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Original Article

The predictive value of physical examination in the decision of laparotomy in penetrating anterior abdominal stab injury

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Abstract: A selective conservative treatment for penetrating anterior abdominal stab injuries is an increasingly recognized approach. We analyzed patients who followed-up and treated for penetrating anterior abdominal stab injuries. The anterior region was defined as the area between the arcus costa at the top and the mid-axillary lines at the laterals and the inguinal ligaments and symphysis pubis at the bottom. An emergency laparotomy was performed on patients who were hemodynamically unstable or had symptoms of peritonitis or organ evisceration; the remaining patients were followed-up selectively and conservatively. A total of 175 patients with purely anterior abdominal injuries were included in the study. One hundred and sixty-five of the patients (94.29%) were males and 10 (5.71%) were females; the mean age of the cohort was 30.85 years (range: 14-69 years). While 16 patients (9%) were made an emergency laparotomy due to hemodynamic instability, peritonitis or evisceration, the remaining patients were hospitalized for observation. During the selective conservative follow-up, an early laparotomy was performed in 20 patients (12%), and a late laparotomy was performed in 13 patients (7%); the remaining 126 patients (72%) were discharged after non-operative follow-up. A laparotomy was performed on 49 patients (28%); the laparotomy was therapeutic for 42 patients (86%), non-therapeutic for 4 patients (8%), and negative for 3 patients (6%). A selective conservative approach based on physical examination and clinical follow-up in penetrating anterior abdominal stab injuries is an effective treatment approach.

Keywords: Anterior abdominal penetrating stab injuries, emergency laparotomy, non-operative treatment, physical examination

Introduction

A routine laparotomy has long been preferred in the patients with penetrating abdominal stab injuries. New treatment algorithms have been sought due to the high rates of unnecessary laparotomies and morbidity reported in various studies; a selective conservative treatment has been adopted in today's modern medicine [1-6]. In the conservative approach, while an emergency laparotomy is performed on hemodynamically unstable patients or patients with peritonitis symptoms, the watch-and-see policy is adopted for other patients [2, 3, 5]. Physical examination and clinical follow-up is primary; laparotomy is performed when necessary.

Here, we analyzed patients who were selectively and conservatively followed-up and treated in our clinic due to penetrating anterior abdominal stab injuries.

Material and methods

This study was conducted at Umraniye Training and Research Hospital Department of Surgery, Istanbul, Turkey after we obtained approval from the ethics committee of our hospital. Patients who had been followed-up and treated for penetrating anterior abdominal stab injuries between April 2009 and January 2014 were evaluated prospectively in accordance with our clinical algorithm (**Figure 1**).

We defined the anterior abdominal region as the area between the arcus costa superiorly, the mid-axillary lines on both lateral sides, and the inguinal ligaments and symphysis pubis

