

ORIGINAL RESEARCH



Comparison of routine laparotomy results performed by solo surgeons with suspicious computed tomography and inflammatory markers in penetrating abdominal stab wounds in a suburban area: a retrospective cohort of 91 patients

Nuray Colapkulu-Akgul^{1,*}, Caner Akgul¹, Abdullah Gunes², Servan Yasar³

¹Department of General Surgery, Gebze Fatih State Hospital, 41400 Kocaeli, Turkey

²Department of General Surgery, Kocaeli City Hospital, University of Health Science, 41060 Kocaeli, Turkey

³Department of Radiology, Istanbul Sancaktepe Sehit Prof Dr Ilhan Varank Training and Research Hospital, 34785 Istanbul, Turkey

***Correspondence**

nuray.akgul@saglik.gov.tr
(Nuray Colapkulu-Akgul)

Abstract

Background: One of the most encountered challenges in trauma is predicting an intraabdominal hollow viscus injury or foreseeing a nontherapeutic laparotomy in patients with penetrating abdominal stab injuries. Suspicious computed tomography (CT) findings like free air and free fluid can leave surgeons in doubt about an injury's presence. This study aimed to compare the therapeutic and nontherapeutic laparotomy results in patients with penetrating abdominal stab wounds who had suspicious intraabdominal hollow viscus injury CT findings. **Methods:** Retrospective and single-center cohort of all patients with penetrating abdominal stab wounds between January 2012 and January 2023 in Gebze Fatih State Hospital were evaluated. All patients had CT evaluation and complete blood count (CBC) and then underwent laparotomy. The laparotomies were classified as therapeutic or nontherapeutic and the patients were grouped according to the results. We then analyzed the diagnostic value of CT and initial CBC on laparotomy. **Results:** A total of 91 patients with penetrating abdominal stab wound who underwent laparotomy were included in the study. Of the 91 patients, 56 (61.5%) had nontherapeutic laparotomies, and 35 (38.4%) had therapeutic laparotomies for hollow viscus injury. The CT findings of intraabdominal free air or fluid were present in all patients but were not significant predictors of hollow viscus injury (p value, 0.06, 0.09, respectively). The initial CBC values, neutrophil/lymphocyte ratio and platelets/lymphocyte ratio were also not significant predictors (p -value, 0.49, 0.37, respectively). **Conclusions:** In this retrospective study of abdominal penetrating stab wound management, we were not able to use the CT and CBC to distinguish the injuries that require therapeutic laparotomy for hollow viscus injury.

Keywords

Penetrating; Stab; Trauma; Computed tomography; Nontherapeutic laparotomy

1. Introduction

Predicting intraabdominal hollow viscus injury and determining the necessity of emergency laparotomy in hemodynamically stable patients with penetrating abdominal stab wounds is a significant challenge in trauma settings. Diffuse peritonitis and hemodynamic instability are still strong indicators for surgical exploration [1–5]. However, ambiguous imaging findings, physical examinations or suspicious initial laboratory results upon patient arrival often lead to controversy [6–11]. Despite the numerous diagnostic tools for predicting the presence of any intraabdominal hollow viscus injury requiring surgical intervention, there is no single method that can demonstrate the presence of an injury with adequate efficiency

[1, 6–8, 12–15].

Tracking a stab wound's path on computed tomography (CT) through the abdominal organs is difficult because of excessive tissue damage, unlike in gunshot injuries [16, 17]. The entry of a sharp object into the abdominal cavity can cause free air and free fluid. These conditions can mimic a gastrointestinal leakage [18]. According to a study conducted in a level 1 trauma center by Inaba *et al.* [16], the routine use of CT in penetrating abdominal stab wounds increases unnecessary radiation exposure and can safely be replaced with a thorough physical examination.

Therefore, this study aimed to compare the therapeutic and nontherapeutic laparotomy results in patients with penetrating abdominal stab wounds who had suspicious CT findings for

an intraabdominal hollow viscus injury. In this study, we hypothesized to answer the question of whether CT or initial laboratory findings can predict a therapeutic and nontherapeutic laparotomy.

