



ROLE OF LAPAROSCOPY IN ABDOMINAL TRAUMA. A PROSPECTIVE STUDY.

*Chaudhary S., Adhikary S., Sah N. P., Bhatarrai B. K. and Agrawal C. S.

Bpkihs, Dharan, Nepal.

*Corresponding Author: Dr. Chaudhary S.

Bpkihs, Dharan, Nepal.

Article Received on 15/11/2018

Article Revised on 05/12/2018

Article Accepted on 26/12/2018

INTRODUCTION

Trauma is still one of the major causes of death and disability (WHO), and in the case of young people under 40 years it is the most significant cause of morbidity (MacKenzie et al., 2008). Different studies show abdominal injuries in 1.5 to 36.5 of traumatic injuries getting progressively frequent and severe (Cheynel N et al, 2009) (Ong CL et al. 1994). Additionally, high rate of diagnostic mistakes, postoperative complications and mortality have been observed in treatment of abdominal trauma (Ong CL et al. 1994) (Karch DL et al, 2009) (Abakumov MM et al. 2005) (Salimi J. et al 2009). Thus, there is an obvious need to improve management of this patient population (Abakumov MM et al. 2005) (Nast-Kolb D. et al. 2005) The improvement of medical care for abdominal patients is particularly important because the overwhelming majority of them (77 to 98) are young adults (Karch DL et al, 2009) (Salimi J. et al 2009).

Despite the availability of different diagnostic modalities, the number of non-therapeutic laparotomies remain high. The use of mini-invasive techniques opens up new possibilities, which can lead to diagnostics and treatment optimization of patients after severe abdominal trauma.

In 1976 Gazzaniga et al. presented the result of clinical observation of diagnostic laparoscopy used in patients after penetrating and blunt abdominal injuries (Gazzaniga AB et al, 1977). In the following year, a lot of reports appeared confirming the benefits of diagnostic laparoscopy in patients with penetrating abdominal trauma (Berci G et al, 1983) (Tortella BJ et al, 1992) (Fernando HC et al 1994) (Ortega et al, 1996) (Ertekin C, et al 1998). In recommendation for abdominal trauma management published by different associations, the possibility of diagnostics and mini-invasive treatment with endoscopic technique, especially laparoscopy is emphasized (Sugre M, et al 2007) (Neugebauer E et al 2006) (Inaba K et al 2007) (Brongel L et al 2010). An indubitable advantage of a diagnostic laparoscopy is the possibility to assess the kind of injuries, its location and severity, and often it creates a possibility to treat minor injuries without laparotomy, which is why negative or non-therapeutic application can be avoided (Zantut LF et al 1997).

Despite these clear potentialities, laparoscopy has not yet gained wide acceptance and it is not consistently performed in trauma patients.

At our centre we have been providing laparoscopy service for elective patients since 1998. We wanted to study the role and value of laparoscopy in abdominal trauma and to see how we could increase skills in laparoscopy at emergency and avoid unnecessary laparotomies during the study period and also for the future management of patients with abdominal trauma.

OBJECTIVES

GENERAL OBJECTIVES

- To assess the abilities and limitations of laparoscopy and evaluation of its role in examination and treatment of patients with abdominal trauma

SPECIFIC OBJECTIVES

- To study demographic profile in abdominal trauma
- To study the nature of trauma
- To study pattern of injury(hollow viscus, solid organs, mesentery etc)
- Sensitivity and Specificity of laparoscopy in abdominal trauma

MATERIALS AND METHODS

Methodology

- **Place of study:** Department of Emergency and department of Surgery, B. P. Koirala Institute of Health sciences.
- **Type of study design:** Prospective interventional study.
- **Duration of study:** One year.

Inclusion Criteria

- Age > 8 years
- Patients with blunt trauma abdomen
- Patients with penetrating trauma abdomen
- Hemodynamically stable patients

Exclusion Criteria

- Age < 8 years
- Haemodynamically unstable patients
- Polytrauma and head injury
- Posterior abdominal wall penetration
- Multiple ugly scars in abdomen
- Refusal of consent

METHODS

Patients presenting with abdominal trauma were attended promptly. In case of mass casualties, priority was given according to the Australian Triage Score (ATS). Patients with the lower score got the first priority. Patients were then assessed with the primary and secondary survey. Two wide bore needle 16 gauge was inserted and blood sample collected for cross match and investigations. Vitals (temperature, pulse rate, blood pressure, respiratory rate, spo₂), electrical activities of heart and urine output were monitored. IV fluids and Inotropes was titrated accordingly. inter-departmental calls was made as and when required. Non-invasive investigations such as laboratory investigations (CBC, Blood Grouping, X-match, sodium/potassium, urea/creatinine, PT/INR, Serology), serial abdominal US examinations, X-ray in multiple views and computed tomography if necessary was done. A systolic blood pressure > 100mmHg and diastolic >60mmHg, a heart rate <110 beats per minute was targeted to make patients hemodynamically stable sufficient to consider for laparoscopy. The patient and the relatives were explained about the course of trauma, the surgery to be done and its prognosis. A written consent was taken before the patient was shifted to operation table.

The Laparoscopic Technique of abdominal cavity inspection

Positioning and preparation of the patient for trauma laparoscopy was essentially the same as for any trauma laparotomy. The instruments for a conversion to laparotomy was made readily available. The patient was placed supine and well strapped. Bed was tilted to allow gravity to retract abdominal organs and to increase working space as per requirement. Pneumo peritoneum was achieved with low a CO₂ flow and maintained at a low pressure (8-12 mmHg).

