hospital, Istanbul, Türkiye
E-mail: ikbalakin34@gmail.com

Ulus Travma Acil Cerrahi Derg 2026;32(3):259-269 DOI: 10.14744/tjtes.2025.31877
Submitted: 19.07.2025 Revised: 24.10.2025 Accepted: 30.10.2025 Published: 10.03.2026

INTRODUCTION

Trauma remains a leading cause of mortality worldwide and is the primary cause of death among individuals aged 1–44 years.[1] Penetrating injuries, particularly those caused by firearms, account for a substantial proportion of trauma-related deaths.[2] The management of abdominal gunshot wounds presents unique challenges, requiring rapid assessment and timely decision-making to optimize patient outcomes.

Advanced Trauma Life Support (ATLS) principles emphasize the importance of a primary survey, prompt resuscitation, and timely secondary assessments to identify specific injuries.[3] Traditionally, the management of penetrating abdominal trauma was guided by the principle that any breach of the peritoneal cavity necessitated exploratory laparotomy. However, contemporary evidence suggests that selective nonoperative management may be appropriate in carefully selected patients.[4,5]

The role of diagnostic imaging, particularly computed tomography (CT), in the management of abdominal gunshot wounds continues to evolve. Contrast-enhanced abdominal CT can provide detailed information regarding bullet trajectory, peritoneal violation, organ injuries, and retroperitoneal involvement.[6] Although CT offers valuable diagnostic insight, concerns remain regarding potential delays in definitive treatment, especially in hemodynamically unstable patients.[7]

The "golden hour" concept in trauma care underscores the importance of time in determining patient outcomes. Delays in definitive treatment have been associated with increased mortality, particularly in patients with hemorrhagic shock.[3] However, rapid CT acquisition with modern multidetector scanners may provide critical information without significant time delays when integrated into a well-coordinated trauma system.[8]

Hemodynamic assessment plays a crucial role in trauma management decision-making. Current guidelines categorize patients as hemodynamically stable, responders to resuscitation, transient responders, or nonresponders.[9] While hemodynamic instability has traditionally been considered a contraindication to CT imaging, an increasing body of evidence suggests that selected unstable patients who respond to initial resuscitation (hemodynamically stable patients) may benefit from CT-guided evaluation and management.[10,11]

The balance between diagnostic precision and timely intervention remains a critical consideration in trauma management. Avoiding unnecessary laparotomies through improved diagnostic accuracy must be weighed against the potential risks of delayed intervention.[12] Recent advances in trauma care have led to the development of hybrid operating rooms and rapid imaging protocols aimed at optimizing this balance.[13]

The primary aim of this study was to evaluate the impact of abdominal CT on surgical decision-making in patients with abdominal gunshot wounds. Additionally, we sought to analyze time factors in the management process, including time to CT acquisition and time to definitive treatment, and their relationships with patient outcomes.

MATERIALS AND METHODS

Study Design and Population

We conducted a retrospective analysis of patients with abdominal gunshot wounds treated at the Department of General Surgery, Marmara University Hospital, between January 1, 2013 and January 1, 2023. The study was conducted in accordance with the principles of the Declaration of Helsinki and received approval from the Ethics Committee of Marmara University (approval number: 09.2023.40). The study was reported in line with the STROCSS (Strengthening the Reporting of Cohort, Cross-Sectional and Case-Control Studies in Surgery) guidelines.[14]

Inclusion Criteria

- Patients aged ≥16 years who presented to the emergency department with abdominal gunshot wounds and were evaluated by the general surgery team

- Patients with isolated abdominal injuries or multitrauma patients with abdominal involvement

- The abdominal region was defined as the area between the diaphragm superiorly and the pelvic brim inferiorly, including lower thoracic injuries with diaphragmatic involvement.

Exclusion Criteria

- Patients with incomplete initial or follow-up data
- Patients with isolated extra-abdominal injuries
- Patients who were dead on arrival.

(The patient selection process is summarized in Figure 1.)

Patient records were identified using the *International Classification of Diseases, 10th Revision* (ICD-10) codes (S31.3, S31.4, S31.6, S36, X73, X74, X93, Y22) related to gunshot wounds through the Hospital Information Management System (HIMS).[15] The extracted data included:

1. Demographic characteristics (age, sex)
2. Admission vital signs

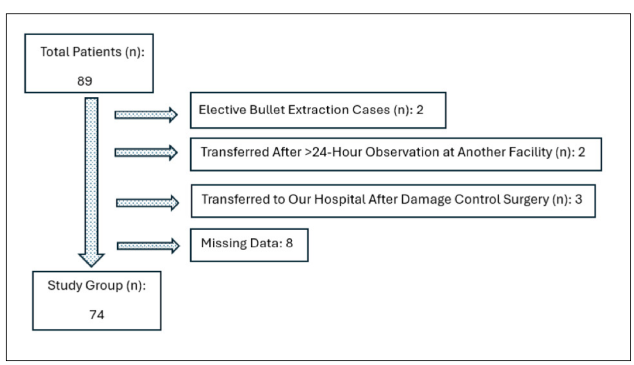

Figure 1. Patient selection flowchart.

3. Laboratory values (hemoglobin, hematocrit, white blood cell count)
4. Resuscitation measures (blood product administration)
5. Imaging studies (timing and findings of abdominal CT)
6. Surgical details (timing, procedures, findings, duration)
7. Trauma scores were assessed according to standardized criteria:
    o Injury Severity Score (ISS)
    o Revised Trauma Score (RTS)
    o Trauma and Injury Severity Score (TRISS).

The ISS evaluates anatomical injury severity, whereas the RTS assesses physiological parameters. The TRISS combines both anatomical and physiological parameters to estimate the probability of survival. The ISS, RTS, and TRISS scores for the patients in this study were calculated using the MDCalc website (https://www.mdcalc.com).[16]

The time intervals were calculated as follows (Fig. 2):

• Time to CT: Time in minutes from admission to completion of CT in the emergency department

• Time to surgery: Time in minutes from admission to entry into the operating room

• Duration of surgery: Time in minutes from incision to closure.

Hemodynamic Classification

Patients were classified based on their hemodynamic status at presentation according to established trauma guidelines:[3]

1. Stable:

o Systolic blood pressure >90 mmHg
o Heart rate <100 beats/minute
o Estimated blood loss <750 mL
o Normal tissue perfusion

2. Unstable: Presence of:

o Systolic blood pressure <90 mmHg
o Heart rate >100 beats/minute
o Poor tissue perfusion
o Altered level of consciousness.