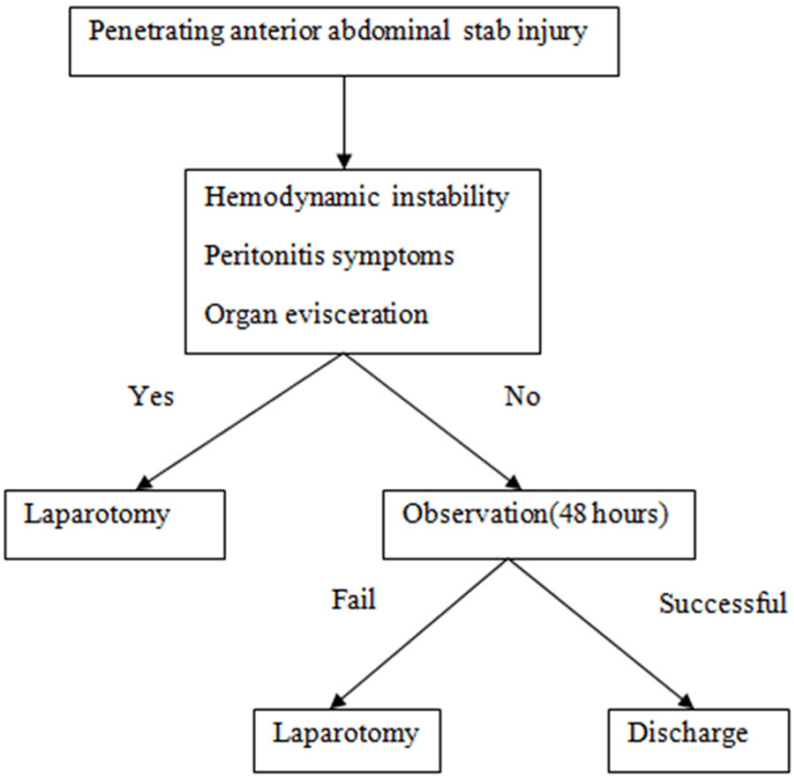

Figure 1. Algorithm of penetrating anterior abdominal stab injury.

inferiorly. This region was further divided into 9 different subgroups with the vertical line passing through both nipples and horizontal lines passing through the crista iliaca anterior superior and the lower rib curves. We examined the distributions of injuries and laparotomies according to these groups.

When an initial evaluation with physical examination revealed peritonitis symptoms and organ evisceration (except the omentum), an emergency laparotomy was performed. This procedure was also performed when hemodynamic stability was not maintained despite resuscitation according to advanced trauma life support (ATLS) criteria. A selective conservative treatment was applied to the remaining patients. The omentum was washed with saline in patients with omentum evisceration, and it was reduced into the abdomen via partial resection in necessary situations.

Hemodynamic stability

Despite performing resuscitation according to the ATLS criteria, some patients still presented hemodynamic instability. These cases included a systolic blood pressure below 90 mmHg, the presence of tachycardia, patients with dry, pale, and cold skin, and symptoms of hypovolemic shock such as fatigue and dehydration.

Peritonitis

A decision about the presence of peritonitis was made on the basis of rigidity and/or rebound and tenderness at the far region of the injury in the abdominal examination.

Local injury site exploration

In the local injury exploration, the injuries that passed through the anterior abdominal fascia were accepted as peritoneal penetration.

Laparotomy time

The patients were divided into 3 groups according to the time at which they had been taken into laparotomy. Patients who had been taken directly into laparotomy following resuscitation were accepted as cases of emergency laparotomy, and patients who had been taken into the operating room within 8 hours were accepted as early laparotomy cases. Patients who taken into the operating room after 8 hours were accepted as late laparotomy cases.

Laparotomy findings

The patients were divided into 3 groups according to the surgical findings. Patients without any determined intra-abdominal pathology were defined as negative laparotomy cases; patients with solid organ and serosa injuries that were not life-threatening and not deteriorating the patient's hemodynamic stability were defined as non-therapeutic laparotomy cases, and patients in whom the presence of injuries were life-threatening or that deteriorated the patient's stability when no surgical intervention was performed were defined as therapeutic laparotomy cases.