2. Material and methods

2.1 Study design and setting

This retrospective single-center cohort study was conducted between January 2012 and January 2023 in Gebze Fatih State Hospital. Our institution is a secondary (according to Turkish Ministry of Health classification) state hospital with solo working surgeons and routine laparotomy (with or without CT) is the standard approach for managing penetrating abdominal stab wounds. The reason for routine laparotomy in our hospital is that sometimes one single surgeon has to cover subsequent days of a week by themselves (mostly on call at home) and this prevents the surgeon from following selective nonoperative management. State hospitals are not designed as trauma centers. Nevertheless, state hospitals in suburban areas receive the majority of trauma cases due to their close location to the scene.

2.2 Patient selection

The patients who were brought to the emergency department with penetrating abdominal stab wounds and underwent laparotomy were retrospectively evaluated for enrollment. This was conducted by searching the following the ICD-10 (International Statistical Classification of Diseases and Related Health Problems) codes:

- W26 (Contact with sharp objects).
- W44 (Foreign body entering into or through a natural orifice).
- W45 (Foreign body or object entering through skin).
- X78 (Intentional self-harm by sharp objects).
- Y28 (Contact with sharp object, undetermined intent).
- X99 (Assault by sharp object).

No age range was predetermined. The exclusion criteria were: (1) patients without a CT evaluation, (2) patients with solid organ injury requiring surgical intervention, and (3) patients who had hemodynamic instability before surgery. All abdominal regions (anterior, left thoracoabdominal, right thoracoabdominal, posterior) were included (Fig. 1).

2.3 Study groups and diagnostic evaluation

According to the laparotomy results, the patients were divided into two groups. The patients with the absence of a hollow viscus injury or injuries requiring no surgical intervention were classified as the nontherapeutic laparotomy group (nonTLG). The patients with any hollow viscus injury requiring surgical intervention or any other injury requiring surgical intervention was classified as the therapeutic laparotomy group (TLG). All included patients had had intravenous contrasted CT scan upon admission. An independent radiologist, blinded to the laparotomy results, conducted an evaluation of the scans. Intraabdominal free fluid and/or free air at the wound entrance without the presence of a suggestive hollow viscus injury (such

as bowel wall discontinuity, intestinal wall thickening, *etc.*) were considered suspicious findings. The data of the patients were retrieved from the hospital's electronic database. The initial laboratory values (complete blood count (CBC)) and CT findings of the groups were recorded.

2.4 Statistical analysis

Descriptive statistics were presented as numbers and percentages (n, %) for categorical variables. Normal distribution was assessed using histograms, Q-Q plots, and Shapiro-Wilk test. Categorical variables were compared using the Pearson, chi-square test or Fisher's exact test. According to normality, the Student's *t*-test or Mann-Whitney U test was used to compare continuous variables between nonTLG and TLG. We used receiver operating characteristics (ROC) curve analysis to determine the threshold values of the continuous-scale laboratory tests predicting hollow viscus in laparotomy. The R version 4.0.2 (<https://www.r-project.org>) was used in statistical analysis and visualizations. Double-sided *p*-values of less than 0.05 were considered significant.

3. Results

Out of 91 patients with penetrating abdominal stab wounds who underwent laparotomy, 56 (61.5%) had a non-therapeutic laparotomy while 35 (38.4%) had a therapeutic one. Among all patients, 84 (92.3%) were male and the mean age was 31.9 years (range 15 to 76), and the majority (71/91, 78%) had anterior abdominal wall injuries (Table 1).

TABLE 1. Demographic characteristic and injury sites of the patients.