Diagnostic laparoscopy was achieved through a 10mm umbilical port best inserted with an open technique. A 30⁰ laparoscope (10 mm in diameter) was used. Positioning was done as per requirement. In the case of penetrating wounds, air leaks through the skin was controlled with sutures or external digital pressure. Visceral handling was carried out with 5mm atraumatic

bowel graspers through two paramedian 5mm ports placed on the umbilical line. Peritoneal violation was determined easily and reliably. A full laparoscopic exploration of the abdominal cavity in search for injuries was done systemically following all principles of open exploratory laparotomy. Indirect signs of bowel injury, such as digestive fluids or purulent liquids was carefully looked for. The bowel was examined using the hand-over-hand technique with small bowel graspers from the ligament of Treitz to the terminal ileum. The colon was inspected from the cecum to the rectum and the supramesocolic space was inspected from the abdominal esophagus to the duodenum including spleen, liver and gallbladder. For therapeutic laparoscopy more ports were required based on the surgical procedure required and the size of the patient. Laparoscopic suturing of bowel injuries was carried out with either silk or polyglactin suture. An extra port was necessary to achieve lining up of the bowel.

Total operative time was calculated. Most of the patients after the surgery were followed up with an eye on wound inspection, days of hospital stay, post-operative paralytic ileus etc.

There were two groups of patients according to mechanism of injury: blunt and penetrating abdominal trauma and they were divided into two groups according to the procedure they underwent after admission. Group A: Those who underwent only laparoscopy and group B those who underwent laparoscopy followed by laparotomy.

Both the groups were compared for different variables. For the study purpose several terminologies were defined.

- Negative laparoscopy was defined as a procedure when no abnormalities or no peritoneal breach was identified.
- Non therapeutic laparoscopy was labeled when no surgical intervention was required.
- Therapeutic laparoscopy was defined as a procedure when surgical intervention was successful laparoscopically.
- Similarly Non-therapeutic laparotomy was defined when no abnormalities were detected or no surgical intervention was required and Therapeutic laparotomy was labeled when surgical correction of injury or pathology was required.

Mean, Median, Range, and Frequencies were reported as descriptive statistics. The variables were compared using chi-square test and Student t-test for qualitative and quantitative parameters as appropriate. A p value of <0.05 was considered significant. SPSS software was used for statistical analysis

RESULT

During the study period, a total of 112 patients of torso trauma were managed in our hospital. Among

them, 60(53.6%) patients had abdominal trauma, 41(36.6%) had thoracic trauma and the remaining 11(18.33%) patients had a combined abdominal and thoracic trauma. Out of 60 patients of abdominal trauma, laparotomy was done in 29 (48.33%) patients and laparoscopy was done in 31(51.7%) patients. The consort diagram (fig 1) summarizes the study

Demographic profile

A total of 31 patients with 22(70.96%) men and 9 females (29.03%) were included in this study. The male

to female ratio was 2.4:1. The mean age was 32 years (range 8-45 years) (Table 1). The median hospital arrival time was 8 hours (range 2 hrs-10 days).

Isolated abdominal injuries were seen in 22(70.96%) patients and the remaining 9(29.03) patients had poly-trauma. The most common associated injury was chest trauma in 7(77.7%) patients followed by extremities injuries in 2(22.2%) patients as seen in table 1.

Table 1: Demographic profile.

| Parameters | Value(percentage) |
|--|-----------------------|
| Age (years) | 32 years (8-45 years) |
| Gender | |
| Male | 22(70.96%) |
| Female | 9(29.03%) |
| Mechanism of injury | |
| Blunt | 19(61.3%) |
| Penetrating | 12(38.70%) |
| System involved | |
| Isolated injury | 22(70.96%) |
| Polytrauma | 9(29.03%) |
| Median time to hospital arrival | 8 hrs (2hrs- 10days) |

AGE GROUP

In our study 15(48.4%) patients were between 31-40 years of age, 7 patients in between 21-30 years and 2 cases were more than 70 years

Types of Abdominal Injuries

Based on the mechanism of injury, 19(61.3%) patients had a blunt abdominal trauma and 12 (38.7%) patients had a penetrating trauma (Table 2). In blunt trauma fall from a height was the common cause in 50% followed by a road traffic accident in 40% cases. There were 12 patients in penetrating trauma and physical assault was the most common cause. Patients with blunt abdominal trauma were more commonly associated with poly-trauma but the difference (p0.07) was not statistically significant. Poly-trauma were in the form of chest injury, head injury, urinary bladder injury, corneal injury, and extremities injury

etc.

Characteristics of blunt and penetrating abdominal trauma

In our study, 13 patients had isolated blunt trauma abdomen and 6 patients had polytrauma. Out of 6 patients, 3 patients had ribs fracture with haemothorax, 1 patient had pelvis fracture with grade IV urinary bladder injury, 1 patient with chip fracture of body of T5 vertebrae and 1 patient with avulsed scalp injury. There were 12 patients with penetrating trauma out of which 9 patients had isolated injury and 3 patients had polytrauma. One patient had penetrating chest injury with haemopneumothorax, 1 scalp laceration and 1 corneal injury and can be seen in Table 2.

| Parameters | Blunt abdominal trauma (n 19) | Penetrating abdominal trauma (n 12) | p value |
|-----------------|-------------------------------|-------------------------------------|---------|
| System involved | | | |
| Isolated | 13(68.42%) | 9(75%) | 0.07 |
| Polytrauma | 6 (31.67%) | 3(25%) | |

Imaging modalities of abdomen

Ultrasonogram of abdomen was done in all the patients followed by CECT scan of patients when ultrasound showed injury to solid organ injuries after patient were stabilised.

Table 3: Ultrasonographic findings of Blunt and Penetrating trauma.

| USG findings | Blunt abdominal trauma (n 28) | Penetrating abdominal trauma (n11) |
|----------------|-------------------------------|------------------------------------|
| Hemoperitoneum | 19 | 8 |
| Liver injury | 4 | 2 |
| Spleen injury | 5 | 0 |
| Foreign body | 0 | 1 |

Preoperative Morbidities

Out of 5 patients with splenic injury, 2 patients presented with hypovolemic shock and they were resuscitated. The patient with duodenal injury was a known case of asthma and was in hypovolemic shock after he presented 2 days post blunt trauma. Rest of the patients in our study had no known comorbidities preoperatively.