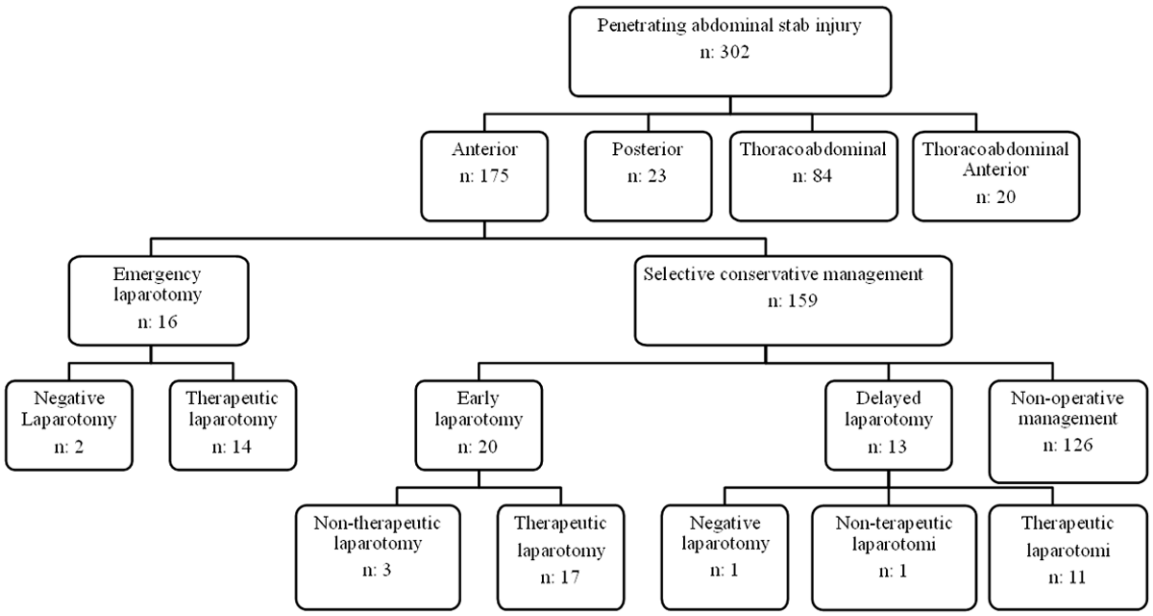

Figure 2. Classify of patients with penetrating abdominal stab injury.

Observation procedure

Patients not needing an emergency laparotomy that received a selective conservative approach were hospitalized and followed-up with physical examinations for at least 48 hours. Physical examination included an evaluation of peritonitis and vital signs, and was performed by the experienced team every two hours. Positive physical examination was defined as the presence of peritonitis signs or hemodynamic instability. In addition to the physical examination, routine complete blood count and other imaging methods such as triple-contrast computerized tomography (CT), ultrasonography, and endoscopy were performed in necessary situations.

Statistical analyses

All of the patients' data were placed in a digital database prospectively. We used the IBM SPSS Statistics 22 program for evaluating the findings. Beside descriptive statistical methods (mean, frequency, ratio), we employed Fisher's Exact chi-squared test, the Fisher Freeman Halton Exact test, and the Continuity (yates) correction to compare the qualitative data for evaluating the study data. Significance was assessed at a p value less than 0.05.

Results

Three hundred and two patients with penetrating abdominal stab injuries were hospitalized. Twenty-three patients had a posterior injury, 84 patients had a thoraco-abdominal injury, and 20 patients had an anterior injury accompanying their thoraco-abdominal injury; these individuals were excluded from the study. A total of 175 patients with isolated anterior abdominal injuries were included in the study (**Figure 2**). One hundred and sixty-five of the patients (94.29%) were males and 10 (5.71%) were females, and the mean age of the cohort was 30.85 year (range: 14-69 years).

A laparotomy was performed on 49 patients (28%) according to the physical examination and the clinical follow-up. Of these procedures, 16 (33%) were emergency laparotomies; 2 patients had hemodynamic instability, 11 patients had peritonitis symptoms, and 3 patients had organ evisceration. The laparotomies were therapeutic in 2 patients who were hemodynamically unstable, in 10 patients with peritonitis, and in 2 patients with organ evisceration; the laparotomy was negative in one patient with organ evisceration and in one patient with peritonitis (**Table 1**).

In the 159 patients who had been followed-up selectively and conservatively, an early laparotomy was performed in 20 patients due to the development of peritonitis (n=19) and the deterioration of hemodynamic stability (n=1), and a delayed laparotomy was carried out in 13 patients who developed signs of peritonitis.