	All patients n = 91
Age	31 (15–76)
Sex	
Male	84 (92.3%)
Female	7 (7.7%)
Localization of injury:	
Anterior	71 (78.0%)
Right thoracoabdominal	9 (9.9%)
Left thoracoabdominal	8 (8.8%)
Posterior	3 (3.3%)
Length of hospital stay (d, median)	4.00 (2.00–15.0)

No significant difference was observed between groups according to suspicious CT findings. The presence of intraabdominal free fluid or air at injury site showed no significance for predicting hollow viscus injury ($p = 0.097$ and $p = 0.068$ respectively) (Table 2). The initial CBC values, neutrophil/lymphocyte ratio (NLR) and platelets/lymphocyte ratio (PLR) upon admission to the emergency department also showed no statistical significance between the nonTLG and TLG (Table 2). The sensitivity of leukocyte count, NLR and PLR for predicting hollow viscus injury and laparotomy necessity was not also statistically significant (AUC (area

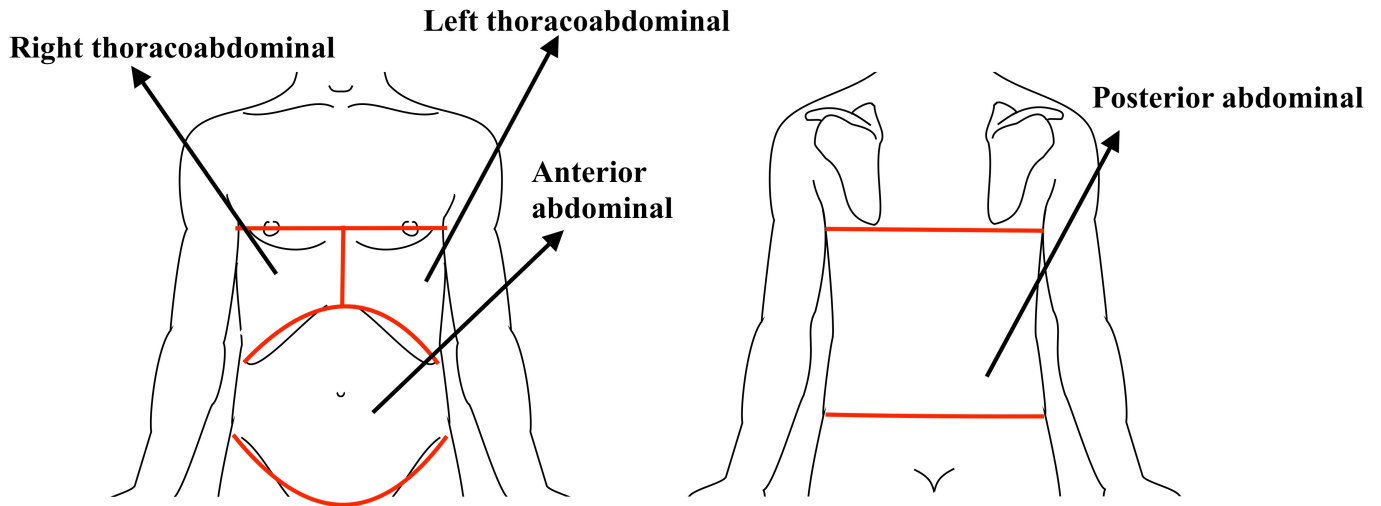


FIGURE 1. Anatomic regions of injuries.

TABLE 2. Comparison of initial complete blood count values and computed tomography findings between groups.

	nonTLG n = 56	TLG n = 35	p value
Intraabdominal free fluid	40 (71.4%)	31 (88.6%)	0.097
Intraabdominal free air	25 (44.6%)	28 (80.0%)	0.068
Leukocyte	11.9 (5.75–27.6)	12.0 (6.25–29.7)	0.695
Neutrophil	6.61 (2.81–23.2)	8.10 (2.70–23.9)	0.546
Lymphocyte	3.13 (0.88–10.2)	3.28 (0.72–6.36)	0.498
Monocyte	0.70 (0.16–1.53)	0.72 (0.13–1.47)	0.671
Eosinophil	0.16 (0.00–1.54)	0.13 (0.00–1.26)	0.562
Basophil	0.05 (0.00–0.28)	0.07 (0.00–0.24)	0.150
Platelet	254 (83.1–410)	264 (76.0–737)	0.316
Neutrophil/Lymphocyte ratio	1.96 (0.71–16.1)	2.02 (0.62–18.1)	0.498
Platelet/Lymphocyte ratio	83.6 (13.3–276)	80.2 (25.6–309)	0.370
Length of hospital stay	3.00 (2.00–15.0)	7.00 (4.00–15.0)	<0.001

nonTLG, nontherapeutic laparotomy group.

under the curve): 0.53 (95% CI (Confidence interval): 0.40–0.65), 0.54 (95% CI: 0.41–0.67), 0.44 (95% CI: 0.31–0.58), respectively) (Fig. 2).