Laparoscopy and laparotomy

A total of 31 patients underwent diagnostic laparoscopy. Out of 19 patients with blunt trauma abdomen, 15(78.94%) patients had haemoperitoneum and 4 (26.7%) patients had peritoneal breach. Similarly, out of 12 patients with penetrating injury, 10(83.33%) patients had peritoneal breach and 2(16.7%) patients had haemoperitoneum. The commonest reason for laparoscopic examination was peritoneal breach in penetrating injury and haemoperitoneum in blunt trauma patients (Table 4).

Table 4: Indications of laparoscopy.

| Indications for laparoscopy | Blunt abdominal trauma (n 19) | Penetrating abdominal trauma (n 12) |
|-----------------------------|-------------------------------|-------------------------------------|
| Peritoneal breach | 4 | 10 |
| Haemoperitoneum | 15 | 2 |

During laparoscopy common findings in blunt abdominal trauma were haemoperitoneum, splenic injury and mesenteric injury. Haemoperitoneum and peritoneal breach were common findings in penetrating injuries as outlined in Table 5. In blunt trauma abdomen there were

6 patients with mesenteric injury, 5 with splenic injury, 4 with liver injury and 4 with small bowel injuries. In penetrating trauma, 3 were of mesenteric injury, 3 patients with parietal wall bleed, 2 with liver injury and 2 patients with small bowel injury.

Table 5: Laparoscopy findings.

| Laparoscopy findings | Blunt trauma abdomen (n19) | Penetrating trauma abdomen (n12) |
|------------------------|----------------------------|----------------------------------|
| Hemoperitoneum | 19 | 8 |
| Stomach injury | 0 | 1 |
| Small bowel | 3 | 2 |
| Large bowel | 1 | 0 |
| Breach in peritoneum | 4 | 12 |
| Liver injury | 3 | 2 |
| Splenic injury | 5 | 0 |
| Mesentry injury | 6 | 3 |
| Foreign body | 0 | 1 |
| Urinary bladder injury | 1 | 0 |
| Parietal wall bleed | 0 | 3 |

Based on the operative findings with laparoscopy performed, Patients were divided into two groups. In Group A: simply laparoscopic procedure was performed and in Group B: laparoscopy was followed by laparotomy. There were 21(67.74%) patients in Group A and 10(32.25%) patients in Group B.

7(33.33%) patients with blunt trauma and 3(25%) patients with penetrating trauma were in group B.

12(63.15%) patients of blunt trauma and 9(75%) patients of penetrating trauma were in group A. Similarly,

Table 6: Division of groups.

| Division | No of patients (n) | % |
|--|--------------------|-------|
| Group A (laparoscopy) | 21 | 67.74 |
| Group B (laparoscopy followed by laparotomy) | 10 | 32.25 |

REASONS FOR CONVERSION

Out of 10 patients where laparoscopy was converted to laparotomy, 4 patients had a moderate hemoperitoneum with mesenteric injury, 1 near total transection of 2nd part of duodenum, 2 patients with jejunal perforation, 2

patients with grade IV splenic injury and 1 patient with grade IV urinary bladder injury. The most common reason for conversion was mesenteric bleed and the hemostasis was very difficult to achieve. (Table 7).

Table 7: Reasons for conversion to laparotomy.

| Reasons | Number of patients (n) | Conversion |
|------------------------|------------------------|------------|
| Mesenteric injury | 4 | 40% |
| Small bowel injuries | 3 | 30% |
| Splenic injury | 2 | 20% |
| Urinary bladder injury | 1 | 10% |

Out of 4 patients with mesenteric bleed, 2 was converted because edematous, inflamed and distended bowel loops making intra-operative difficulty, 1 was converted because of less working space due to morbid obesity and the last one was converted because of intra-op fall in BP due to shock. Among hollow viscus injuries, duodenal injury had to be converted because of difficulty in mobilization of duodenum, two jejunal perforations were converted because of large perforation with unhealthy bowel margins which required placement of stomas. Both splenic injury had to be converted because of active bleed difficult to take care. The urinary bladder injury was converted because of urologists preferring it to do it openly.

laparoscopy was labeled in 18 patients where abnormalities were detected but didn't require any further intervention. Therapeutic laparoscopy was successful in 3 patients: 1 case of a foreign body removal, 1 serosal repair of colon injury and one case of clipping of mesenteric bleed. In Group B, no surgical intervention was required in 2 patients after laparotomy and was termed as Non therapeutic laparotomy. These 2 patients of non- therapeutic laparotomy had a mesenteric bleed which had stopped bleeding with no other injuries. Therapeutic Laparotomy was done in 8 patients (Table 8). Among the therapeutic laparotomies, ligation of bleeding mesenteric blood vessel was done in 2 patients, triple duodenostomy done in 1 patient, double barrel stoma in both jejunal perforation patients, splenectomy in 2 patients and primary repair of intraperitoneal bladder injury. At laparotomy, no additional injuries were found.

Operative procedure

In Group A, there were no patients with injuries or peritoneal breach during laparoscopic examination and were labeled as Negative laparoscopy. Non- therapeutic

Table 8: Operative Procedures.

| Group A (21): laparoscopy | Number of patients (n) | % |
|--|------------------------|-------|
| Negative laparoscopy | 0 | 0% |
| Non Therapeutic laparoscopy | 18 | 58.1% |
| Therapeutic laparoscopy | 3 | 9.7% |
| Group B (10): laparoscopy followed by laparotomy | | |
| Non therapeutic laparotomy | 2 | 6.45% |
| Therapeutic laparotomy | 8 | 25.8% |
| Total no. of patients | 31 | 100% |

Organ injury scale

Developed by the organ injury scaling committee of the American Association for the Surgery of Trauma (AAST), we classified our organ injury accordingly as shown in Table 9. In group A, one patient of mesenteric bleed was of grade I which required

clipping of artery laparoscopically. Out of 5 patients of liver injury, 1 patient was of grade IV, 2 patients of grade III and 2 patients of grade I. Similarly, out of 3 patients of splenic injury, 2 patients had grade II and 1 patient had grade I injury.

