Comparison between Open and Laparoscopic Formal Abdominal Exploration in Penetrating Anterior and Thoraco-Abdominal Stab Wounds

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Abstract

Background: The management of patients with anterior and thoraco-abdominal stab wounds has been debated for many years. Although laparotomy is mandatory in patients presenting with shock, evisceration and peritonitis, controversies still exist regarding the best approach for patients without these presentations. Laparoscopic surgery plays an important role regarding the diagnosis and management of this group of patients.

Aim of the Study: This study was conducted to compare the results regarding the open and laparoscopic formal abdominal exploration in penetrating anterior and thoraco-abdominal stab wounds.

Patients: This prospective randomized controlled study included 50 vitally stable patients who presented to Kasr Al-Ainy Emergency Department with anterior and thoraco-abdominal stab wounds during the period from March 2014 to June 2015.

Methods: All patients were subjected to screening laparoscopy. Those who were proven to be non-penetrating were excluded. Patients with proven peritoneal penetration were randomly divided into two groups (laparotomy and laparoscopic groups) using closed envelope technique for randomization. The following variables were then compared between the 2 groups: Operative time, postoperative pain using numerical rating system (NRS), length of postoperative hospital stay, wound complications, chest infection and missed injuries.

Results: Based on the statistical analysis, it was found that the laparoscopy when used as a diagnostic tool is superior to laparotomy as regards the operative time and postoperative pain. As a therapeutic tool, laparoscopy was able to repair liver, stomach and diaphragmatic injuries and was superior to laparotomy regarding postoperative pain and length of hospital stay. Laparotomy had a higher rate of chest infection and wound infection with no statistical significance. Currently, the main drawbacks of laparoscopy are the technical challenges regarding bowel inspection and therapeutic procedures, which was reflected on the presence of converted cases in the study.

Key Words: Stab wounds – Anterior – Thoraco-abdominal – Diagnostic laparoscopy – Laparotomy.

Introduction

STABBING is the most common cause of homicide. Stab wounds are incised wounds where the length of injury on the surface is less than the depth of penetration into the body, and are the result of a thrusting action, where the force is delivered along the long axis of a narrow, pointed object. The force of impact is concentrated at the tip of the implement, and the sharper the tip, the easier it will penetrate the skin [1].

There is no doubt that patients presenting with abdominal stab wounds who are vitally unstable require immediate surgery. However, there are several possible options for the evaluation of abdominal stab wounds in the hemodynamically stable patients. These include using serial clinical assessment, diagnostic modalities or a combination of both. The goal of any algorithm for the management of these patients should be to identify injuries requiring surgical repair, and avoid unnecessary laparotomy with its associated morbidity [2].

With the advent of fine precision instruments, minimally invasive surgeries have been applied to various specialties. Current use of laparoscopy in the diagnosis and management of trauma patients has been a natural extension of this trend [3].

The rapid development of laparoscopic surgery has further been added to the issue of the best approach for the anterior and thoraco-abdominal
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stab wounds. Not only is it possible to identify penetration through the diagnostic laparoscopy but also the procedure has been used as therapeutic modality that includes repair of diaphragmatic lacerations, treatment of gastrointestinal perforations, repair of low-grade liver and splenic lacerations, and resection of small bowel and colon [4,5].

Despite these advances, the role of laparoscopy in trauma has not yet paralleled the popularity of open surgery for several reasons, including the emergent nature of many of the operations, the lack of expertise and comfort level of surgeons, the added time for equipment setup, the difficulty assessing the small bowel, and the fear of missed injuries. This represents the main motive for this study [6].

Material and Methods

This prospective randomized controlled study included 50 patients who presented to Kasr Al-Ainy Emergency Department with anterior and thoraco-abdominal stab wounds during the period from March 2014 to June 2015.

Patients who were presenting with hemodynamic instability, multiple stab wounds and stab wounds to the back and flanks were excluded from the study. All vitally stable patients without peritonitis were subjected to screening laparoscopy. Those who were proven to be non-penetrating were excluded. Patients with proven peritoneal penetration were randomly divided into two groups (laparotomy and laparoscopic groups) using closed envelope technique for randomization.