Thirteen (14.2%) patients experienced postoperative complications. Three patients with evisceration or eventration required surgical intervention (Table 3). The median length of hospital stay was significantly higher in the TLG than in the nonTLG (7 days vs. 3 days respectively, $p < 0.001$) (Table 2). There was no patient mortality.

4. Discussion

Due to high nontherapeutic laparotomy rates, selective non-operative management for penetrating abdominal stab wounds has been suggested and supported by scientific guidelines [1, 2, 19–21]. According to data from high-volume trauma centers, selective nonoperative management is the primary treatment option for stable patients. Nontherapeutic laparotomy rates have been associated with the experience of trauma teams, as well as the trauma volume of the center [22]. According to

TABLE 3. Postoperative complications.

Complications	nonTLG n = 56	TLG n = 35
Surgical site infection	2 (3.5%)	3 (8.5%)
Evisceration/Eventration	2 (3.5%)	1 (2.8%)
Atelectasis	1 (1.7%)	2 (5.7%)
Ileus	1 (1.7%)	1 (2.8%)
Total	6 (10.7%)	7 (20.0%)

nonTLG, nontherapeutic laparotomy group.

the previous reports, nontherapeutic laparotomy rates can be as low as 3% in high volume trauma centers with experienced trauma teams; however, rates can go up to 77% when patients are operated only based on peritoneal penetration [3, 19, 23]. Accepting the presence of peritoneal penetration as the only indication for surgical exploration might lead to high non-therapeutic laparotomy rates for centers lacking infrastructure

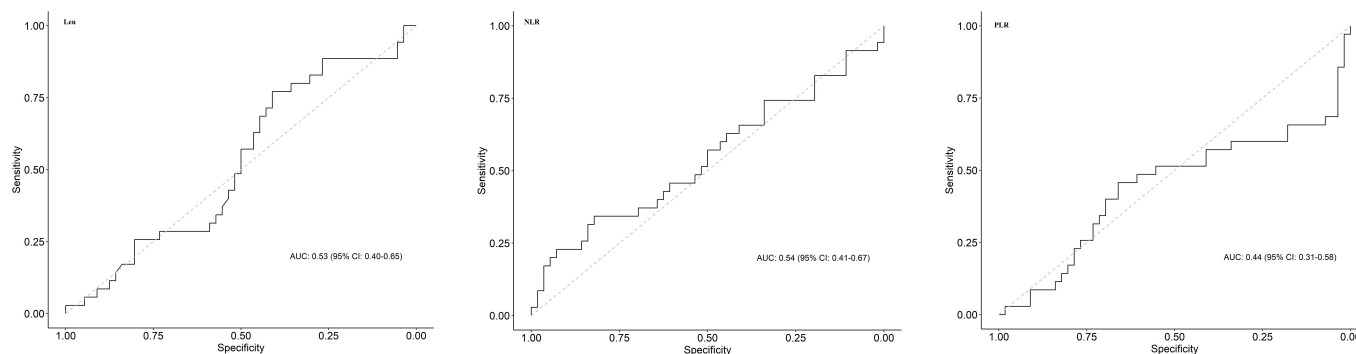


FIGURE 2. ROC curve for initial values of leukocyte, NLR and PLR values upon patient arrival in predicting intraabdominal hollow viscus injury (AUC (area under the curve): 0.53 (95% CI: 0.40–0.65), 0.54 (95% CI: 0.41–0.67), 0.44 (95% CI: 0.31–0.58), respectively). AUC, area under the curve; Leu, leukocyte; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; CI, Confidence interval.

and experienced trauma teams. Furthermore, the search for a diagnostic method still holds a crucial importance. Our hospital, which was not designed as a trauma center, has outnumbered surgeons who sometimes cover all emergency consultations for a whole week by themselves; as a result, laparotomy is the standard approach for managing penetrating abdominal stab wounds. In this study, 61.5% of the patients underwent nontherapeutic laparotomy and 6.5% experienced unnecessary postoperative complications.