In group B, both the patients of splenic injury were of grade IV. Similarly, 2 patients had grade I mesenteric

injury and 1 patient suffered grade IV urinary bladder injury.

Table 9: Organ injury scaling.

| Group A: laparoscopy | No. of patients | Grade |
|---|-----------------|----------|
| Mesentric bleed | 1 | I |
| Liver injury | 2+2+1 | I+III+IV |
| Splenic injury | 1+2 | I+II |
| Group B: laparoscopy followed by laparotomy | | |
| Mesenteric injury | 2 | I |
| Splenic injury | 2 | IV |
| Urinary bladder injury | 1 | IV |

Primary outcome measure

- (a) Diagnostic laparoscopy helped 67.74 % patients avoid laparotomy
- (b) In our study, both Sensitivity and Specificity of laparoscopy as a diagnostic tool was 100 %.

Secondary outcome measures

(a) Accuracy rate of laparoscopy in diagnosing injuries

Out of 31 study subjects, 21 (67.74%) patients were managed laparoscopically and they did not require any further surgical intervention. No injuries were missed in

these patients. Laparoscopy was 100% accurate in identifying injuries.

(b) Effect of Laparoscopy on post operative complications

In group A, 3 patients had fever and 5 patients had chest infection during their hospital stay. There were no port site infection in this group. Fever, port or surgical site infection and chest infection were significantly higher in the laparotomy group (Table 10).

Table 10: Comparision of post operative complications.

| Morbidity | No of patients (Group –A) n 8 | No of patients (Group-B) n 16 | p value |
|-------------------------|-------------------------------|-------------------------------|---------|
| Fever | 3 | 5 | 0.01 |
| Surgical site infection | 0 | 4 | 0.02 |
| Chest infection | 5 | 7 | 0.2 |

(a) Effect of laparoscopy on the length of hospital stay

The median length of hospital stay in laparoscopy group was 4 days (range 1-14 days) and in the laparotomy group it was 19.5 days (range 14-25 days) (p=0.001). The reason for prolonged hospital stay in group B patients were due to chest infection with reactive pleural effusion in 3 patients which was managed with tube thoracostomy. Other reason was surgical site infection which required debridement and dressing.

Outcome of treatment

In our study all of the 31 patients were successfully discharged after treatment with a 100% success rate.

Follow up

Out of 21 patients in group A, 15 patients followed up, 1 patient had hypertrophic scar. Remaining 6(28.6%) patients were lost to follow up. Similarly in group B, out of 10 patients, 4 patients with midline wound infection were followed up and secondary suturing was done once granulation tissue appeared. Rest of 4 patients in group B were lost to follow up.

Photographs

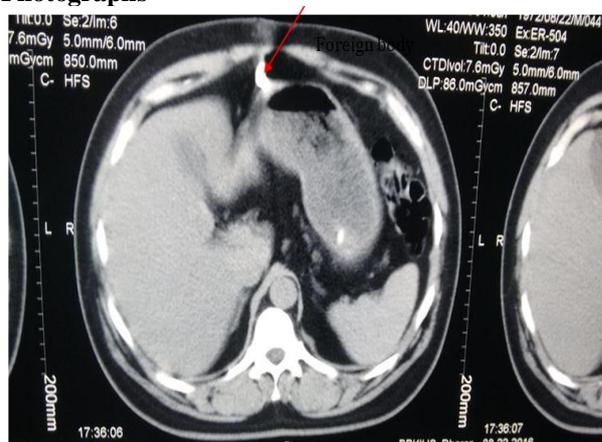


Fig 1: CT scan image showing foreign body in ligamentum flavum.



Fig 2: Retrieved foreign body done laparoscopically.



Fig 3: CT scan image showing liver injury.



Fig 4: CT scan image showing Splenic injury



Fig 5: Omental injury.

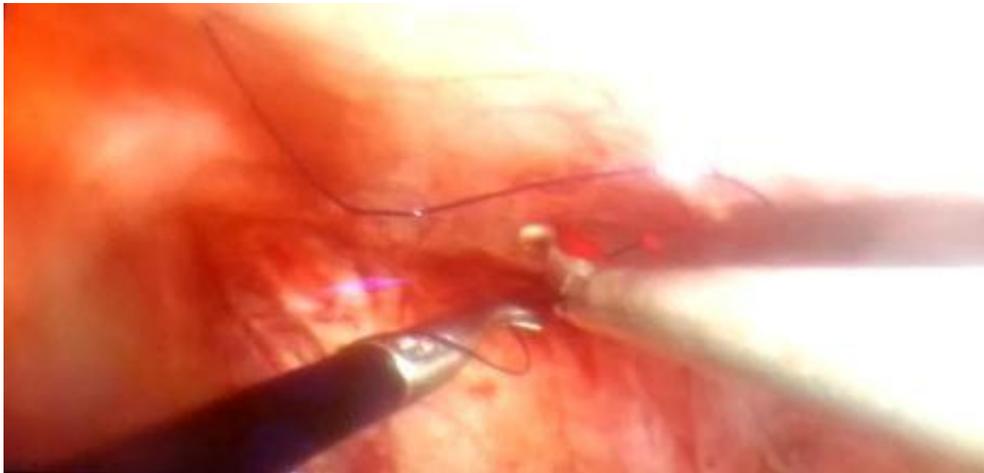


Fig 6: Laparoscopic suturing.