Unstable patients were further subcategorized according to their response to initial fluid resuscitation:

• Responders:

o Normalized blood pressure (>90 mmHg)
o Decreased heart rate
o Improved lactate levels
o Normalized base deficit

• Nonresponders:

o Persistent hypotension
o Ongoing tachycardia
o Worsening metabolic parameters
o Continued physiological deterioration despite resuscitation.

Patients were grouped accordingly and compared based on these criteria.

Management and Imaging Protocol

Patient management was conducted in accordance with Advanced Trauma Life Support principles. In cases with clear signs of peritonitis (tenderness, rigidity, rebound) or evident hemodynamic instability, immediate surgical intervention was generally preferred. However, in patients with a partial response to resuscitation or inconclusive clinical findings, computed tomography imaging was occasionally performed prior to definitive surgical decision-making. In hemodynamically unstable patients, CT was utilized only when there was a partial response to resuscitation and when it could be performed rapidly without delaying surgical intervention. No patient experienced delayed surgery due to CT scanning. Throughout the study period, our institution adopted a relatively liberal approach to CT utilization, including its use in selected hemodynamically unstable patients when deemed potentially beneficial for assessing organ injuries and bullet trajectories. Additionally, CT imaging was employed to facilitate early notification of relevant specialists—such as cardiovascular surgeons, thoracic surgeons, hepatopancreatobiliary surgeons, and urologists—when complex or multi-organ injuries were suspected. Clinical decision-making was conducted through multidisciplinary collaboration between the emergency department and surgical teams. A single standardized management algorithm was not

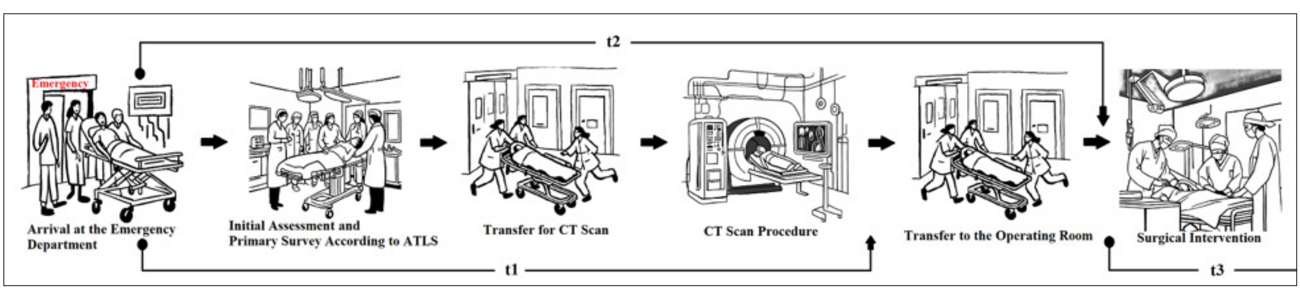

Figure 2. Management process of patients with abdominal gunshot wounds, from emergency department arrival to surgical intervention, highlighting critical time intervals (t1, t2, t3). ATLS: Advanced Trauma Life Support; CT: Computed tomography.

applied consistently throughout the 10-year study period.

The CT examinations performed were intravenous contrast-enhanced, 256-slice multidetector scans. Oral and rectal contrast agents were not routinely administered. Depending on the mechanism of injury, CT imaging also included the thorax and other relevant body regions.

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY). Data distribution was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed variables are presented as means±standard deviations, whereas non-normally distributed variables are expressed as median (interquartile range [IQR]). Categorical variables are presented as frequencies and percentages. Comparisons between groups were performed using Student's t-test or the Mann–Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. A p-value <0.05 was considered statistically significant. Post hoc power analysis was performed using G*Power software (version 3.1.9.7).

RESULTS

Patient Demographics and Clinical Characteristics

A total of 74 patients with abdominal gunshot wounds were included in the analysis, comprising 70 males (94.5%) and four females (5.5%), with a median age of 32 years (IQR: 13). At presentation, 47 patients (63.5%) were hemodynamically stable, whereas 27 (36.5%) were classified as unstable.

Significant differences in vital signs were observed between the stable and unstable groups (Table 1). Mean arterial pressure was significantly lower in the unstable group (median 65 mmHg vs. 89 mmHg; p<0.01). Similarly, systolic blood

Table 1. Patient characteristics and clinical outcomes

Variables	Total	Stable	Unstable	P value
Total number of patients (n, %)	74	47 (63.5)	27 (36.5)	
Age (years), median (IQR)	32 (13)	31 (14)	33 (11)	0.486
Sex (n, %)				
Male	70 (94.6)	45	25	0.620
Female	4 (5.4)	2	2	
MAP (mmHg), median (IQR)	86.1 (24.3)	89 (19.6)	65 (33)	<0.01
SBP (mmHg), (mean±SD)	107.5±21.8	118.2±15.7	89±18.3	<0.01
Heart rate (beats/min), (mean±SD)	100.2±18.5	94±14.3	111±20.3	<0.01
SpO_2 (%), median (IQR)	98 (5)	98 (2)	94 (7)	<0.01
Hgb (g/dL), median (IQR)	14.2 (2.1)	14.2 (1.9)	14.2 (4)	0.437
Hct (%), (mean±SD)	40.6±5.5	41.3±4.2	39.3±7.2	0.146
WBC (10^3/µL), (mean±SD)	13.9±4.6	14.1±4.5	13.6±4.7	0.707
Blood transfusion in emergency department (n, %)	21 (28.4%)	6 (13.3%)	15 (55%)	<0.01
Abdominal CT performed (n, %)	67 (90.5%)	45 (95.7%)	22 (81.4%)	0.092
Time to CT (min), median (IQR)	28 (17.5)	28 (19)	30 (21)	0.934
TRISS (%), median (IQR)	98.54 (1)	96.17 (13.3)	<0.01	
RTS, median (IQR)	7.8 (0.2)	7.84 (0)	7.55 (1.7)	<0.01
ISS, median (IQR)	17 (14)	16 (11)	25 (15)	<0.01
Extra-abdominal injury (n, %)	46 (62.1%)	28 (59.5%)	18 (66.6%)	0.545
Surgery performed (n, %)	64 (86.5%)	38 (80.8%)	26 (96.2%)	0.082
Time to surgery (min), (mean±SD)	73.4±38.1	93.2±76.6	60.4±36.7	0.034
Blood transfusion during surgery (n, %)	24 (37.5%)	6 (66.6%)	18 (38.2%)	<0.01
Perioperative blood loss (mL), median (IQR)	400 (1075)	0 (500)	700 (2500)	0.009
Duration of surgery (min), median (IQR)	121 (65)	99 (68)	150 (60)	0.001
Postoperative length of stay (days), median (IQR)	5 (4)	4 (3)	5.5 (7)	0.034
Perioperative mortality (n, %)	6 (9.3%)	0	6 (22.2%)	<0.01

MAP: Mean arterial pressure; SBP: Systolic blood pressure; Hgb: Hemoglobin; Hct: Hematocrit; WBC: White blood cell count; CT: Computed tomography; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; ISS: Injury Severity Score.