The management of penetrating abdominal stab wounds in patients who are hemodynamically stable or without peritonitis is controversial among different centers. The high rates of nontherapeutic laparotomy in such injuries have put surgeons in a dilemma about mandatory laparotomy indications [5, 19, 20]. Although a number of imaging and laboratory test methods are being used to prove the presence of an abdominal hollow organ injury, there is no single test today whose sensitivity and specificity alone are sufficient to be a diagnostic tool.

Close hemodynamic monitoring and serial physical examinations without a CT scan can prevent nontherapeutic laparotomies. According to two previous studies, physical examination alone is enough to predict hollow viscus injury or select patients for nonoperative follow-up in hemodynamically stable patients with penetrating abdominal stab wounds without increasing morbidity and mortality rates [20, 24]. van Haarst *et al.* [13] reported the successful outcomes of 202 patients with penetrating abdominal stab wounds who were managed nonoperatively without an initial CT evaluation but were examined by a trauma team (senior surgeon) for 24–48 hours. One of the most challenging factors in our center is the lack of trauma care providers who are present 7/24 and work as a team to be able to reduce nontherapeutic laparotomy rates. Therefore, surgical exploration becomes a mandatory approach for non-trauma centers for faster management.

Although CT has a high sensitivity and specificity for determining the necessity of laparotomy in penetrating abdominal traumas, the value of CT remains unclear due to its high false positive rates when it comes to predicting penetrating stab wounds [3, 11, 15]. In the literature, the use of gastrointestinal contrast administration in addition to intravenous contrast for hemodynamically stable patients for penetrating stab injuries

is controversial and varies between trauma centers. According to the study by Saksobhavit *et al.* [14], triple-contrast (oral, rectal, intravenous) is the most specific test that shows hollow viscus injury for abdominal penetrating injuries. There are also studies that reported no increased diagnostic value of additional gastrointestinal contrast for predicting hollow viscus injury [9, 10]. However, these results were associated with unstandardized contrast administration protocols and heterogeneous patient groups. In our study, all patients had suspicious CT findings such as intraabdominal free fluid or air that can be interpreted as hollow viscus injury. Kong *et al.* [8] reported that pneumoperitoneum on CT scan might indicate a breach of hollow viscus wall, but pneumoperitoneum alone on CT scan without the sign of peritonitis cannot be considered as an absolute indicator for emergency laparotomy.

The CBC is almost always the first test that is performed for the patients who are admitted to emergency departments. Subgroups of CBC are valuable for the clinicians to understand the presence of an acute inflammatory response, severe sepsis or early detection of a severe blood loss as new biomarkers, the NLR and PLR, are the mostly investigated parameters for patients who had trauma [25]. According to El-Menyar *et al.* [7], patients with abdominal trauma who had low PLR were associated with more severe injuries and high complications risks, including mortality. A study by Yucel *et al.* [24] investigated the CBC subgroups, and the NLR and PLR were measured and compared between patients with penetrating abdominal injury who underwent laparotomy and who were managed nonoperatively. They reported that the follow-up values of NLR and PLR that were higher than the cut-off values are good predictor for laparotomy. In the same study initial leukocyte and neutrophil count upon arrival were significantly higher in patients who underwent laparotomy [6]. In our study, initial values of the CBC subgroups, leukocyte, NLR or PLR of the patient upon arrival was not sufficient to predict the need for laparotomy.

In the present study, while no mortality was experienced in the non-TLG, 6 (10%) patients in the non-TLG had complications. However, the length of hospital stay was significantly shorter in the non-TLG group. We think that nontherapeutic laparotomies for penetrating stab wounds carry a significant

morbidity rate.