Table 1. Distribution of patients performed laparotomy

Timing and indication of laparotomy	Therapeutic laparotomy n=42 (85.7%)	Non-therapeutic laparotomy n=4 (8.2%)	Negative laparotomy n=3 (6.1%)	Total n=49
Emergency laparotomy	14		2	16 (33%)
Hemodynamic	2			
instability	10		1	
Peritonitis	2		1	
Organ evisceration				
Early laparotomy	17	3		20 (41%)
İnstability	1			
Peritonitis	16	3		
Delayed laparotomy	11	1	1	13 (26%)
Peritonitis	11	1	1	

Table 2. Evaluation of patients according to localizations

Localization	Management of patients	
	Laparotomy	Non-operative
	n	n
Right hypocondrium	6	13
Epigastrium	2	19
Left hypocondrium	2	8
Right lumbar	5	15
Umbilical	19	42
Left lumbar	6	14
Right inguinal	4	6
Hypogastrium	2	2
Left inguinal	3	7
p	0.561	

Fisher Freeman Halton Exact test.

Table 3. Management of patients according to evisceration organ and omentum

Evisceration	Laparotomy	
	Yes	No
	n (%)	n (%)
Yes	15 (78.9)	4 (21.1)
No	34 (21.8)	122 (78.2)
p	0.001**	

Continiutiy (yates) test, **P<0.01.

While the laparotomy was non-therapeutic in 3 patients and therapeutic in 17 patients in the early laparotomy group, it was therapeutic in 11 patients and non-therapeutic in 1 patient in the delayed laparotomy group. The sole negative laparotomy was observed in 1 patient in the late laparotomy group (**Table 1**).

All of the laparotomies were performed within 48 hours with the exception of one case. Among the patients who were followed-up non-operatively, a late laparatomy was performed on one patient who developed signs of peritonitis on the 5th day of follow-up. At the laparatomy, a perforation was found in the ascending colon, and a right hemicolectomy and anastomosis was performed. The patient was discharged uneventfully. Triple-contrast CT was performed on this patient during the follow-up for a 48-hour period. The CT revealed a minimal free fluid collection in the abdomen, but this finding did not motivate the laparatomy.

Of the 49 laparotomies performed according to the physical examination findings, the laparotomy was therapeutic in 42 cases (85.7%), non-therapeutic in 4 cases (8.2%), and negative in 3 cases (6.1%). The remaining 126 patients (72%) were followed-up conservatively and discharged without any complications (**Table 1**). After an observational period of 48 hours, the sensitivity, specificity, positive and negative predictive values, and accuracy of the physical examination were calculated to be 97.67%, 94.69%, 85.71%, 99.20%, and 95.42%, respectively.

Although the most injury and need for a laparotomy was observed in the umbilical area according to the subgroup analysis of the anterior abdominal region, we did not find any statistically significant differences (P>0.05; **Table 2**).

Organ evisceration was found in 3 patients (1.7%) (small bowel in two of the patients and the stomach in one patient), and omentum evisceration was found in 16 patients (9.1%). While the laparotomy was negative in the patient with gastric evisceration, it was therapeutic in patients with small intestine evisceration. Of the 16 patients with omentum evisceration, an emergency laparotomy was performed

Table 4. Distribution of patients performed ultrasonography or computerized tomography

		Total	Therapeutic laparotomy	Non-therapeutic laparotomy	Negative laparotomy	Non-operative management
US n=30	Negative sign	23	3			20
	Positive sign	7	4	1		2
CT n=31	Negative sign	16		1		15
	Positive sign	15	8	1		6
PE n=175	Negative sign	126				126
	Positive sign	49	42	4	3	

US: Ultrasonography, CT: Computerized tomography, PE: Physical examination.