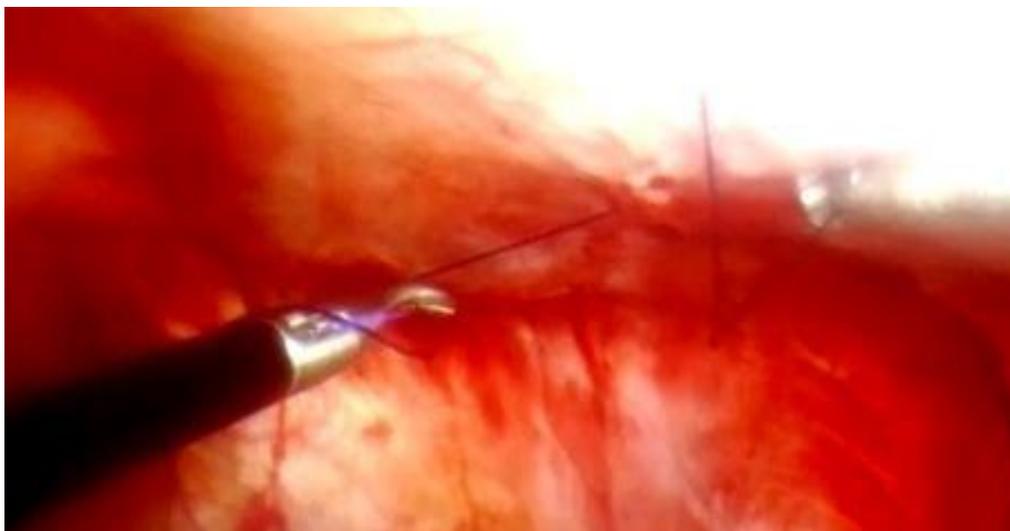


Fig 7: Laparoscopic suturing.

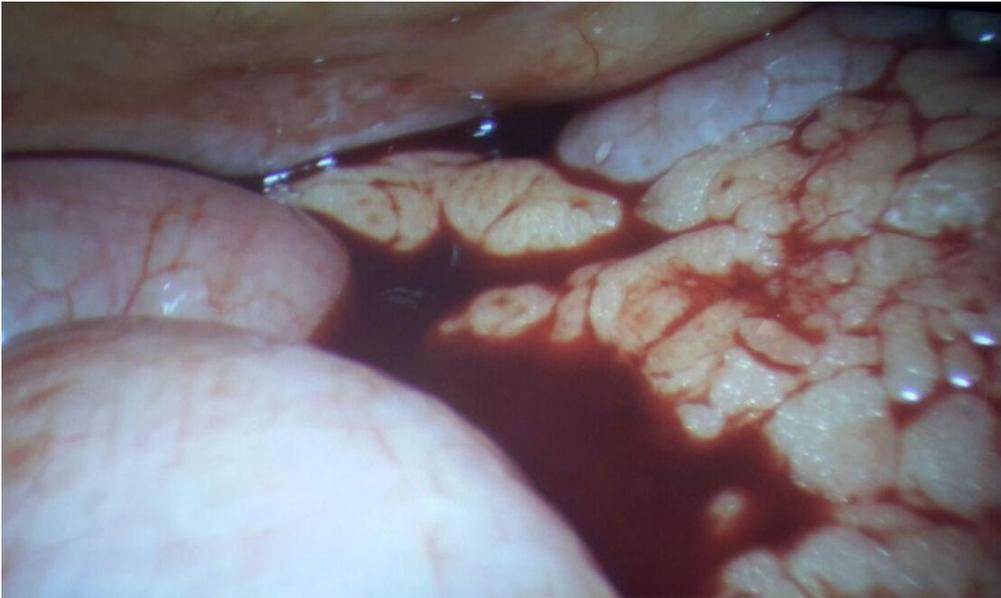


Fig 8: Hemoperitoneum

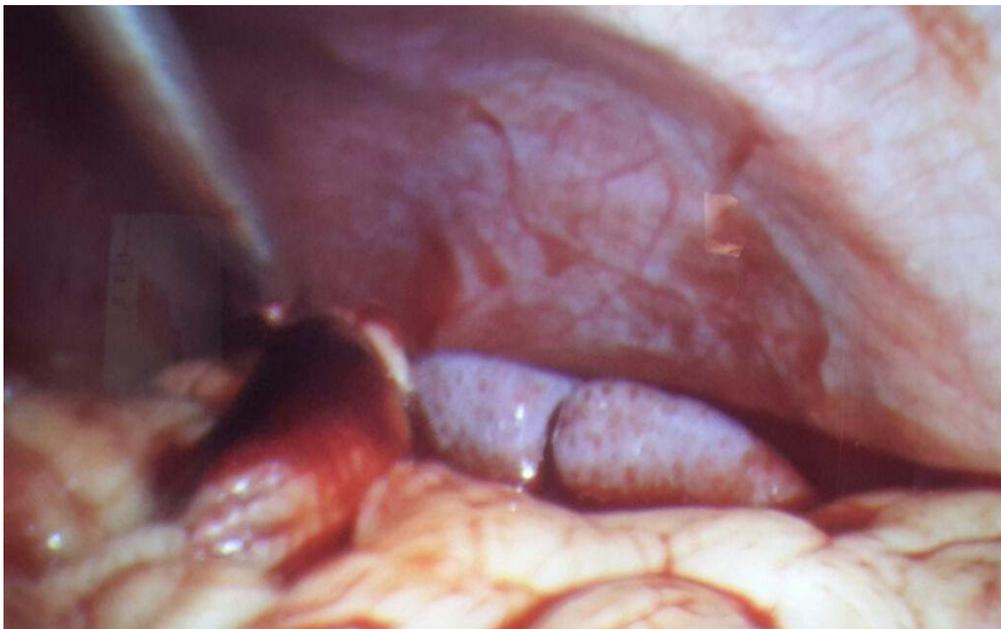


Fig 9: splenic injury.