The screening laparoscopy was performed under general anesthesia. Pneumoperitoneum was achieved with low CO2 flow and maintained at low pressures (8-12mmHg). Visualization of the abdominal wall and the diaphragm was achieved first. Laparoscopic formal exploration was started with the patient in the reverse Trendelenburg position. The supracolic compartment was visualized by inspection of the liver, gall bladder, hepatic flexure of the colon, the anterior wall of the stomach to the GE junction, the posterior wall of the stomach (by dividing the gastrocolic omentum), the spleen and the splenic flexure of the colon. The infracolic compartment was visualized next with the patient in the supine position with right or left tilting of the table accordingly. The pelvis was visualized with the patient in the steep Trendelenburg position, the small bowel loops are lifted in the abdomen and inspection of the rectum, bladder, female pelvic organs was done. The technique for inspection of the small bowel was started at the Ileocecal valve towards the duodeno-jejunal junction. The small bowel was visually divided into 3 parts: Distal one-third: The patient should be in a Trendelenburg position with a right anterior oblique table tilt. Most of the small intestines were pushed in the left upper abdomen. The surgeon stood to the left side of the patient with the monitor near the right foot. Each segment of intestine evaluated was placed in the pelvis. Middle one-third: A reverse Trendelenburg position with left table tilt was used, the surgeon moved to the right side of the patient facing the upper torso and the monitor were moved to the patient’s head. The open exploration inspected the same structures through a midline exploratory laparotomy.

The procedures were defined as follows: Negative laparoscopy: If the stab was not penetrating the peritoneum, these patients were excluded from the study. Non therapeutic laparoscopy or laparotomy: If the stab was penetrating but not injuring any intra-abdominal structure or injuring a structure but did not require repair as a non-bleeding liver tear. Fig. (1). Therapeutic laparoscopy or laparotomy: If an intra-abdominal injury that required management was encountered Figs. (2,3).

The following variables were then compared between the 2 groups: Operative time, postoperative pain using numerical rating system (NRS), length of postoperative hospital stay, wound complications, chest infection and missed injuries.

Data were statistically described in terms of mean, standard deviation, median and range, or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student t-test for independent samples. For comparing categorical data, Chi square test was performed. Exact test was used instead when the expected frequency is less than 5. Accuracy was represented using the terms sensitivity, specificity, +ve predictive value, –ve predictive value, and overall accuracy. p-values less than 0.05 was considered statistically significant. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) release 15 for Microsoft Windows (2006).
Fig. (1): A- Non bleeding right lobe liver tear with hemoperitoneum in the right upper quadrant. B- Falciiform ligament tear.

Fig. (2): A- Gastric perforation in the anterior wall. B- Peritoneal penetration in the same patient, note the presence of pyogenic membranes and the peritoneal inflammation caused by the spillage.

Fig. (3): A- Anterior wall stomach tear found during laparotomy for an anterior abdominal stab wound. B- Small bowel perforation seen in a patient with an anterior abdominal stab wound.

**Results**

The study included 50 patients, most of the patients in this study were males (97.8%), in the middle age group (Mean age: 25.09 years). 58% of all the explorations were non-therapeutic, whereas 42% were therapeutic. There was no significant difference in the distribution of the therapeutic and non-therapeutic operations among the open, laparoscopic groups ($p=0.33$). When the laparoscopic
Comparison between Open & Laparoscopic Formal Abdominal Exploration was used, it spared a non-therapeutic laparotomy in 48.2% of patients and was therapeutic in 33%. In contrast, with the open approach, 48.2% of patients had non-therapeutic laparotomies.

Four out of the 25 patients in the laparoscopic group were converted to open resulting in a conversion rate 16%. These cases were excluded from the further comparisons as parameters like operative time would be affected by the conversion rather than the approach itself (laparoscopic) Table (1) 

<table>
<thead>
<tr>
<th>Type of the intervention</th>
<th>Approach</th>
<th>Total</th>
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<tbody>
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<td></td>
<td>Open</td>
<td>Laparoscopic</td>
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<tr>
<td><strong>Non-therapeutic:</strong></td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>% within group</td>
<td>48.2%</td>
<td>48.2%</td>
</tr>
<tr>
<td><strong>Therapeutic:</strong></td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>% within group</td>
<td>52.3%</td>
<td>33%</td>
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The operative time was shorter in the laparoscopic group than the open group with a mean of 1.5 days, 2.5 days respectively in the non-therapeutic population \((p=0.03)\), and 2.2 days, 4.6 days respectively in the therapeutic population \((p<0.01)\).

Wound complications were higher in the open group. This result was statistically significant in the therapeutic population \((p=0.035)\) and insignificant in the non-therapeutic population \((p=0.2)\). Higher incidence of chest complications was observed in the open group compared to the laparoscopic group regardless of the type of the procedure (therapeutic or non-therapeutic) with no statistical significance \((p=0.2)\). Pneumothorax was associated with diaphragmatic injuries in 60% of open group, and 66% of the laparoscopic group. No missed injuries were encountered in the study.