Table 2. Distribution of injured organs

Small intestine	34 (26.5%)
Colon	19 (14.8%)
Liver	15 (11.7%)
Diaphragm	13 (10.1%)
Stomach	9 (7%)
Mesentery	8 (6.2%)
Major vessels	8 (6.2%)
Kidney	5 (3.9%)
Rectum	4 (3.1%)
Spleen	4 (3.1%)
Pancreas	2 (1.5%)
Duodenum	2 (1.5%)

pressure was lower in unstable patients (mean 89.0±18.3 mmHg vs. 118.2±15.7 mmHg; p<0.01). Unstable patients also had significantly higher heart rates (mean 111.0±20.3 vs. 94.0±14.3 beats/min; p<0.01).

Imaging and Time Factors

Abdominal CT was performed in 67 patients (90.5%), including 45 stable patients (95.7%) and 22 unstable patients (81.4%). The median time from admission to CT completion was 28 minutes (IQR: 19), with no significant difference between stable and unstable patients (28 vs. 30 minutes; p=0.934).

The mean time to surgery was 73.4±38.1 minutes overall and was significantly shorter in unstable patients than in stable patients (60.4±36.7 vs. 93.2±76.6 minutes; p=0.034). The duration of surgery was significantly longer in unstable patients (median 150 vs. 99 minutes; p=0.001).

Management and Outcomes

In our series, the small intestine (26.5%), colon (14.8%), and liver (11.7%) were the most frequently injured abdominal organs due to gunshot wounds (Table 2).

Based on clinical evaluation and CT findings, 10 patients (13.5%) were managed nonoperatively, whereas 64 (86.5%) underwent surgical intervention. One patient presented with evisceration and hemodynamic instability and was taken directly to emergency surgery without undergoing CT imaging. Among the operated patients, the most common procedures were small bowel resection with anastomosis (39.1%), primary small bowel repair (20.3%), and liver laceration repair (23.4%). The negative laparotomy rate was 7.8% (five patients) (Table 3).

Table 3. Types of surgical procedures and patient distribution

Type of Surgery	Number of Patients Treated (n)
Small Bowel Procedures	
Resection + Anastomosis	25 (39.1%)
Primary Repair	13 (20.3%)
Resection + Ileostomy	2 (3.1%)
Colon Procedures	
Primary Repair	8 (12.5%)
Resection + Anastomosis	5 (7.8%)
Resection + Colostomy	5 (7.8%)
Rectal Procedures	
Resection + Colostomy	3 (4.7%)
Primary Repair + Colostomy	1 (1.6%)
Abdominal Organs and Vascular Procedures	
Liver Laceration Repair and Hemorrhage Control	15 (23.4%)
Diaphragm Repair	13 (20.3%)
Major Vessel Repair*	6 (9.4%)
Splenectomy	4 (6.3%)
Primary Stomach Repair	8 (12.5%)
Duodenal Repair	2 (3.1%)
Pancreatic Repair	2 (3.1%)
Nephrectomy	5 (7.8%)
Negative Laparotomy	5 (7.8%)

*Includes repairs of major abdominal vessels such as the inferior vena cava, portal vein, and iliac vessels.

Table 4. Clinical comparison: hemodynamic responders vs. nonresponders

Variables	Nonresponder (n=11)	Responder (n=16)	P value
Age (years) (mean±SD)	35.9±10.9	31.6±6.9	0.232
MAP (mmHg) (mean±SD)	61.2±12.2	75.5±20.3	0.049
SBP (mmHg) (mean±SD)	79.9±11.2	95.2±19.9	0.030
Heart rate (bpm) (mean±SD)	124.5±18.9	101.6±15.7	0.002
Hgb (g/dL) median (IQR)	11.7 (4.4)	14.5 (2.5)	0.087
Hct (%) median (IQR)	34.9 (11)	43.5 (6.6)	0.056
WBC (10^3/µL), (mean±SD)	12±6.1	14.4±3.9	0.289
Blood product administration in ER (n, %)	7 (63.6%)	8 (50%)	0.696
CT performed (n, %)	7 (63.6%)	15 (93.7%)	0.125
Time to CT (min) (mean±SD)	27.4±13.1	30.2±11	0.606
TRISS (%), median (IQR)	73.8 (57.3)	97.7 (2.7)	<0.01
RTS, median (IQR)	6 (2.1)	7.8 (0.2)	<0.01
ISS (mean±SD)	33.1±13.9	20.7±9.1	<0.01
Surgery performed (n, %)	11 (100%)	15 (93.7%)	1
Intraoperative blood product administration (n, %)	10 (90.9%)	8 (50%)	0.042
Intraoperative blood loss (mL) (mean±SD)	2890±1082	1159±998	0.001
Time to OR (min) (mean±SD)	44.7±25.3	67.7±39.6	0.177
Surgery duration (min) median (IQR)	210 (181)	140 (35)	0.002
Extra-abdominal injury (n, %)	7 (63.6%)	11 (68.7%)	0.808
Length of hospital stay (days), median (IQR)	4.5 (8)	6 (6)	0.407
Perioperative mortality (n, %)	6 (54.5%)	0	

MAP: Mean arterial pressure; SBP: Systolic blood pressure; Hgb: Hemoglobin; Hct: Hematocrit; WBC: White blood cell count; CT: Computed tomography; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; ISS: Injury Severity Score; OR: Operating room; ER: Emergency room; bpm: Beats per minute.