DISCUSSION

Urgent exploratory laparotomy is standard treatment in management of abdominal trauma patients who are hemodynamically unstable or non-responders and/or FAST positive. FAST is of great value in patients with abdominal trauma especially in those, who are hemodynamically unstable. Because it can be done at bedside, it's non-invasive and repeatable. FAST positive hemodynamically unstable patients can be directly shifted to Operation Theater. Its role lies in its high sensitivity for detecting intra-peritoneal fluid which accumulates in dependent areas around the liver, spleen, pouch of douglas and pelvis (Abu-ZidanFm et al, 1999). It is not accurate in obese patients, in case of paralytic ileus or in presence of subcutaneous emphysema. It may miss 25% of intra-abdominal injuries in case it is only

the diagnostic tool and is not accurate in detecting retroperitoneal or hollow viscus injuries (Peitzman AB et al, 1986) (Cogbill TH, Moore EE, Jurkovich GJ, 1990).

The rate of non-therapeutic laparotomy continued to be high, even though many diagnostic modalities are available to diagnose intra-abdominal injuries in abdominal trauma patients. This is often associated with increased post-operative complications, longer length of hospital stay and higher hospital cost. The adoption of laparoscopic surgery in trauma may be associated with surgeon's expertise and comfort. Surgeons with advanced laparoscopic skills can perform therapeutic laparoscopic procedures.

Abdominal trauma patients with a stable hemodynamics at times become a challenge to trauma surgeon. Most of these patients can be managed non-operatively with active monitoring and careful observation. But many studies have reported high rate of complications following non-operative treatment in cases of missed intra-abdominal injuries (Walker ML et al, 2012)(Biff WL et al, 2011)(Niedere MJ et al, 2003). Neideree et al demonstrated an increase in sepsis and acute respiratory distress syndrome when surgical intervention was delayed for 24 hours (Plackett TP et al, 1992-2008). On the other hand exploratory laparotomy is one of the options in such patients but various studies have reported that no injuries were found in 15 to 40 % of the cases (Berci G et al, 1991)(Chol YB, Lim KS, 2003). High rate of non-therapeutic laparotomies (Berci G et al, 1991)(Chol YB, Lim KS, 2003), on one hand and drawbacks of non-operative management on other hand led to new approach in treatment. Diagnostic laparoscopy is a good option with potential advantages in such patients. Diagnostic laparoscopy can help where imagings are not conclusive. It is minimal invasive and procedure can easily be converted to open.

Several studies have shown that, blunt abdominal trauma patients frequently had associated multiple injuries in comparison to the penetrating trauma patients. Blunt trauma patients had a higher rate of conversion to laparotomy and post-operative complications (Khubutiya MSh et al, 2003)(Dittrich K, Abu-Zidan FM, 2004). In our study, rate of conversion to laparotomies was 33.3% in blunt trauma as compared to 25% in penetrating trauma.

This study summarized our experience with laparoscopy in treatment of abdominal trauma patients. Laparoscopy has been available in our hospital since 1998. We have been doing non trauma related Laparoscopic procedures such as Laparoscopic Cholecystectomy, Common Bile Duct Exploration, Hernia repairs, splenectomy, surgeries of pseudocyst and hydatid cyst, colo-rectal surgeries etc regularly. The use of laparoscopy in trauma patients is its natural extension.

It has been well established that laparoscopy is an acceptable diagnostic or therapeutic modality in a hemodynamically stable patients with penetrating abdominal injuries (Khubutiya MSh et al, 2003)(Dittrich K, Abu-Zidan FM, 2004). We used laparoscopy in blunt abdominal trauma patients with a haemoperitoneum and in penetrating trauma with suspicion of peritoneal breach. Berci et al have reported 25% reduction in non-therapeutic laparotomies in 150 blunt abdominal trauma patients (Lingawi SS, Buckley AR, 2000). Renz BM et al in another study showed that laparoscopy had a diagnostic accuracy of 100 % and averted nontherapeutic laparotomy in 82% of cases (Brefort JL et al, 1997). Laparoscopy prevented 67.74% of laparotomies in our study.

Therapeutic laparoscopy was performed in 3(9.7%) cases. However, our data is comparable with the published data which have reported 30-70% reduction of non-therapeutic laparotomies (Brefort JL et al, 1997)(Lingawi SS, Buckley AR, 2000). Zafar S.N et al in a systematic review reported, Therapeutic laparoscopy rate of 19.3%.With increasing surgeon's expertise, improved equipment and enhanced technology, these rates are likely to increase in future.

Another review article of 20 studies by O'Malley et al demonstrated that out of 1,263 diagnostic laparoscopic procedures for penetrating abdominal trauma, 597 cases had injuries, and 145 of them were managed laparoscopically with a success rate of 24% (range 6.7 % to 100)(SosaJL et al, 1995). In our study, 9.7% patients with abdominal injuries were managed laparoscopically. Most common reason for conversion to laparotomy in our study was mesenteric bleed difficult to control in 40% patients followed small bowel injury in 30%. Khubutiya et al reported 21.3% conversion to open procedure to detect source of bleeding and hemostasis, similarly 11.8% conversion because of hollow viscus injury (Dittrich K, Abu-Zidan FM, 2004).

Lower rate of post-operative complications, shorter length of hospital stay and shorter recovery time are other advantages associated with laparoscopic procedure (Khubutiya MSh et al, 2003)(Dittrich K, Abu-Zidan FM, 2004). In our study patients who underwent only laparoscopy had a significantly lower rate of post-operative complications and shorter length of hospital stay compared to patients who underwent laparotomy. In our study, no surgical site infection was present in group A whereas 4 patients had surgical site infection in group B. Similarly 7 patients had chest infection in group B compared to 5 patients in group A. The median length of hospital stay in laparoscopy group was 4 days and in the laparotomy group it was 19.5 days.