Table 5. Summary of sensitivity, specificity, positive and negative predictive value and accuracy of test for therapeutic laparotomy

Test	SENS %	SPEC %	PPV %	NPV %	Accuracy %
US	57.14	86.95	57.14	86.95	80
CT	100	69.56	53.33	100	77.41
PE	97.67	94.69	85.71	99.20	95.42

US: Ultrasonography, CT: Computerized tomography, PE: physical examination, SENS: Sensitivity, SPEC: Specificity, PPV: Pozitive predictive value, NPV: Negative predictive value.

on 5 of the patients, an early laparotomy was performed on 5, and a late laparotomy was performed on 2 patients. While 11 of the laparotomies were therapeutic, one was negative. The remaining 4 patients were discharged non-operatively.

The need for a laparotomy in patients with organ and omentum evisceration was found to be statistically significantly higher than in patients without evisceration ($P<0.01$; **Table 3**).

During the clinical follow-up, abdominal ultrasonography imaging was performed on 30 patients (17.14%), and triple-contrast CT was performed on 31 patients (17.71%). While the findings were negative in 23 of the performed abdominal ultrasounds (77%), intra-abdominal free fluid was detected in 7 cases (23%). Three patients with negative ultrasound findings and 4 patients with positive ultrasound findings underwent a thearapeutic laparotomy. While abdominal CT detected intra-abdominal and abdominal wall pathologies in 15 patients (48%), there were normal findings in 16 patients (52%). In the group with positive CT findings, 8 patients had a therapeutic laparotomy, and 1 patient had a non-therapeutic laparotomy. In the group with negative CT findings, only 1 patient had a non-therapeutic laparotomy (**Table 4**). The sensitivity, specificity, positive predictive value, negative predictive value, and the accuracy of the ultrasound were determined to be 57.14%, 86.95%, 57.14%, 86.95%, and 80.00%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value and the accuracy of the CT were calculated to be 100%, 69.56%, 53.33%, 100%, and 77.41%, respectively (**Table 5**).

A total of 6 patients (3.4%) had morbidity. Of these patients, 4 were in the early laparotomy group; these morbidities were intra-abdominal abscess, bile fistulas, and incisional hernias in 2 patients. Wound site infections and bile fistulas were observed in 2 patients in the late laparotomy group. The incisional hernias were treated surgically, and the remaining patients recovered with medical treatment. One patient (0.57%) died who was operated on for hemodynamic instability secondary to liver injury.

Discussion

The most important decision when evaluating a penetrating abdominal stab injury is whether a laparotomy is required. Due to the risk of missing probable intra-abdominal pathologies, a routine laparotomy has long been a preferred procedure. However, the prevalence of laparotomies began to be questioned after a study conducted by Saftan et al. revealed selective conservative treatment [7-9]. In several studies, it has been demonstrated that routine laparotomies are unnecessary in up to 40% of cases, and they cause morbidity in 5-22% of cases and mortality in 0-5% of cases [4, 5, 10-12].

A emergency laparotomy is generally merited for patients who are hemodynamically unstable or patients who have peritonitis symptoms or

organ evisceration. A selective conservative treatment can be applied to patients who lack these findings [1, 3, 4, 13-15]. In this application, a patient who has no indication for an emergency laparotomy is hospitalized for the purpose of follow-up and close monitorization with serial physical examinations. In order to eliminate evaluation variability, the physical examinations of the patients should be performed by the same team as much as possible [3, 15]. The most important component in selective conservative treatment is the clinical follow-up and physical examination findings in the patient. In several studies, the sensitivity of the physical examination has been reported to be 97.4%; this sensitivity can decrease the overall laparotomy rate from 55% to 30% and the unnecessary laparotomy rate from 24% to 0% [4, 13, 15, 16]. In our study, the decision of whether or not to perform a laparotomy was predominantly made depending on the physical examination findings, and the sensitivity of the physical examination was determined to be 97.67%. Our unnecessary laparotomy rate was 14.3%.

