

# Penetrating abdominal stab and gunshot injuries: 10-year experience of a secondary public hospital located in a suburban area with solo surgeons

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## ABSTRACT

**OBJECTIVE:** Trauma care systems are life-saving significant implementations of a country's healthcare systems. Trauma care requires well-established trauma settings and organizations with experienced trauma teams including experienced emergency medicine, surgery and anesthesiology staff. This study aimed to investigate the outcomes of penetrating abdominal injuries treated by solo surgeons in a suburban area.

**METHODS:** Medical records of the patients who were admitted to the emergency department with penetrating abdominal injuries between January 2012 and December 2021 were retrospectively analyzed. Patients were evaluated based on their injury sites and treatment approaches.

**RESULTS:** In total, 110 patients with anterior abdominal penetrating injuries were enrolled in the study; 83 (75.4%) were stabbed and 27 (24.6%) had gunshot wounds. According to the injury site, there were 90 (81.8%) anterior; 11 (11%) right thoracoabdominal and 9 (7.2%) left thoracoabdominal injuries. Fifty-one (61.4%) stab wounds were treated with immediate laparotomy and 21 (41.1%) of these operations resulted in negative or nontherapeutic laparotomy. Also, 32 (38.6%) stab wounds were managed nonoperatively; three (9.3%) failed conservative management and received delayed laparotomy. All gunshot wounds were treated with immediate laparotomy and 14.8% resulted in either negative or nontherapeutic laparotomy. On-call surgeons were found to be more prone to perform immediate laparotomy on weekends when they were on call for 48 or 72 hours.

**CONCLUSION:** Being a solo surgeon may increase negative laparotomy rates of penetrating abdominal injuries. This high percentage (41.1%) of negative laparotomy rates can be reduced by establishing well-organized trauma teams.

*Keywords:* Negative laparotomy; nonoperative management; penetrating trauma; surgeon; trauma center.

**Cite this article as:** Colapkulu Akgul N, 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. *North Clin Istanbul* 2024;11(3):184–190.

Trauma is a global health problem and consists of a majority of the global surgical burden, especially in regions with poorer infrastructures worldwide [1]. Trauma care systems are life-saving significant implementations of a country's healthcare systems [2, 3]. Trauma care requires well-established trauma settings and orga-

nizations with experienced trauma teams including experienced emergency medicine, surgery and anesthesiology staff. In Turkiye, the presence of structurally developed hospital buildings and settings is widespread, nevertheless, most of the suburban and rural hospitals lack prompt trauma teams and have outnumbered surgeons [4, 5].



Received: May 12, 2023

Revised: June 14, 2023

Accepted: August 05, 2023

Online: June 11, 2024

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Diagnosis and treatment algorithms for penetrating anterior abdominal injuries have evolved in the past century on a wide scale ranging from routine emergency laparotomy to conservative follow-up with the development of experienced trauma teams. After the First World War, surgeons started questioning routine laparotomy algorithms for penetrating abdominal injuries because of the high negative laparotomy rates. Surgeons experienced the difference between gunshot and stab injuries since stab injuries are more common among civilians [6, 7]. Therefore, the question “Who to operate and when?” has arisen.

Laparotomy is still the gold standard for penetrating abdominal injuries when patients are hemodynamically unstable and with impaired mental status. However, since the 60s selective nonoperative treatment with appropriate physical examination findings started to gain interest among surgeons in penetrating abdominal injuries where an experienced trauma team is available [8–21].

This study aims to reveal the management approach for penetrating abdominal injuries in our institution, interpret our results by reviewing the current literature, and additionally evaluate the outcomes of those patients handled by solo surgeons.

## MATERIALS AND METHODS

This study has a retrospective design and was conducted by the rules of the Declaration of Helsinki, in the General Surgery Department of Kocaeli Gebze Fatih State Hospital (with an approval number 2022-134 received from Kocaeli Derince Training and Research Hospital Ethics Committee on 22.12.2022). And patients with penetrating abdominal SW and GSW between January 2012 and December 2021 were evaluated retrospectively.