One of the main drawbacks regarding diagnostic laparoscopy in trauma is a potential of missing injury, which is associated with significant morbidity or mortality. A number of retrospective and prospective studies have reported no missed injuries (Barzana DC et al, 2011)(Smith RS et al, 1995). While some studies have reported a rate of 3 to 4% (Villavicencio RT, Aucar JA) (SosaJL et al, 1995). In our study, no injuries were missed on laparoscopic examination and conversion to open was done with a therapeutic intention and for patients' safety and well-being. A review of 50 papers published by O'Malley in 2013, reported an average missed injury rate of 3.2% (SosaJL et al, 1995).

Outcomes after laparoscopic surgery vary greatly with surgeons' expertise. The logistics required in laparoscopic surgery is another major hindrance to its adoption in trauma. Availability of laparoscopic facility and surgeon with experience in laparoscopy are minimum basic requirements.

CONCLUSION

In conclusion, laparoscopy has a definite role in the management of hemodynamically stable patients with suspected abdominal injury to prevent nontherapeutic laparotomies, and thereby decreasing post-operative complications and decreasing length of hospital stay. In our study, we did not miss any injuries. We were successful in 67.74% cases to avoid laparotomy. However, we should conduct studies on a much larger scale to come to a more justified and scientific inference.

REFERENCES

1. Abakumov MM (2005). Diagnostics abdominal injuries in combined trauma. In: Abakumov MM, Lebedev NV, Maliarchuk VI, eds. *Abdominal Injuries in Combined Trauma*. Moscow: OAO Medicina Publisher's, 1–176.
2. Abu-Zidan Fm, Sheikh M, Jaddallah F, Windsor JA. Blunt abdominal trauma: Comparison of ultrasonography and computed tomography. *Austral Radiol*, 1999; 43: 440–443.
3. Ahmad N, Whelan J, Brownlee J (2005). The contribution of laparoscopy in evaluation of penetrating abdominal wounds. *J Am Coll Surg*, 201; 213-6.
4. Barzana DC, Kotwall CA, Clancy TV, et al. Use of laparoscopy in trauma at a level II trauma center. *JLS*, 2011; 15: 179–81.
5. Berci G, Dunkelman D, Michel SL,(1983). Emergency minilaparoscopy in abdominal trauma. An update. *Am J Surg*, 146: 261-5.
6. Biffi WL, Kaups KL, Pham TN. Validating the Western Trauma Association algorithm for managing patients with anterior abdominal stab wounds: a Western Trauma Association multicenter trial. *J Trauma*, 2011; 71: 1494–1502.
7. Brefort JL, Samama G, Le Roux Y, Damamme A. Contribution of laparoscopy in the management of abdominal stab wounds. *Ann Chir*, 1997; 51: 697–702.
8. Brongel L, Hładki W, Karski J, (2010). Postępowanie w przypadku urazów. Zalecenia Sekcji Urazów Towarzystwa Chirurgów Polskich. *Medycyna Praktyczna – Chirurgia*, 5: 9-25.
9. Carnevale N, Baron N, Delaney HM (1977). Peritoneoscopy as an aid in the diagnosis of abdominal trauma: a preliminary report. *J Trauma*, 17: 634-41.
10. Cherry RA, Eachempti SR, Hydo LJ, Barie PS (2005). The role laparoscopy in penetrating abdominal stab wounds. *Surg Laparosc Endosc Percutan Tech*, 15: 14-7.
11. Cheynel N, Gentil J, Freitz M,(2011). Abdominal and pelvic injuries caused by road traffic accidents: characteristics and outcomes in a French cohort of 2009 casualties. *World J surg*, 35: 1621-1625.
12. Cogbill TH, Moore EE, Jurkovich GJ. Nonoperative management of blunt splenic trauma: a multicenter experience. *J Trauma*, 1990; 29: 1312-1317.
13. Cuschieri A, Hennessy TP, Stephens RB, Berci G (1988). Diagnosis of significant abdominal trauma after road traffic accidents: preliminary results of a multicentre clinical trial comparing minilaparoscopy with peritoneal lavage. *Ann R Coll Surg Engl*, 70: 153-5.
14. DeMaria EJ, Dalton JM, Gore DC, (2000). Complementary roles of laparoscopic abdominal exploration and diagnostic peritoneal lavage for evaluating abdominal stab wounds: a prospective study. *J Laparoendosc Adv Surg Tech A*, 10: 131-6.
15. Ditmars ML, Bongard F (1996). Laparoscopy for triage of penetrating trauma: the decision to explore. *J Laparoendosc Surg*, 6: 285-91.
16. Dittrich K, Abu-Zidan FM. Role of Ultrasound in Mass-Casualty Situations. *International Journal of Disaster Medicine*, 2004; 2: 18–23.
17. Ertekin C, Onaran Y, Gülog˘lu R,(1998). The use of laparoscopy as a primary diagnostic and therapeutic method in penetrating wounds of lower thoracic region. *Surg Laparosc Endosc*, 8: 26-9.
18. Fabian TC, Croce MA, Stewart RM (1993). A prospective analysis of diagnostic laparoscopy in trauma. *Ann Surg*, 217: 557-64.
19. Fernando HC, Alle KM, Chen J (1994). Triage by laparoscopy in patients with penetrating abdominal trauma. *Br J Surg*, 81: 384-5.
20. Forde KA, Ganepola GA (1974). Is mandatory exploration for penetrating abdominal trauma extinct? The morbidity and mortality of negative exploration in a large municipal hospital. *J Trauma*, 14: 764-6.
21. Gazzaniga AB, Santon WW, Bartlett RH (1976). Laparoscopy in the diagnosis of blunt and penetrating to the abdomen. *Am J Surg*, 131: 315-8.
22. Haan J, Kole K, Brunetti A (2003). Nontherapeutic laparotomies revisited. *Am Surg*, 69: 562-5.
23. Hallfeldt KK, Trupka AW, Erhard J (1998). Emergency laparoscopy for abdominal stab wounds. *Surg Endosc*, 12: 907-10.
24. Inaba K, Demetriades D (2007). The nonoperative management of penetrating abdominal trauma. *Adv Surg*; 41: 51-62.
25. Ivatury RR, Simon RJ, Stahl WMA (1993). Critical evaluation of laparoscopy in penetrating abdominal trauma. *J Trauma*, 34: 822-7.
26. Karch DL, Logan J, McDaniel D (2012). Centers for Disease Control and Prevention (CDC). Surveillance for violent deaths—National Violent Death Reporting System, 16 states, 2009. *MMWR Surveill Summ*, 61: 1–43.
27. Kawahara NT, Alster C, Fujimura I (2009). Standard examination system for laparoscopy in penetrating abdominal trauma. *J Trauma*; 67: 589-95. Khubutiya MSh, Yartsev PA, Guliaev AA, Levitsky VD, Tlibekova MA. Laparoscopy in blunt and penetrating abdominal trauma. *Surg Laparosc Endosc Percutan Tech*, 2013 Dec; 23(6): 507-12.