This study has several limitations. First, the study population was small to provide powerful statistical results. Second, due to its retrospective design, there are some missing data. Initial physical examination findings were absent in majority of the patients and these data were excluded. Local wound exploration notes were also missing from files of the patients. Additionally, reliance on data accessibility makes the retrieval process vulnerable for the selection bias. Data that were verified manually by the authors may cause selection bias.

5. Conclusions

In conclusion, according to our results in patients with penetrating abdominal stab wounds, the ability to predict a hollow viscus injury or a therapeutic laparotomy with initial CBC values or suspicious CT findings is unlikely.

AVAILABILITY OF DATA AND MATERIALS

Please contact the corresponding author.

AUTHOR CONTRIBUTIONS

NCA and CA—study conception and design; analysis and interpretation of the data. NCA, CA and SY—acquisition of the data. NCA—drafting of the manuscript. NCA, CA, SY and AG—critical revision.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by Kocaeli Derince Training and Research Hospital Ethic Committee (Ethics approval number: 2022-134). This is a retrospective non-interventional study. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Data collection and analysis are in accordance with the Declaration of Helsinki and approved by the local Ethics Committee. Consent to participate was waived by the Kocaeli Derince Training and Research Hospital Ethic Committee.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors have no commercial associations or sources of support that might pose a conflict of interest.

REFERENCES

- [1] Martin MJ, Brown CVR, Shatz DV, Alam HB, Brasel KJ, Hauser CJ, *et al.* Evaluation and management of abdominal stab wounds: a western trauma association critical decisions algorithm. *The Journal of Trauma and Acute Care Surgery.* 2018; 85: 1007–1015.
- [2] Saar S, Jorgensen J, Lemma AN, Gaarder C, Naess PA, Leppäniemi A, *et al.* Selective non-operative management of penetrating abdominal injuries at Northern European trauma centers: the NordiPen study. *European Journal of Trauma and Emergency Surgery.* 2022; 48: 2023–2027.
- [3] 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. *The Journal of Trauma.* 2010; 68: 721–733.
- [4] Obadiel YA, Albrashi A, Allahabi N, Sharafaddeen M, Ahmed F. Outcomes of nonoperative management of penetrating abdominal trauma injury: a retrospective study. *Cureus.* 2024; 16: e58599.
- [5] Akgul NC, Erbil OA, Celik Y. Penetrating abdominal stab and gunshot injuries: 10-year experience of a secondary public hospital located in a suburban area with solo surgeons. *Northern Clinics of Istanbul.* 2024; 11: 184–190.
- [6] Yucel M, Yildiz A, Basak F. The role of leukocytes in predicting whether laparotomy is required in patients with penetrating abdominal stab wound. *Surgery.* 2022; 171: 549–554.
- [7] El-Menyar A, Mekkodathil A, Al-Ansari A, Asim M, Elmenyar E, Rizoli S, *et al.* Platelet-lymphocyte and neutrophil-lymphocyte ratio for prediction of hospital outcomes in patients with abdominal trauma. *BioMed Research International.* 2022; 2022: 5374419.
- [8] Kong V, Cheung C, Elsabagh A, Rajaretnam N, Varghese C, Bruce J, *et al.* Radiographic pneumoperitoneum following abdominal stab wound is not an absolute indication for mandatory laparotomy—a South African experience. *Injury.* 2021; 52: 253–255.
- [9] Thorisdottir S, Oladottir GL, Nummela MT, Koskinen SK. Diagnostic performance of CT and the use of GI contrast material for detection of hollow viscus injury after penetrating abdominal trauma. Experience from a level I Nordic trauma center. *Acta Radiologica.* 2020; 61: 1309–1315.
- [10] Jawad H, Raptis C, Mintz A, Schuerer D, Mellnick V. Single-contrast CT for detecting bowel injuries in penetrating abdominopelvic trauma. *American Journal of Roentgenology.* 2018; 210: 761–765.
- [11] Uzunosmanoğlu H, Çorbacioğlu ŞK, Çevik Y, Akıncı E, Hacifazlıoğlu Ç, Yavuz A, *et al.* What is the diagnostic value of computed tomography tractography in patients with abdominal stab wounds? *European Journal of Trauma and Emergency Surgery.* 2017; 43: 273–277.
- [12] Butt MU, Zacharias N, Velmahos GC. Penetrating abdominal injuries: management controversies. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.* 2009; 17: 19.
- [13] van Haarst EP, van Bezooijen BP, Coene PP, Luitse JS. The efficacy of serial physical examination in penetrating abdominal trauma. *Injury.* 1999; 30: 599–604.
- [14] Saksobhavit N, Shanmuganathan K, Boscak AR, Sliker CW, Stein DM, Bodanapally UK, *et al.* Diagnostic accuracy of triple-contrast multi-detector computed tomography for detection of penetrating gastrointestinal injury: a prospective study. *European Radiology.* 2016; 26: 4107–4120.
- [15] Malkomes P, Störmann P, El Youzouri H, Wutzler S, Marzi I, Vogl T, *et al.* Characteristics and management of penetrating abdominal injuries in a German level I trauma center. *European Journal of Trauma and Emergency Surgery.* 2019; 45: 315–321.
- [16] Inaba K, Okoye OT, Rosenheck R, Melo N, Branco BC, Talving P, *et al.* Prospective evaluation of the role of computed tomography in the assessment of abdominal stab wounds. *JAMA Surgery.* 2013; 148: 810–816.
- [17] Berardoni NE, Kopelman TR, O'Neill PJ, August DL, Vail SJ, Pieri PG, *et al.* Use of computed tomography in the initial evaluation of anterior abdominal stab wounds. *American Journal of Surgery.* 2011; 202: 690–695; discussion 695–696.
- [18] Choi EJ, Choi S, Kang BH. Indications for laparotomy in patients with abdominal penetrating injuries presenting with ambiguous computed tomography findings. *Journal of Trauma and Injury.* 2021; 34: 112–118.