The perioperative mortality rate was 9.3% (six patients), with all deaths occurring in the hemodynamically unstable nonresponder group. No mortality was observed among stable patients or unstable responders.

Subgroup Analysis: Responders vs. Nonresponders

Among the 27 hemodynamically unstable patients, 16 were classified as responders and 11 as nonresponders. Nonresponders demonstrated significantly worse hemodynamic parameters, including lower mean arterial pressure (61.2±12.2 vs. 75.5±20.3 mmHg; p=0.049) and higher heart rate (124.5±18.9 vs. 101.6±15.7 beats/min; p=0.002).

CT scans were performed in seven nonresponders (63.6%) and 15 responders (93.8%), with similar times to CT completion (27.4±13.1 vs. 30.2±11 minutes; p=0.606). All nonresponders and 15 of 16 responders underwent surgical intervention. The time to the operating room was shorter in nonresponders than in responders, although the difference was not statistically significant (44.7±25.3 vs. 67.7±39.6 minutes; p=0.177). The duration of surgery was significantly longer in nonresponders (median 210 vs. 140 minutes; p=0.002) (Table 4).

The mortality rate in the nonresponder group was 5/11 (45.5%), whereas no deaths occurred in the responder group (0/16). Comparison of trauma severity scores revealed significantly higher ISS values (median 48 vs. 25; p=0.03) and lower TRISS values (median 50.3% vs. 89.4%; p=0.03) in deceased nonresponders compared to survivors (Table 5).

Nonoperative Management

Ten patients (13.5%) were managed nonoperatively based on CT findings and clinical evaluation. Nine patients were hemodynamically stable at presentation, and one unstable patient stabilized after resuscitation. CT findings supporting nonoperative management included the following:

1. Back-region trajectories (flank or midline at the L1 vertebral level) (four patients) (Figs. 3, 4)

2. Suspected rectal proximity with normal rectosigmoidoscopy findings (three patients) (Fig. 5)

Table 5. Comparison of deceased and surviving nonresponder patients

Variable	Survived	Deceased	P value	95% CI	Effect Size (Cohen's d)	Post Hoc Power
Total number of patients (n)	5	6				
Age (years) (mean±SD)	41.6±11.6	31.1±8.5	0.121	-2.8 to 23.8	1.03	31%
TRISS (%), median (IQR)	89.4 (26.7)	50.3 (48.9)	0.03	8.2 to 69.9*	1.76	70%
ISS, median (IQR)	25 (16)	48 (21)	0.03	7.5 to 38.5*	1.65	65%
RTS, median (IQR)	7.1 (1.8)	5 (1.9)	0.247	-0.6 to 4.8*	1.12	36%
CT performed	3	4	1		-	-
Not performed	2	2				
Time to CT (min) (mean±SD)	23.6±10.9	30.2±15.5	0.562	-18.6 to 31.8	0.49	10%
Intraoperative blood loss (mL) (mean±SD)	2550±1236	3116±1018	0.450	-963 to 2095	0.51	11%
Surgery duration (min) (mean±SD)	195±102	253±114	0.477	-115 to 231	0.53	11%

TRISS: Trauma and Injury Severity Score; ISS: Injury Severity Score; RTS: Revised Trauma Score; CT: Computed tomography; IQR: Interquartile range; min: Minutes; ml: Milliliters. *Confidence intervals for median differences were estimated using the Hodges-Lehmann method. Statistical significance was defined as p<0.05. However, both statistically significant findings (TRISS and ISS) demonstrated observed power <80%, indicating a potential risk of Type II error. Therefore, these results should be considered preliminary and require validation in larger cohorts.

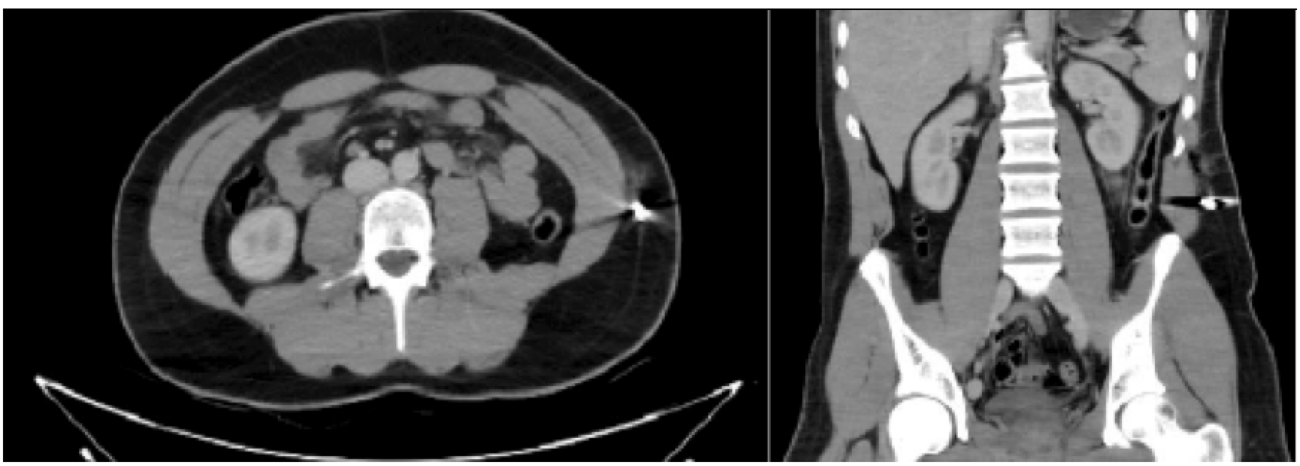

Figure 3. Computed tomography showing a bullet in the left flank without intra-abdominal injury.