Our hospital is classified as a secondary hospital according to the Turkish healthcare system. Secondary hospitals in Turkiye provide general health care services without the presence of a clinical staff who works as a team and doesn't provide medical education or training. Depending on the population that the hospital covers, number of the surgeons is designated by the Ministry of Health. In our institution during a ten-year period, 1–5 surgeons worked at the same time and shared night shifts. When the surgeons were outnumbered, they had to cover the whole weekend for 72 hours by themselves (from Friday to Monday). During these 72 hours, the on-call surgeon stays at home and only attends when it is required.

### Highlight key points

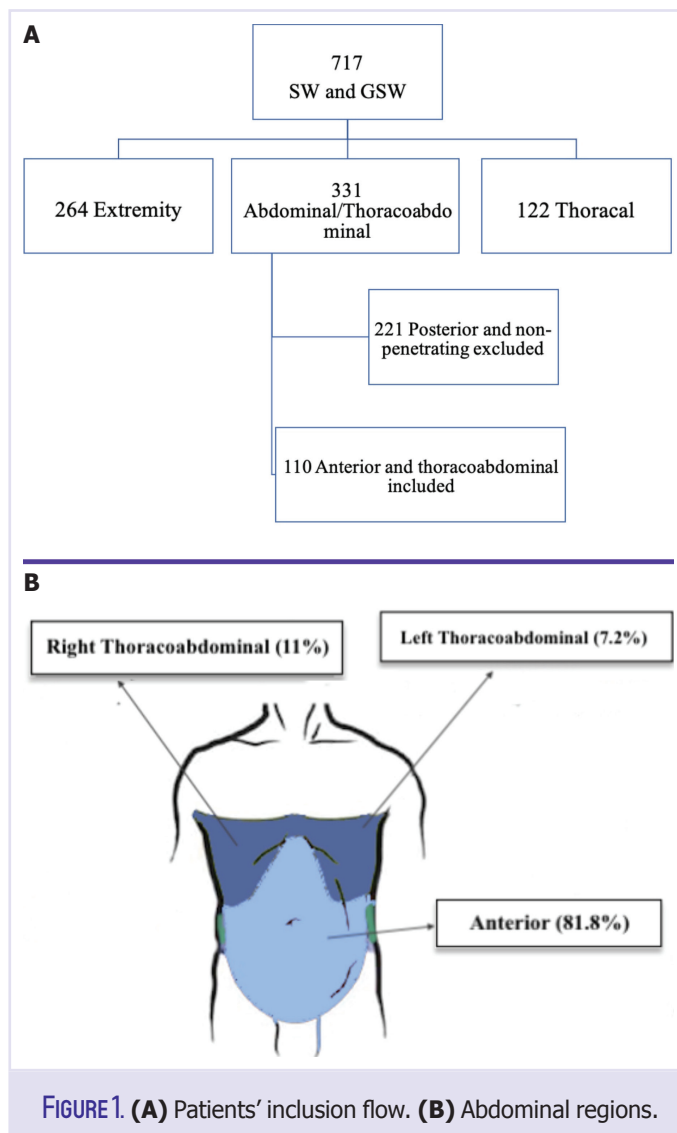
- Routine immediate laparotomy for penetrating abdominal wounds increases negative laparotomy rates.
- Being solo surgeon without a support of a trauma team creates a tendency to perform routine laparotomy for penetrating abdominal wounds.
- Infrastructures of a hospital that accepts high volume major traumas are the key pillars to facilitate health services.

The medical record database of the institution was searched via predetermined ICD-10 codes. Patients who had a diagnostic code with “W25-26 (Contact with sharp objects); W34 (Accidental discharge and malfunction from other and unspecified firearms and guns); X73-74, Y24-25-34-35 (Intentional/Legal self-harm/intervention by other and unspecified firearm and gun discharge)” were enrolled and only anterior penetrating abdominal injuries were included in the study.