28. Kremer K (2001). Diagnostic laparoscopy for trauma. In: Minimally abdominal surgery. Kremer K, Platzer W, Schreiber HW, Steichen FM (eds.). Thieme Stuttgart, New York, 61-68.
29. Leppäniemi AK, Haapiainen RK (1996). Selective nonoperative management of abdominal stab wounds: prospective, randomized study. *World J Surg*, 20: 1101-5.
30. Lingawi SS, Buckley AR. Focused Abdominal US in Patients with Trauma. *Radiology*, 2000; 217: 426-429.
31. MacKenzie EJ, Fowler CJ (2008). Epidemiology. In: Trauma. Feliciano DV, Mattox KL, Moore EE (eds.) 9th ed. McGrawHill, New York, 25-39.
32. Nast-Kolb D, Bail HJ, Taeger G (2005). Current diagnostics for intraabdominal trauma. *Chirurg*, 76: 919-926.
33. Neugebauer E, Sauerland S (2006). Guidelines for emergency laparoscopy. *World J Emerg Surg*, 1: 31.
34. Ong CL, Png DJ, Chan STF (1994). Abdominal trauma—a review. *Singapore Med J.*, 35: 269-270.
35. Niederee MJ, Byrnes MC, Helmer SD, Smith RS. Delay in diagnosis of hollow viscus injuries: effect of outcome. *Am Surg*, 2003 Apr; 69(4): 293-8; 298-9.
36. Ortega AE, Tang E, Froes ET (1996). Laparoscopic evaluation of penetrating thoracoabdominal traumatic injuries. *Surg Endosc*, 10: 19-22.
37. Peitzman AB, Makaroun MS, Slasky BS, Ritter P. Prospective study of computed tomography in initial management of blunt abdominal trauma. *J Trauma*, 1986; 26: 585-592.
38. Plackett TP, Fleurat J, Putty B. Selective non-operative management of anterior abdominal stab wounds: 1992-2008. *J Trauma*, 2011; 70: 408-413.
39. Renz BM, Feliciano DV (1995). Unnecessary laparotomies for trauma: a prospective study of morbidity. *J Trauma*, 38: 350-6.
40. Salimi J, Ghodsi M, Zavvarh MN (2009). Hospital management of abdominal trauma in Tehran, Iran: a review of 228 patients. *Chin J Traumatol*, 12: 259-262.
41. Simon RJ, Rabin J, Kuhls D (2002). Impact of increased use of laparoscopy on negative laparotomy rates after penetrating trauma. *J Trauma*, 53: 297-302.
42. Smith RS, Fry WR, Morabito DJ, et al. Therapeutic laparoscopy in trauma. *Am J Surg*, 1995; 170: 632-637.
43. Sosa JL, Arrillaga A, Puente I. Laparoscopy in 121 consecutive patients with abdominal gunshot wounds. *J Trauma*, 1995; 39: 501-506.
44. Sugrue M, Balogh Z, Lynch J (2007). Guidelines for the management of haemodynamically stable patients with stab wounds to the anterior abdomen. *ANZ J Surg*, 77: 614-20.
45. Taner AS, Topgul K, Kucukel F (2001). Diagnostic laparoscopy decreases the rate of unnecessary laparotomies and reduces hospital costs in trauma patients. *J Laparoendosc Adv Surg Tech A*, 11: 207-11.
46. Tortella BJ, Blackwood J, Machiedo GW, Rush BF Jr (1992). The role of laparoscopy in abdominal trauma. *J Trauma*, 33: 471-5.
47. Walker ML, Akpelel, Spence SD. The role of repeat computed tomography scan in the evaluation of blunt bowel injury. *Am Surg*, 2012; 78: 979-985.
48. Weinberg JA, Magnotti LJ, Edwards NM, Claridge JA, Minard G, Fabian TC, Croce MA (2007). "Awake" laparoscopy for the evaluation of equivocal penetrating abdominal wounds. *Injury*, 38: 60-4.
49. World Health Organization. Global Burden of Disease. Available at: http://www.who.int/healthinfo/global_disease/en.
50. Villavicencio RT, Aucar JA, Analysis of laparoscopy in trauma. *J Am Coll Surg*, 1999; 189: 11-20.
51. Zantut LF, Ivatury RR, Smith RS (1997). Diagnostic and therapeutic laparoscopy for penetrating abdominal trauma: a multicenter experience. *Trauma*, 42: 825-9.