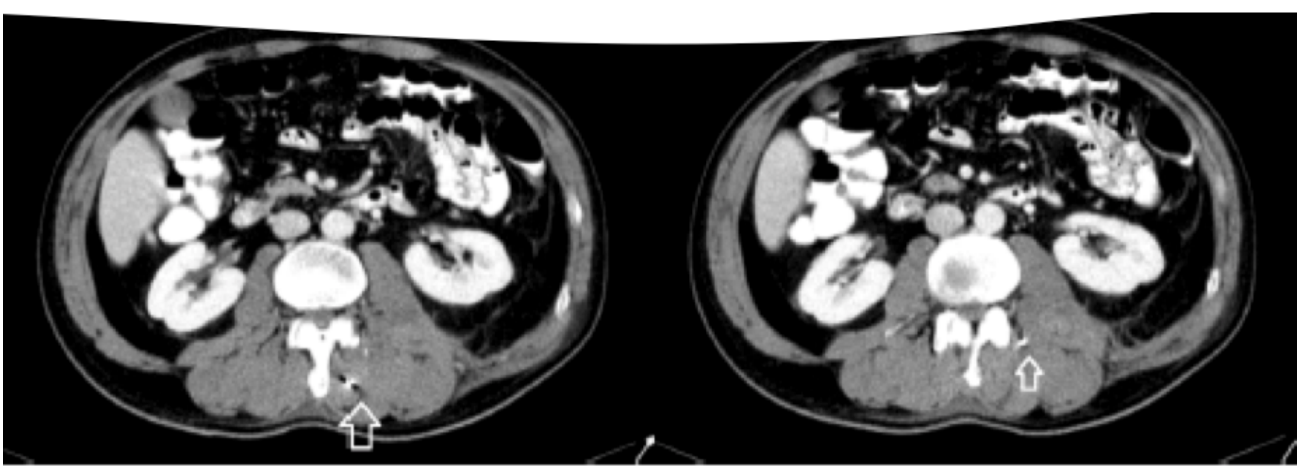

Figure 4. Midline bullet position at the level of the L1 vertebral spinous process.

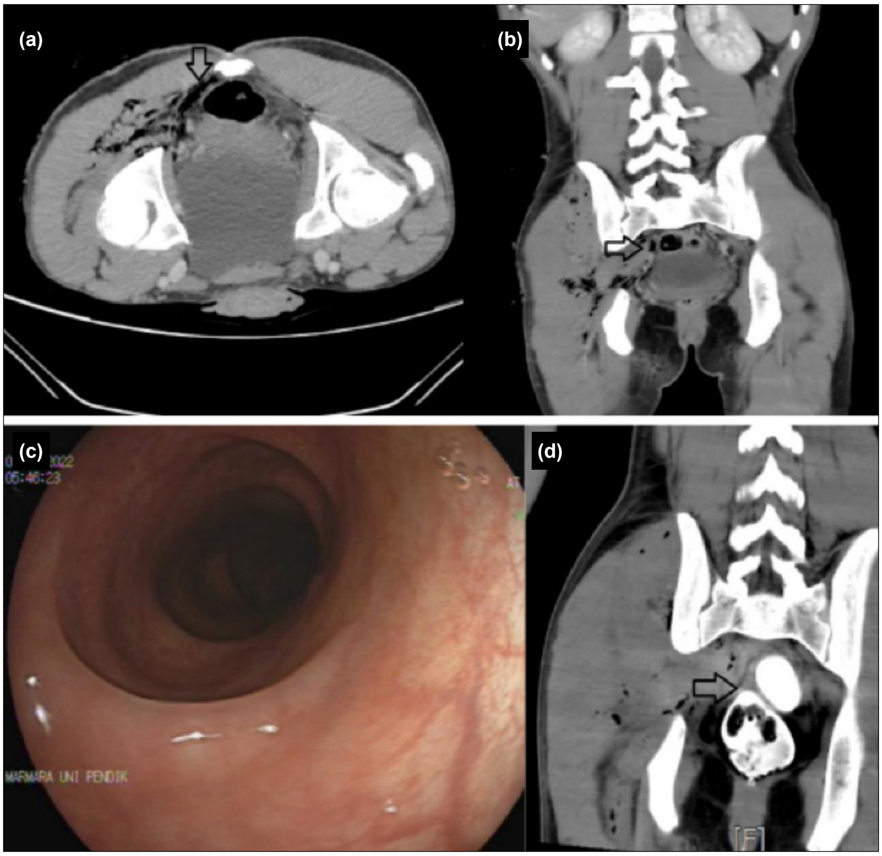

Figure 5. (a) Bullet trajectory and air bubbles in the right pararectal area. **(b)** Bullet trajectory extending from the right gluteal region to the pararectal area. **(c)** Same-day rectosigmoidoscopy showing intact mucosa. **(d)** Pre-discharge rectal contrast-enhanced computed tomography (CT) showing no contrast leakage.

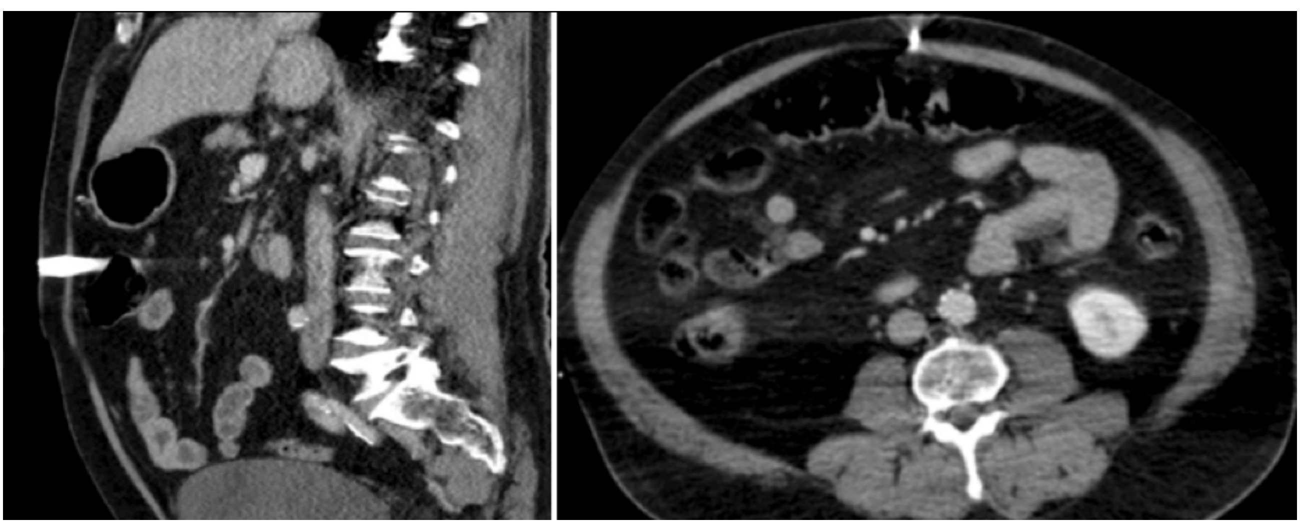

Figure 6. Anterior injury with a subcutaneous bullet trajectory and no peritoneal penetration.