The region between anteroinferior margins of arcus costarum, pubic symphysis and midaxillary lines was defined as the anterior abdomen. And, the region between midaxillary lines, anteroinferior margins of arcus costarum and 4<sup>th</sup> intercostal spaces was defined as left or right thoracoabdominal region (Fig. 1). If any intra-abdominal viscus or solid organ injury requiring repair was considered as therapeutic laparotomy; if the injury did not require any intervention, it was considered as non-therapeutic laparotomy; and presence of no injury was defined as negative laparotomy. Additionally, the presence of intraperitoneal free fluid or air was considered positive computed tomography (CT) findings (All CTs are referred to as intravenous contrasted tomography in the study). All clinical data were collected from patient documents, radiologic images and operation notes.

## RESULTS

A total of 717 SW and GSW were collected from the database. There were 331 (46.1%) abdominal/thoracoabdominal; 264 (36.8%) extremity and 122 (17.1%) thoracic penetrating injuries. After reviewing files and radiologic scans of the 331 patients, 221 (30.8%) posterior and non-penetrating injuries were excluded; and finally, 110 (15.3%) patients with an anterior abdominal injury that penetrates the peritoneum were included in the study. There were 100 (90.9%) male and 10 (9.1%) female, and their mean age was 33.68 (range 15–76) years. Of the 110 penetrating abdominal injuries, 83



(75.4%) were SWs and 27 (24.6%) were GSWs. By regions, there were 90 (81.8%) anterior; 11 (11%) right thoracoabdominal and 9 (7.2%) left thoracoabdominal injuries (Fig. 1).

All SW results according to injury sites and management are shown in Figure 2. Of the 83 SWs, 53 (63.8%) were evaluated with CT before decision-making. Forty-one (77.3%) patients had positive CT findings and 16 (39%) of these patients underwent immediate laparotomy. Seven (43.7%) patients resulted in either nontherapeutic or negative laparotomy. Twenty-five (60.9%) patients who had positive CT findings followed up nonoperatively and two (8%) patients developed peritonitis within 24 hours. One of them was due to intestinal perforation in anterior injury that was treated with laparotomy and primary closure, and the

other one was due to intrahepatic biliary tract injury in right thoracoabdominal injury that was referred to tertiary center and treated successfully with open drainage and endoscopic sphincterotomy. Of 53 SW with CT evaluation, 12 (22.7%) had negative CT findings; of these patients, 5 (41.6%) underwent immediate laparotomy and all patients resulted with either non-therapeutic or negative laparotomy. Seven (58.4%) patients with negative CT findings followed up nonoperatively and one anterior injury (14.2%) failed follow-up due to intestinal perforation and underwent laparotomy for primary closure. Of 83 SWs, 30 (36.2%) had immediate laparotomy without CT evaluation. Nine (30%), had either non-therapeutic or negative laparotomy. In all SW, non-therapeutic laparotomies were performed due to minor liver laceration in three patients with right thoracoabdominal injury; and omentum evisceration in two patients with anterior injury.

All GSW results are shown in Figure 3. All 27 GSWs were treated with immediate laparotomy. Two (7.4%) negative laparotomies with anterior injury were due to two tangential injury patterns. Two (7.4%) non-therapeutic laparotomies with right thoracoabdominal injuries were due to liver lacerations that did not require additional intervention.

Of negative and non-therapeutic laparotomies for SW who underwent immediate laparotomy, 14 (70%) were performed during weekend (from Friday to Monday) when one single surgeon covered the whole 48–72 hours. Mean length of hospital stay was 5.6 days (range 3–15) including all patients; and was 7.9 days when non-operative patients were excluded.

