Penetrating Injuries to the Abdomen: a Single Institutional Experience with Review of Literature

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Abstract Penetrating abdominal trauma forms an important component of surgical emergencies, most of the victims being young aged in the prime of their life. Over the past century, the diagnosis and management of this common problem has seen drastic changes, finally reaching the destination of *selective approach*. We present our experience in the management of this group of patients in the rural setup. This is a prospective observational study done at our hospital between 1 April 2013 and 31 March 2015 including patients who presented with penetrating abdominal injury. The clinical presentation, imaging features, diagnosis, management, and complications of all these patients are analyzed. The mean age was 33.5 years with majority being males. Homicidal stab injuries accounted for most of the injuries (62.5 %). Forty-eight patients underwent laparotomy, and among which, the procedure was therapeutic in 36 patients. Peritoneal penetration was the best predictor of a therapeutic laparotomy with a high sensitivity and positive predictive value (100 and 80 %, respectively). The small intestine was the most commonly injured organ. The mean postoperative stay was 8.25 days, and there was no mortality. Though the management of these patients should aim at minimizing the rate of negative laparotomies, this should not be done at the expense of delayed diagnosis and treatment. Diagnostic laparoscopy may avoid unnecessary laparotomies; however, it requires adequate skills in laparoendoscopy. Management is best tailor made for each individual based on the nature of injury, findings at presentation, and the organ injured.

Keywords Penetrating injury · Bowel perforation · Abdominal injury · Bull gore injury

Introduction

Penetrating abdominal trauma forms an important component of surgical emergencies. The importance of this category becomes further apparent when one realizes that most of such trauma victims are essentially healthy people and in the prime of their life. Over the past century, the diagnosis and management of this common problem has changed initially from a more conservative approach to a more operative approach and finally to a selective approach. The technical advances in imaging and the appropriate use of blood transfusions and antimicrobials have helped in the selective approach to these injuries. In 1960, through their landmark article, Shaftan [1] from the Kings County Hospital Center in Brooklyn suggested selective management of patients with stab wounds after observing an increased rate of negative laparotomy in civilian setting which was reinforced by Nance and Cohn [2] in 1969. According to Inaba and Demetriades [3], selective non-operative management of both stab wounds and gunshot injuries is safe and has been shown to decrease the rate of unnecessary laparotomy, length of hospital stay, and management costs.

In the present study, we have evaluated the various presentations of penetrating abdominal injury in our patients and have studied the indications for an early and mandatory laparotomy. We have also evaluated the impact of these measures on the clinical outcomes.

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Methods

A prospective observational study was done at our hospital between 1 April 2013 and 31 March 2015. The patients who presented with penetrating abdominal injury to casualty were included in the study ($n=64$). Patients with associated chest, renal, or head injuries were excluded from the study. After initial resuscitation in the casualty, the cases were admitted and managed under the surgical department. Based on the clinical presentation, hemodynamics, and imaging features, patients were either managed conservatively in the trauma intensive care unit or underwent emergency laparotomy. All patients underwent local wound exploration for the detection of peritoneal penetration. Wounds with evisceration of the omentum and/or bowel were considered as positive for peritoneal penetration and explored further during laparotomy. The clinical presentation, imaging features, diagnosis, and complications of all these patients were analyzed.

Results

The demographic data and etiology of penetrating injuries is depicted in Table 1. The mean age at presentation was 33.5 years (range 16–64 years) with the majority of being males (50 males and 14 females). Stab injuries accounted for most of the penetrating injuries, most of them being of homicidal intent (62.5 %). The plain abdominal X-ray revealed pneumoperitoneum in just 12 patients (18.75 %). Table 2 depicts the indications and observations at laparotomy. Forty-eight patients underwent laparotomy, and among which, the procedure was therapeutic in 36 patients. Peritoneal penetration was the best predictor of a therapeutic laparotomy with a high sensitivity and positive predictive value (Figs. 1 and 2). Also, hemodynamic instability and omental or bowel evisceration were found to be good predictors. On the other hand,

Table 1 Patient demography and etiology of penetrating abdominal trauma

	<i>N</i> =64
Mean age (range) (years)	33.5 (16–64)
Sex ratio (male/female)	50:14
Mode of penetrating injury, <i>n</i> (%)	
Homicidal stab injury	40 (62.5)
Self-inflicted stab injury	2 (3.13)
Bull gore injury	16 (25)
Fall over sharp objects	4 (6.26)
Gunshot injuries	2 (3.13)
Pneumoperitoneum on plain abdominal X-ray (present/absent)	12:52 (18.75:81.25)