3. Bullet trajectories limited to the subcutaneous tissues without peritoneal penetration (three patients) (Fig. 6).

All nonoperatively managed patients were discharged without complications after 24–48 hours of observation.

DISCUSSION

This study evaluated the impact of abdominal CT on surgical decision-making and time-related factors in patients with abdominal gunshot wounds. Our findings demonstrate that abdominal CT may be safely incorporated into the management algorithm without significantly delaying definitive treatment, even in carefully selected hemodynamically unstable patients who respond to initial resuscitation, particularly when the CT unit is located in close proximity to the trauma resuscitation area.

The efficacy of CT in reducing unnecessary laparotomies is well established in the trauma literature.[17,18] In our cohort, 13.5% (10/74) of patients were successfully managed nonoperatively, with no subsequent surgical intervention required. Among the 64 surgically managed patients, the negative laparotomy rate was 7.8% (n=5), which is higher than the 2.2% reported by Demetriades et al.[19] Our lower nonoperative management rate compared to their reported rate of 29.8% may be attributed to methodological differences: their prospective study applied a standardized protocol with strict criteria for selective nonoperative management, whereas our retrospective analysis relied largely on individual surgeon preference. In our practice, nonoperative management (NOM) was applied to hemodynamically stable patients or those responsive to resuscitation when CT demonstrated limited injury patterns, such as back-region trajectories (flank or midline vertebral level), suspected rectal proximity with normal rectosigmoidoscopy findings, or subcutaneous bullet tracts without peritoneal violation. Notably, in our series of five negative laparotomy cases, CT findings indicated suitability for NOM; however, clinical considerations, such as penetrating abdominal injury or suspected peritonitis, led surgeons to proceed with operative management. This finding suggests that implementation of a standardized NOM protocol could optimize surgical decision-making and reduce unnecessary laparotomies.

In our cohort, the median time from emergency department admission to CT completion was 28 minutes. Fung Kon Jin et al.[20] systematically analyzed time intervals associated with CT use in trauma patients and reported a median of 82 minutes to CT initiation and 105 minutes to CT completion in a high-volume Level I center, with timing influenced by workflow organization and injury severity. When the CT scanner was located within 50 meters of the trauma bay, Huber-Wagner et al.[21] reported a mean admission-to-CT time of 22.7±15.5 minutes. A 10-year analysis from an Australian Level I trauma center demonstrated door-to-CT times ranging from 6 to 299 minutes (mean: 92 minutes), with no significant change over time—underscoring substantial inter-center variability in this metric.[22] This variability is largely attributable to differences in institutional imaging algorithms, CT accessibility, and workflow organization. Notably, most existing literature examines blunt or multitrauma populations, with relatively few studies reporting door-to-CT times specifically for firearm-related injuries. Therefore, our 10-year data may provide a complementary perspective in the context of penetrating trauma.

The proximity of CT scanners to the trauma resuscitation area has a significant positive impact on survival probability in severely injured patients. In our institution, the CT scanner is located approximately 20 meters from the resuscitation room, which contributed to the relatively short imaging acquisition times observed in our study. In the literature, a large multicenter retrospective study by Huber-Wagner et al.[21] demonstrated that locating the CT scanner close to the trauma room improves survival, whereas distances greater than 50 meters negatively affect outcomes. These findings support the concept that the distance between the CT scanner and the resuscitation area directly influences imaging time and the risks associated with potential delays. Shorter distances may facilitate faster imaging and earlier diagnosis, potentially reducing unnecessary delays and associated complication risks.[23]

The use of CT in hemodynamically unstable patients remains a subject of debate in trauma management. Traditional practice advocates immediate surgical intervention in these patients; however, recent evidence has increasingly challenged this approach.[11,24] In our study, 22 of 27 carefully selected unstable patients who responded to initial resuscitation underwent CT imaging without adverse outcomes. This approach was particularly important for facilitating early collaboration with specialty teams, including cardiovascular surgery, thoracic surgery, hepatopancreatobiliary surgery, and urology. In cases where complex or multi-organ injuries were suspected, CT enabled timely notification of these teams, thereby promoting more coordinated and efficient care. Subgroup analysis revealed that CT imaging was associated with favorable outcomes in resuscitation responders with respect to surgical decision-making, whereas in nonresponders, mortality was primarily related to injury severity rather than CT utilization. This finding aligns with multicenter studies suggesting that CT can be safely performed in selected unstable patients who respond to initial resuscitation and may be associated with improved clinical outcomes.[10]

The time from emergency department arrival to operating room entry remains a critical metric in trauma care. Contemporary studies suggest that mortality increases significantly when definitive intervention is delayed beyond 90 minutes in hypotensive trauma patients.[25] Henderson et al.[26] demonstrated that time to emergency trauma laparotomy can serve as an effective audit measure for the clinical governance of a trauma system. In their study, they reported a median time of 127 minutes from the emergency call to operation and 54 minutes from emergency department arrival to operating room entry. In our study, the mean time to surgery was 73.4 minutes overall, 60.4 minutes for unstable patients, and 44.7 minutes for nonresponders, reflecting acceptable performance within currently recommended timeframes. The shorter time to surgery observed in nonresponders highlights appropriate prioritization within our trauma system.

The analysis of trauma scoring systems in our study demonstrated their value in risk stratification. Higher ISS values and lower TRISS values were strongly correlated with mortality, particularly in the nonresponder group. Although these results should be interpreted cautiously given the small subgroup size, the observed pattern suggests that mortality was more closely related to overall injury severity than to CT utilization. This trend highlights the prognostic value of trauma severity scores and underscores their importance in guiding imaging priorities and the timing of surgical intervention in trauma management. These findings are consistent with recent validation studies of trauma scoring systems.[16]

Limitations

Selection Bias: The retrospective design and the discretion of the initial emergency team and consulting surgeon regarding CT utilization introduce significant selection bias. Our findings apply only to carefully selected unstable patients and do not permit conclusions regarding the safety of CT in unselected hemodynamically unstable populations.

Limited Statistical Power: The small sample size, particularly in the nonresponder group (n=11) and in the mortality analysis (n=6 deaths), limits statistical power and increases the risk of Type II error, thereby precluding definitive conclusions regarding predictors of mortality.