## DISCUSSION

In this study, we provide information on injury patterns, treatment approaches and outcomes of SW and GSW in a suburban setting. The main purpose of this study is to review the treatment algorithms and improve the management of abdominal penetrating injuries within limited circumstances. Our hospital is located in the center of an organized industrial zone with a population of more than half a million, located outside a metropolitan city. Penetrating and blunt traumas are frequently treated in our hospital, which we can define as a suburban environment in terms of socio-cultural level, where the low and middle-income populations live in general. Sometimes on a busy shift, we, as surgeons, are obligated to manage several trauma cases at the same time by ourselves.

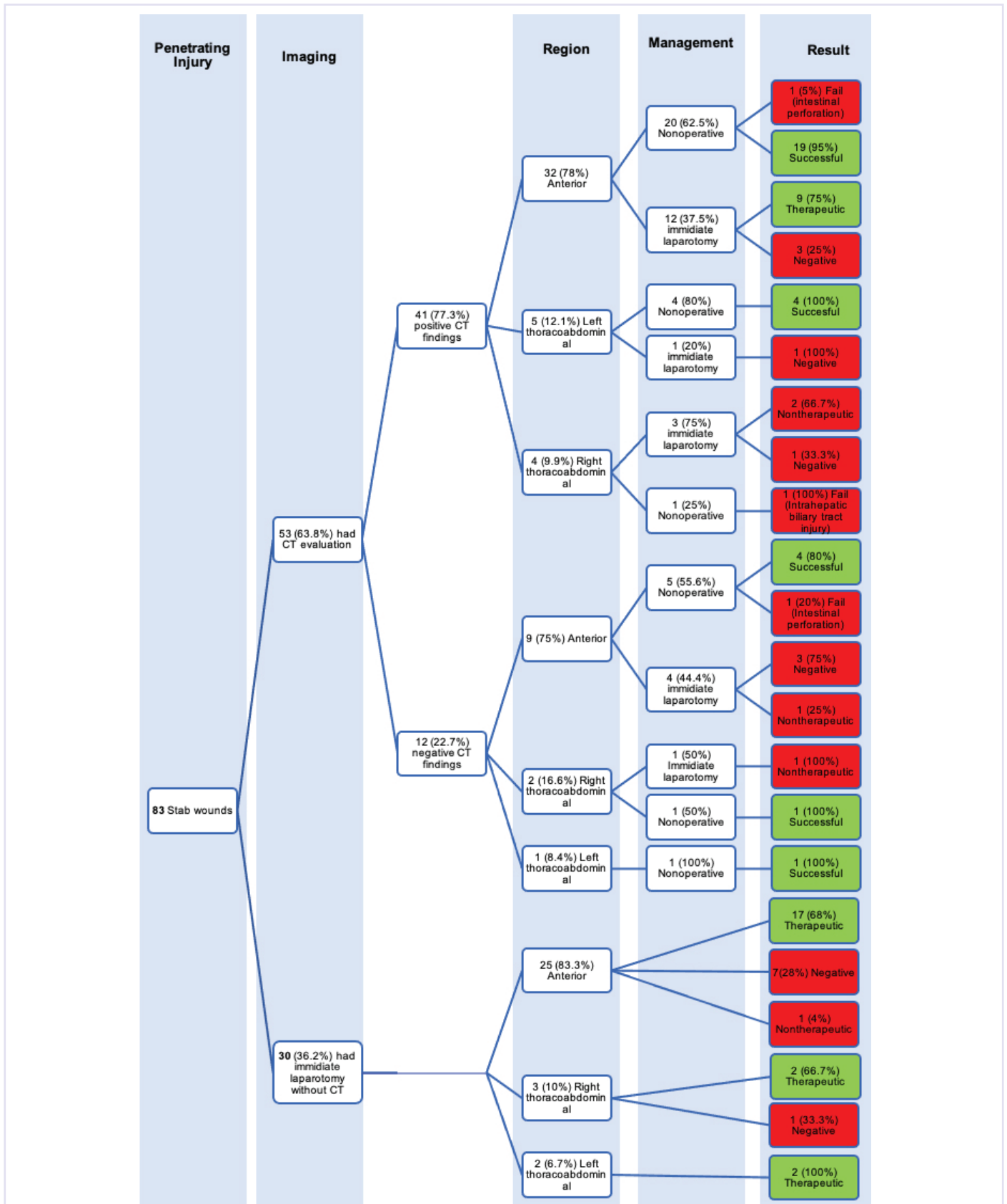
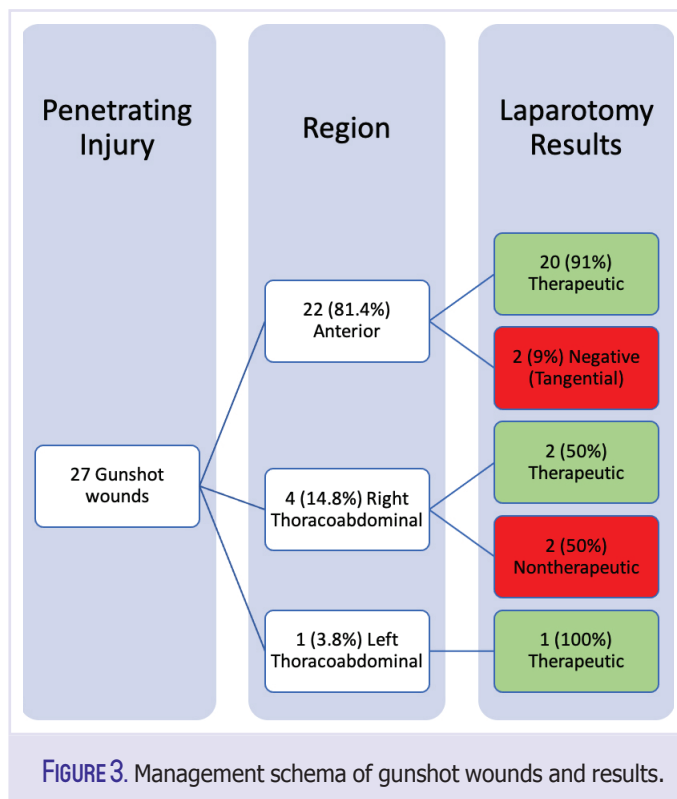