Table 2 Indications and observations of laparotomy

Indication for laparotomy	
Penetration of peritoneum (present/absent), <i>n</i> (%)	45:19 (70.31:29.69)
Generalized tenderness (present/absent), <i>n</i> (%)	34:30 (53.13:46.88)
Omental and/or bowel evisceration (present/absent), <i>n</i> (%)	38:26 (59.38:40.63)
Hemodynamic instability (present/absent), <i>n</i> (%)	11:53 (17.19:82.81)
Mode of management (observation/non-therapeutic laparotomy/therapeutic laparotomy), <i>n</i> (%)	16:12:36 (25:18.75:56.25)
Organs injured (laparotomy group)	
No injury (negative laparotomy), <i>n</i> (%)	4 (8.33)
Liver (therapeutic/non-therapeutic group)	7:4
Spleen (therapeutic/non-therapeutic group)	4:0
Hollow viscus (stomach/small bowel/colon)	4:14:2
Mesentery (therapeutic/non-therapeutic group)	4:4
Multivisceral injury (therapeutic/non-therapeutic group)	1:0

pneumoperitoneum is a poor predictor of therapeutic laparotomy. The intestine was the most commonly injured organ, with the small bowel being the most often involved viscus. One patient had multivisceral injury. Wound dehiscence was the most common complication (Table 3) in the postoperative period (nine patients) followed by respiratory complications (seven patients). The mean postoperative stay was 8.25 days (range 5–24 days), and there was no mortality.

Discussion

Most of the victims of penetrating abdominal trauma are the young- and middle-aged groups who are in the prime of their life [4]. At the same time, the incidence of unnecessary laparotomy as per previous reports ranges from 23 to 53 % for patients with stab wounds and 5.3 to 27 % for patients with gunshot wounds. Complications develop in 2.5 to 41 % of all trauma patients undergoing unnecessary laparotomy [5]. According to the study done by Shaftan [1], it was concluded that “the application of trained surgical judgment rather than dogma is the more rational and intelligent approach to the management of abdominal injury.” The expectant policy toward these injuries was later termed “selective conservatism.”

In penetrating abdominal injuries whether civilian or military, gunshot or stab, the organ most commonly injured is the small bowel accounting 49 to 60 % of all injuries. In general, stab wounds are less damaging than gunshot wounds and result in fewer complications. Nearly one third of abdominal stab wounds do not penetrate the peritoneal cavity and only

Fig. 1 Sensitivity and specificity of the presenting features in co-relation to a therapeutic laparotomy

50 % of those that penetrate require surgical intervention. Studies by Moore et al. and Croce et al. have shown that the number of organs injured, the penetrating abdominal trauma index, and the abdominal septic complications are significantly lower in stab injuries than with gunshot wounds [6, 7].

Bull gore injuries [8] are particularly common in rural setup such as our patient population, accounting for 25 % of the penetrating injuries. Such injuries are often associated with a blunt component. The extent of intra-abdominal injury varies depending on the site of penetration. More than one organ may be affected.

Initial examination of the trauma victim plays a significant role in the proper management of the patient both immediately in the emergency room and later in the surgical department. Lee et al. [9] retrospectively reviewed 219 patients who suffered from stab wounds to the abdomen between 1974 and 1983 and managed selectively. The rate of negative or unnecessary laparotomies was 7.8 %, whereas the false-negative initial examination rate was 5.5 %; the overall accuracy of initial clinical presentation and examination was 88.6 %.

Roentgenogram of the abdomen is questionable in the case of stab wounds and contributes a little to the evaluation of stab wounds to the abdomen. In a study by Kester et al., roentgenograms were abnormal only in 8 % of cases. Pneumoperitoneum was seen in 18.75 % ($n = 12$) of the patients in the present series [10].

Local wound exploration is helpful in determining the integrity of the peritoneum, and a negative finding enables discharge of patients from an emergency department. Thompson and Moore [11] found that local wound exploration followed by diagnostic peritoneal lavage when peritoneal violation was deemed likely after stab wounds resulted in a low unnecessary laparotomy rate of 8 %. In our series, all the patients underwent wound exploration under regional anesthesia and 70.31 % of the patients were detected positive for peritoneal penetration.