Lack of a Standardized Protocol: The absence of a standardized nonoperative management protocol may have contributed to the relatively low NOM rate (13.5%), reflecting variations in institutional practice and individual surgeon judgment rather than strictly applied evidence-based criteria.

Institutional Infrastructure: The proximity of our CT scanner to the resuscitation room (approximately 20 meters) facilitated rapid imaging. This single-center infrastructure characteristic may limit generalizability to institutions where CT scanners are located farther from trauma bays.

Unassessed Factors: Radiation exposure and cost-effectiveness were not evaluated, limiting the comprehensiveness of our analysis.

CONCLUSION

Abdominal CT may provide valuable diagnostic information to support surgical decision-making in patients with abdominal gunshot wounds and, when applied within a well-coordinated trauma system, may not necessarily result in significant delays in definitive treatment. In selected cases of initially hemodynamically unstable patients who respond to resuscitation, CT imaging appears feasible and may potentially be performed safely without adversely affecting outcomes. Factors such as the proximity of CT scanners to resuscitation areas, continuous patient monitoring during imaging, and appropriate prioritization based on hemodynamic response may contribute to optimizing trauma care. Future prospective studies are warranted to develop standardized protocols for CT utilization in penetrating abdominal trauma, particularly with respect to selection criteria for imaging in unstable patients.

A portion of this study was presented at the 14th National Trauma and Emergency Surgery Congress (November 15-19, 2023, Antalya, Türkiye).

Ethics Committee Approval: This study was approved by the Marmara University Clinical Research Ethics Committee (Date: 06.01.2023, Decision No: 09.2023.40).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: M.İ.A.; Design: M.İ.A.; Supervision: C.Y., Ö.G.; Data collection and/or processing: M.İ.A.; Analysis and/or interpretation: A.S.B., M.E., T.K.U., M.İ.A.; Literature review: A.S.B., M.E., T.K.U., M.İ.A.; Writing: M.İ.A., C.Y.; Critical review: Ö.G., C.Y.

Conflict of Interest: None declared.

Use of AI for Writing Assistance: Artificial intelligence was used solely for grammar checking of the text and for creating a copyright-free image.

Financial Disclosure: The author declared that this study has received no financial support.

REFERENCES

1. Rhee P, Joseph B, Pandit V, Aziz H, Vercruysse G, Kulvatunyou N, Friese RS. Increasing trauma deaths in the United States. Ann Surg 2014;260:13–21. [CrossRef]
2. World Health Organization. Injuries and violence: the facts 2022. Geneva: World Health Organization; 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence. Accessed February 18, 2026.
3. Galvagno SM Jr, Nahmias JT, Young DA. Advanced Trauma Life Support® update 2019: management and applications for adults and special populations. Anesthesiol Clin 2019;37:13–32. [CrossRef]
4. Özpek A, Canbak T. Non-operative management of civilian abdominal gunshot wounds. Ulus Travma Acil Cerrahi Derg 2020;26:227–34. [CrossRef]
5. Como JJ, Bokhari F, Chiu WC, Duane TM, Holevar MR, Tandoh MA, et al. Practice management guidelines for selective nonoperative management of penetrating abdominal trauma. J Trauma 2010;68:721–33. [CrossRef]
6. Ramirez RM, Cureton EL, Ereso AQ, Kwan RO, Dozier KC, Sadjadi J, et al. Single-contrast computed tomography for the triage of patients with penetrating torso trauma. J Trauma 2009;67:583–8. [CrossRef]
7. Goodman CS, Hur JY, Adajar MA, Coulam CH. How well does CT predict the need for laparotomy in hemodynamically stable patients with penetrating abdominal injury? A review and meta-analysis. AJR Am J Roentgenol. 2009;193:432–7. [CrossRef]
8. Huber-Wagner S, Lefering R, Qvick LM, Körner M, Kay MV, Pfeifer KJ, et al; Working Group on Polytrauma of the German Trauma Society. Effect of whole-body CT during trauma resuscitation on survival: a retrospective, multicentre study. Lancet. 2009;373:1455–61[CrossRef]
9. Coccolini F, Coimbra R, Ordonez C, Kluger Y, Vega F, Moore EE, et al; WSES expert panel. Liver trauma: WSES 2020 guidelines. World J Emerg Surg. 2020;15:24. [CrossRef]
10. Huber-Wagner S, Biberthaler P, Häberle S, Wierer M, Dobritz M, Rummeny E, et al. Whole-body CT in haemodynamically unstable severely injured patients--a retrospective, multicentre study. PLoS One 2013;8:e68880. [CrossRef]
11. Ordoñez CA, Herrera-Escobar JP, Parra MW, Rodriguez-Ossa PA, Mejia DA, Sanchez AI, et al. Computed tomography in hemodynamically unstable severely injured blunt and penetrating trauma patients. J Trauma Acute Care Surg 2016;80:597–603. [CrossRef]