- [19] SchnÜRiger B, Lam L, Inaba K, Kobayashi L, Barbarino R, Demetriades D. Negative laparotomy in trauma: are we getting better? *The American Surgeon*. 2012; 78: 1219–1223.
- [20] Ertekin C, Yanar H, Taviloglu K, Güloglu R, Alimoglu O. Unnecessary laparotomy by using physical examination and different diagnostic modalities for penetrating abdominal stab wounds. *Emergency Medicine Journal*. 2005; 22: 790–794.
- [21] Bentin JM, Possfelt-Møller E, Svenningsen P, Rudolph SS, Sillesen M. A characterization of trauma laparotomies in a Scandinavian setting: an observational study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*. 2022; 30: 43.
- [22] Tang A, Chehab M, Ditillo M, Asmar S, Khurram M, Douglas M, *et al*. Regionalization of trauma care by operative experience: does the volume of emergent laparotomy matter? *The Journal of Trauma and Acute Care Surgery*. 2021; 90: 11–20.
- [23] Hietbrink F, Smeeing D, Karhof S, Jonkers HF, Houwert M, van Wessem K, *et al*. Outcome of trauma-related emergency laparotomies, in an era of far-reaching specialization. *World Journal of Emergency Surgery*. 2019; 14: 40.
- [24] Yucel M, Bas G, Ozpek A, Basak F, Sisik A, Acar A, *et al*. The predictive value of physical examination in the decision of laparotomy in penetrating anterior abdominal stab injury. *International Journal of Clinical and Experimental Medicine*. 2015; 8: 11085–11092.
- [25] Demirpolat MT, İslam MM. The role of neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and systemic immune inflammation index in predicting the necessity for surgery and therapeutic surgery in patients with anterior abdominal stab wounds. *World Journal of Surgery*. 2024; 48: 1315–1322.

How to cite this article: Nuray Colapkulu-Akgul, Caner Akgul, Abdullah Gunes, Servan Yasar. Comparison of routine laparotomy results performed by solo surgeons with suspicious computed tomography and inflammatory markers in penetrating abdominal stab wounds in a suburban area: a retrospective cohort of 91 patients. *Signa Vitae*. 2025; 21(5): 49-54. doi: 10.22514/sv.2025.065.