Abdominal paracentesis in the setting of penetrating abdominal trauma was described by Shaftan [1] in the 1960s. The use of diagnostic peritoneal lavage (DPL) as an adjunct in the management of these patients was subsequently reported by Thal [12] in 1977. Since then, a number of articles

Fig. 2 Positive and negative predictive value of the presenting features in co-relation to a therapeutic laparotomy

Table 3 Postoperative complications

Postoperative complications	
Respiratory complications (pneumonia/ pleural effusion/ARDS)	7
Anastomotic leak	1
Postoperative Ileus	4
Wound Infection	6
Wound dehiscence	9
Mean duration of postoperative stay, days (range)	8.25 (5–24)

investigated DPL as a means to assess the need for surgery after penetrating abdominal trauma. The recommended thresholds for positivity have ranged from 1000 to 100,000 RBCs/mm³ [11, 13, 14]. With the widespread use of selective management, the non-invasive tools such as CT and focused abdominal sonography for trauma (FAST) became more popular adjuncts and DPL became more often reserved for unstable patients requiring a rapid diagnosis.

Ultrasound is most useful in the detection of hemoperitoneum with an accuracy rate of 91 to 97 % [15]. It has been proposed that additional diagnostic studies are needed in the face of a negative FAST to rule out occult injury [16].

The original use of CT in penetrating abdominal trauma was first reported by Phillips et al. in 1986 [17]. The authors concluded that CT enema reliably identified injuries in this patient population. Another prospective study of triple-contrast helical CT in 200 patients with penetrating torso trauma was published by Shanmuganathan et al. [18] in 2004 concluding that the triple-contrast helical CT accurately demonstrates peritoneal violation and visceral injury. CT scan also identifies the penetrating wound track and its extent. However, the major drawback with the use of CT scan is its insensitivity in detecting injury to the bowel, the commonest organ injured by penetrating trauma [19]. Salim et al. [20] reported a 100 % negative predictive value of CT in the evaluation of the anterior abdominal stab wounds.

Diagnostic laparoscopy for trauma has gained widespread acceptance in recent times in view of the benefits of a minimally invasive approach, i.e., shorter hospital stay; less postoperative pain; faster return to a regular diet, ambulation, and work; lower incisional hernia rates; as well as better cosmetic results. Diagnostic laparoscopy may be considered as a tool to evaluate diaphragmatic lacerations and peritoneal penetration. However, the non-therapeutic laparotomy rate after a laparoscopy positive for peritoneal penetration remains a concern. Another major concern is missed injury. Also, diagnostic laparoscopy is not indicated in hemodynamically unstable patient and also needs good technical skills in laparoscopy. Hence, the routine use of diagnostic laparoscopy to identify hollow viscus injuries is not recommended at the present time [21, 22].

The management of penetrating abdominal trauma in the presence of shock or physical findings of peritonitis should be immediate laparotomy. Selective conservatism is advocated for stab injury patients with no abdominal signs and those who are hemodynamically stable. As per the guidelines established by Biffl and Moore [23], shock, evisceration, and peritonitis warrant immediate laparotomy following penetrating abdominal trauma. Anterior abdominal stab wound victims can be followed with serial clinical assessments in the absence of the above signs. The majority of patients with gunshot wounds are best served by laparotomy; however, select patients may be managed expectantly. In various series, the rate of operated cases reported was 65 to 75 % [4, 6, 7].

The patients who are managed conservatively shall benefit from serial physical examination. Serial physical examination is reliable in detecting significant injuries, if performed by experienced clinicians and preferably by the same team. In these patients, abdominopelvic CT is strongly advised as a diagnostic tool to facilitate management decisions [24].

Peritoneal violation has been mentioned as the indication of laparotomy in 70 to 80 % of cases according to the reported series in the literature [6, 7]. Visceral or omental evisceration in a patient with stable clinical signs and without evidence of peritonitis is a relative rather than absolute indication for exploratory laparotomy. Since there are arguments both for and against routine exploration [2, 25], no recommendation has yet been proposed in this context. Hence, these patients are presently probably best served by laparotomy.

The majority of the patients who were managed non-operatively in the present study were discharged after 2 days of observation. The guidelines published by Como et al. recommend that majority of such patients may be discharged after 24 h of observation in the presence of a reliable abdominal examination and minimal to no abdominal tenderness [24].

Conclusion

Penetrating abdominal trauma is a common type of surgical emergency affecting particularly young males. The commonest mode of injury is by stab wounds to the abdomen. Though the management of these patients should aim at minimizing the rate of negative laparotomies, this should not be done at the expense of delayed diagnosis and treatment. Diagnostic laparoscopy may be applied as a tool to avoid unnecessary laparotomy; however, it requires adequate experience and skills in laparoendoscopy. The best mode of management must be tailor made for each individual based on the nature of injury, findings at presentation, and the organ injured.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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