12. Navsaria PH, Nicol AJ, Edu S, Gandhi R, Ball CG. Selective nonoperative management in 1106 patients with abdominal gunshot wounds: conclusions on safety, efficacy, and the role of selective CT imaging in a prospective single-center study. Ann Surg 2015;261:760–4. [CrossRef]
13. Loftus TJ, Croft CA, Rosenthal MD, Mohr AM, Efron PA, Moore FA, et al. Clinical impact of a dedicated trauma hybrid operating room. J Am Coll Surg 2021;232:560–70. [CrossRef]
14. Rashid R, Sohrabi C, Kerwan A, Franchi T, Mathew G, Nicola M, et al. The STROCSS 2024 guideline: strengthening the reporting of cohort, cross-sectional, and case-control studies in surgery. Int J Surg 2024;110:3151–65. [CrossRef]
15. World Health Organization. International Statistical Classification of Diseases and Related Health Problems (ICD-10). 10th Revision. Geneva: WHO; 2019. Available at: https://www.who.int/standards/classifications/classification-of-diseases. Accessed February 18, 2026.
16. Domingues CA, Coimbra R, Poggetti RS, Nogueira LS, de Sousa RMC. New Trauma and Injury Severity Score (TRISS) adjustments for survival prediction. World J Emerg Surg 2018;13:12. [CrossRef]
17. Shanmuganathan K, Mirvis SE, Chiu WC, Killeen KL, Hogan GJ, Scalea TM. Penetrating torso trauma: triple-contrast helical CT in peritoneal violation and organ injury--a prospective study in 200 patients. Radiology 2004;231:775–84. [CrossRef]
18. Velmahos GC, Constantinou C, Tillou A, Brown CV, Salim A, Demetriades D. Abdominal computed tomographic scan for patients with gunshot wounds to the abdomen selected for nonoperative management. J Trauma 2005;59:1155–61. [CrossRef]
19. Demetriades D, Velmahos G, Cornwell E 3rd, Berne TV, Cober S, Bhasin PS, et al. Selective nonoperative management of gunshot wounds of the anterior abdomen. Arch Surg. 1997;132:178–83. [CrossRef]
20. Fung Kon Jin PH, van Geene AR, Linnau KF, Jurkovich GJ, Ponsen KJ, Goslings JC. Time factors associated with CT scan usage in trauma patients. Eur J Radiol 2009;72:134–8. [CrossRef]
21. Huber-Wagner S, Mand C, Ruchholtz S, Kühne CA, Holzapfel K, Kanz KG, et al; TraumaRegister DGU. Effect of the localisation of the CT scanner during trauma resuscitation on survival -- a retrospective, multicentre study. Injury 2014;45:S76–82. [CrossRef]
22. Yarad CA, Lewis D, Hardy BM, King KL, Fischer A, Balogh ZJ. Time to Computed Tomography for Major Trauma Patients: 10-Year Trends at a Level-1 Trauma Centre. ANZ J Surg 2025;95:1242–6. [CrossRef]
23. Furugori S, Kato M, Abe T, Iwashita M, Morimura N. Treating patients in a trauma room equipped with computed tomography and patients' mortality: a non-controlled comparison study. World J Emerg Surg 2018;13:16. [CrossRef]
24. Kinoshita T, Yamakawa K, Matsuda H, Yoshikawa Y, Wada D, Hamasaki T, et al. The Survival Benefit of a Novel Trauma Workflow that Includes Immediate Whole-body Computed Tomography, Surgery, and Interventional Radiology, All in One Trauma Resuscitation Room: A Retrospective Historical Control Study. Ann Surg 2019;269:370–6. [CrossRef]
25. Clarke JR, Trooskin SZ, Doshi PJ, Greenwald L, Mode CJ. Time to laparotomy for intra-abdominal bleeding from trauma does affect survival for delays up to 90 minutes. J Trauma 2002;52:420–5. [CrossRef]
26. Henderson KI, Coats TJ, Hassan TB, Brohi K. Audit of time to emergency trauma laparotomy. Br J Surg 2000;87:472–6. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Abdominal ateşli silah yaralanmaları: Cerrahi zamanlama ve karar verme sürecinde bilgisayarlı tomografinin rolünün değerlendirilmesi

AMAÇ: Abdominal ateşli silah yaralanmaları, travmaya bağlı morbidite ve mortalite oranlarında önemli bir paya sahiptir. Bilgisayarlı tomografi (BT), tanısal açıdan değerli bilgiler sağlayabilse de, definitif tedavinin gecikmesine neden olabileceği düşünülmektedir. Bu çalışmanın amacı, abdominal BT'nin cerrahi karar süreci ve zamanlama üzerindeki etkisini değerlendirmektir.

GEREÇ VE YÖNTEM: Ocak 2013 ile Ocak 2023 tarihleri arasında, üçüncü basamak bir üniversite hastanesinde abdominal ateşli silah yaralanması nedeniyle tedavi edilen hastalar retrospektif olarak analiz edildi. Toplanan veriler arasında demografik bilgiler, fizyolojik parametreler, travma skorları, BT bulguları, başvurudan BT ve cerrahiye kadar geçen süreler ile klinik sonuçlar yer aldı. Hastalar, başvuru anındaki hemodinamik durumları ve resüsitasyona verdikleri yanıta göre "stabil" ve "instabil" olarak sınıflandırılarak karşılaştırıldı.

BULGULAR: Toplam 74 hastanın %94.5'i erkekti ve medyan yaş 32 idi. Hastaların 47'si (%63.5) hemodinamik olarak stabil, 27'si (%36.5) instabildi. Abdominal BT 67 hastaya (%90.5) uygulandı ve BT'ye kadar geçen medyan süre 28 dakika olarak saptandı. Stabil (28 dakika) ve instabil (30 dakika) hastalar arasında BT süresi açısından anlamlı fark yoktu (p=0.934). BT bulguları doğrultusunda 10 hastada (%13.5) cerrahi dışı tedavi uygulanabildi. İnstabil grup içinde, 11 yanıtsız hastanın 7'sinde BT çekilmiş olup, bunların 6'sı (%54.5) eksitus olmuştur. Cerrahi uygulanan hastalarda, operasyona kadar geçen ortalama süre instabil hastalarda anlamlı ölçüde daha kısaydı (60.4±36.7 dk vs. 93.2±76.6 dk; p=0.034). Perioperatif mortalite oranı %9.3 idi ve tüm ölümler resüsitasyona yanıt vermeyen instabil hastalarda görüldü.

SONUÇ: Abdominal BT, resüsitasyona yanıt veren başlangıçta instabil hastalarda bile, kesin tedavide anlamlı bir gecikmeye yol açmadan cerrahi planlamaya yardımcı olabilir. BT bulguları, seçilmiş olgularda nonoperatif tedaviyi destekleyebilir ve cerrahi girişim gereken hastalarda hedefe yönelik cerrahi yaklaşımların planlanmasına yardımcı olabilir. Ancak bu bulgular dikkatle seçilmiş hastalara özgüdür ve dikkatli biçimde yorumlanmalıdır; çünkü bu çalışma, BT'nin seçilmemiş hemodinamik olarak instabil hastalarda güvenliğini ortaya koymamaktadır. BT cihazının resüsitasyon alanına yakın konumu hızlı görüntülemeyi kolaylaştırmış olup, bulgular BT'nin uzak konumlandığı kurumlara genellenemeyebilir.

Anahtar sözcükler: Abdominal ateşli silah yaralanmaları; bilgisayarlı tomografi (bt); cerrahi karar verme; travma yönetimi; hemodinamik instabilite; zaman faktörleri.

Ulus Travma Acil Cerrahi Derg 2026;32(3):259-269 DOI: 10.14744/tjtes.2025.31877