FIGURE 2. Management schema of stab wounds and results.



Most importantly, as a secondary-level hospital with a shortage of surgeons, this puts practitioners in a difficult position to follow up-to-date trauma algorithms. For example, when serial physical examination for anterior SW to evaluate peritonitis findings in the first 48 hours in patients for whom nonoperative follow-up was initiated; sometimes it is impossible to examine the patient closely for surgeons who are on-call for 72 hours straight by themselves. Most of the time this leads surgeons to perform immediate laparotomy. Consequentially, our high 41.1% negative and nontherapeutic laparotomy rates in SW can be explained by the insufficiency of experienced trauma teams. Furthermore, 66.6% of these negative/nontherapeutic laparotomies were performed during weekends when the second opinion of another surgeon is impossible or when the on-call surgeon only attends the hospital when it is required and surgical exploration is the fastest way to conclude the case. Additionally, when decision-making, one of the most concerning challenges during nonoperative follow-up is missed abdominal injuries. In the current literature delayed laparotomy rates range between 1.3–7% [22–24]. However, in the present study, three (9.3%) of 32 patients with SW, who were followed nonoperatively, had delayed laparotomy. Nevertheless, 34% of SW were successfully managed with nonoperative follow-up.

Emergency laparotomy is still a valid approach today in the treatment of patients with penetrating abdominal injuries who are hemodynamically unstable, have diffuse peritonitis and cannot be evaluated due to their mental status. Despite the widespread acceptance of nonoperative management in abdominal penetrating SWs; surgical exploration is still the first-line treatment method in GSWs, because of the higher rates of hollow organ injuries. Prior to exploration, CT is the most commonly used imaging method in the evaluation of patients. But as a result of the penetration, free fluid and air may be interpreted as a positive scan and lead surgeons to perform a negative or nontherapeutic laparotomy [12, 13]. Decision-making on nonoperative follow-up in gunshot wounds is debatable due to high-energy injuries that can cause additional thermal injuries; therefore, the standard approach has been mainly laparotomy. In particular, patients with isolated right upper quadrant injury can be followed conservatively when computed tomography shows that the injury is limited to the liver [14, 15]. Two right thoracoabdominal GSWs in our patient group with positive CT scans resulted in nontherapeutic laparotomy. Contrary to GSWs, SWs have a lower risk of intra-abdominal organ injury. Today, the optimal approach is a proper wound examination followed by a close follow-up and serial physical examination. The accuracy of peritoneal lavage and even CT in SWs is also controversial [10, 16, 17]. For example, in a meta-analysis comparing serial physical examination and multi-slice tomography, no superiority of tomography over serial physical examination was reported in 319 patients with anterior abdominal SWs [18]. Peev et al. [25] reported that contrary to the common belief in clinical practice, patients with penetrating abdominal injuries can be followed safely in level 1 trauma centers by applying appropriate protocols and will not increase morbidity and mortality. In our series, 3 SWs (9.3%), who received nonoperative treatment and developed peritonitis, also had delayed laparotomy and were discharged without complications.

Multislice computed tomography is recommended for evaluation of the diaphragmatic integrity since the diaphragm is a mobile organ and it is easier to miss smaller injuries; additionally, studies performed with conventional computed tomography have reported low sensitivity and specificity rates [16, 26]. In a recent study by Alizade et al. [27], it was suggested that magnetic resonance imaging is a successful diagnostic tool to evaluate diaphragmatic injury and can reduce negative laparoscopy rates in left thoracoabdominal stabbing in-

juries. In our series five left thoracoabdominal stabbing injuries were followed nonoperatively and they all had either free fluid or air on conventional CT but it was hard to evaluate the continuity of the diaphragm because CT was performed with wide slice intervals.

The management of intraabdominal organ and omental evisceration is still contentious. Mandatory laparotomy is advocated in current literature for intraabdominal organ eviscerations; however, some authors suggest that nonoperative follow-up can be performed with isolated organ evisceration in stab wounds [19–21]. There were two SW patients in our series who underwent nontherapeutic laparotomy with isolated omental evisceration.

This study has several limitations. As a retrospective study, we were only able to assess written documents of patients and CT images on the hospital's data system. Additionally, we do not know the indications that led surgeons to perform immediate laparotomy or nonoperative follow-up. We were also unable to find sufficient information on wound explorations and initial physical examinations, consequently, these sorts of data were excluded. In addition, there was missing data on short- and long-term complications and morbidity of the patients.

## Conclusion

Solo surgeons without the support of a trauma team have more tendency to perform immediate laparotomy for penetrating abdominal injuries especially when they are pulling long hours by themselves. Penetrating abdominal SW can be safely managed with nonoperative follow-up by establishing trauma teams and developing infrastructures in hospitals located in high-risk districts.

**Ethics Committee Approval:** The Health Sciences Kocaeli Derince Training and Research Hospital Ethics Committee granted approval for this study (date: 22.12.2022, number: 2022-134).

**Authorship Contributions:** Concept – NCA, OAE, YC; Design – NCA, OAE, YC; Supervision – NCA, OAE, YC; Fundings – NCA, OAE, YC; Materials – NCA, OAE, YC; Data collection and/or processing – NCA, OAE, YC; Analysis and/or interpretation – NCA, OAE, YC; Literature review – NCA, OAE, YC; Writing – NCA, OAE, YC; Critical review – NCA, OAE, YC.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Use of AI for Writing Assistance:** AI was not used for writing assistance.

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

**Peer-review:** Externally peer-reviewed.

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