The routine use of imaging methods such as abdominal ultrasonography and abdominal CT in penetrating anterior abdominal stab injuries is controversial and has been questioned in various studies. In a study conducted by Schmelzer et al. evaluating a total 100 patients with penetrating abdominal injuries, 32 patients had undergone CT, and no pathology was detected in 16 individuals [4]. The sensitivity of CT had been determined to be 100%, and the specificity had been determined to be 94%. In our study, in addition to the physical examination, abdominal ultrasonography was performed on 30 patients (17.14%), and abdominal CT was performed on 31 patients (17.71%). No pathology was determined in 23 of the abdominal ultrasounds (77%) and in 16 of the CTs (52%). Positive imaging findings consistent with the physical examination were accepted to be significant for the laparotomy. The sensitivity and the specificity of the ultrasound were 57.4% and 87.0%; these values were 100% and 69.56% for CT, respectively.

While the presence of organ evisceration is accepted by many institutions as sign that an emergency laparotomy is necessary, there is no clear-cut situation in the case of omentum evisceration [4, 5, 17, 18]. In a study conducted by Ertekin et al., a laparotomy was required only in 1 out of 19 patients who had organ and/or omentum evisceration [5]. In another study performed by Michelle et al., organ and/or omentum eviscerations were detected in 66 of patients (17.4%), and a therapeutic laparotomy was performed on 57 patients (86.4%) [17]. In our study, omentum evisceration was not accepted as an exact indication for laparotomy, and the eviscerated omentum was cleaned with saline, reduced into the abdomen, and the routine observational procedure was applied. We determined organ and omentum eviscerations in 19 patients (10.85%) in which 13 (68.4%) had therapeutic laparotomies and 2 (10.5%) had negative laparotomies. Thus, the presence of omentum evisceration was found to be significant for the prediction of a probable intra-abdominal injury.

Many authors have reported that approximately one quarter of abdominal injuries are not penetrating to the peritoneum; of the penetrating injuries, only one third require surgical intervention [13, 19, 20]. For this reason, wound site exploration should be made delicately in every case. There is controversy regarding the assessment of the margin for peritoneal penetration in the literature. In many studies, the anterior abdominal fascia was accepted as the peritoneal penetration border, but in other studies the posterior abdominal fascia was accepted as the frontier for peritoneal penetration [1, 4, 21, 22]. The rates of unnecessary laparotomies varied between 16% and 50% in studies that accepted both the anterior and the posterior fascia as the boundary of peritoneal penetration [5, 21, 22]. We know that an evaluation of the posterior abdominal fascia is frequently difficult. Thus, we treated patients with injuries penetrating the anterior abdominal fascia as having peritoneal penetration. This choice was a more appropriate approach in terms of patient safety, although it may have increased the unnecessary hospitalization rate.

In some studies, a routine diagnostic laparoscopy has been recommended to evaluate abdominal penetrating stab injuries [1, 3, 5, 10]. Although a diagnostic laparoscopy is a minimally invasive procedure, general anesthesia and laparoscopy have their own potential complication risks. In several studies, it has been observed that routine laparoscopies are

highly non-therapeutic [3, 10, 23, 24]. When the high sensitivity and specificity rates obtained with physical examination are taken into consideration, a diagnostic laparoscopic exploration as a component of selective conservative treatment would not be an appropriate approach. However, a therapeutic laparoscopy can be used as a minimally invasive method instead of a laparotomy at experienced medical centers.

Conclusions

Selective conservative treatment involving physical examination and clinical follow-up in penetrating anterior abdominal stab injuries is an effective approach that reduces unnecessary laparotomies and ensuing morbidity and mortality. In patients with organ and omentum evisceration, the need for therapeutic laparotomies may be more frequent. Laparoscopy should be reserved for therapeutic purposes rather than acting as a diagnostic tool.

Imaging methods such as ultrasonography and CT may help surgeons make decisions about whether to proceed with a laparotomy in selected patients.

Disclosure of conflict of interest

None.

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