Discussion

The management of penetrating stab wounds has been a subject of debate, Mandatory laparotomy for stable patients without signs of peritonitis has lead to unnecessary operations in 38-40% of patients, and postoperative morbidity ranging from 3% to 16% \([2]\). Despite technological advances in surgery, the role of laparoscopy in trauma has not yet paralleled the popularity of open surgery \([4,5]\).

This prospective randomized controlled study included 50 patients who presented to Kasr Al-Ainy Emergency Department with anterior and thoraco-abdominal stab wounds during the period from March 2014 to June 2015.

Both groups were homogenous from the start regarding age, sex and stab zone distribution (Anterior and TAB) as no statistical differences were detected for the above mentioned parameters \((p>0.05)\). Most of the patients in this study were males (97.8%), in the middle age group (Mean age: 25.09 years). These results were more or less similar to other studies \([7,8]\).

4 out of the 25 patients in the laparoscopic group were converted to open resulting in a conversion rate 16%. The reasons for conversion were inability to adequately evaluate the bowel for injuries, laparotomy revealed small bowel and colon tears, suspected bowel injury (pyogenic membranes, purulent collection) that required proper assessment through a mini laparotomy that revealed bowel injury, difficult control for a bleeding liver tear and hemoperitoneum with no obvious source, a laparotomy was performed which was negative for intra-abdominal injury. The source of bleeding was found in the abdominal wall muscu-
lature after removal of clots from the penetration site of the stab wound. A significant correlation was found between the anterior stab wounds and the conversion rate ($p$-value=0.04).

These 4 cases were excluded from the further comparisons as parameters like operative time would be affected by the conversion rather than the approach itself (laparoscopic).

Lower conversion rates (2 to 4%) were reported in recent studies [8,9]. Amber et al., reported a higher conversion rate 39% [22], however his study included all types of penetrating injuries. The reason for this considerable variation might be related to the experience of the attendant surgeons in the emergency departments, the learning curve and the advances in laparoscopic instrumentation.

No missed injuries were encountered in the study. The same result was obtained in several studies [9,11-14]. A systematic review showed that missed injuries accounted for 3.2% of abdominal stab wounds [15]. However, some older studies reported a missed injury rate of 30% concluding that a complete laparoscopic examination of the bowel was challenging [16,17].

The key points to avoid missed injuries in the laparoscopic group included a systematic and careful inspection, using atraumatic graspers when handling the bowel and, most importantly, conversion to laparotomy when the surgeon was not confident regarding the full and adequate inspection of the bowel.

The operative time in this study was shorter in the laparoscopic group in the non-therapeutic population but higher when the laparoscopy was used as a therapeutic tool. The mean operative time was found to be 68.79min, 46.2min in the open and laparoscopic non-therapeutic explorations respectively and 112.5min, 92.5min in both groups of the therapeutic explorations. These differences were statistically significant ($p<0.05$).

This result might be due to the fact that a non-therapeutic laparoscopy requires less time than a non-therapeutic laparotomy. In contrary, a therapeutic laparoscopy is technically time consuming especially early in the learning curve.

A variation in the operative time was found in the literature, while some studies demonstrated a shorter operative time for laparoscopic repair [8], some authors reported a significant increase in the operative time in the laparoscopic groups [15,16]. Again this variation between different studies might due to the fact that the operative teams are not equivalent in terms of experience.

Postoperative pain, measured using the NRS, was significantly less in the laparoscopic group ($p<0.001$) regardless of whether the procedure was therapeutic or not. The same was proved by other prospective studies which consistently showed a lower pain score after laparoscopic than after open explorations [8,19]. In the study, The length of hospital stay was shorter in the laparoscopic group than the open group with a mean of 1.5 days, 2.5 days respectively in the non-therapeutic population ($p=0.03$), and 2.2 days, 4.6 days respectively in the therapeutic population ($p<0.01$). The same result was shown in many studies [5,11,20,21]. However, a report by Leppaniemi and Haapiainen, showed that there are only minimal benefits with respect to length of stay and cost savings by using laparoscopy [7]. Wound complications in the form of superficial surgical site infection, wound seroma and wound dehiscence were the most common morbidity in the open group and were higher than those among the laparoscopic group. This result was statistically significant in the therapeutic population ($p=0.035$) and insignificant in the non-therapeutic population ($p=0.2$).

Similarly, in a retrospective cohort study by Heng et al., he concluded that the wound complications were lower after adoption of laparoscopy as a diagnostic and therapeutic tool in his hospital [8]. This difference in the incidence of wound complications between the two groups is a common feature to all surgical abdominal procedures in which wound complications is higher in open surgical procedures than laparoscopic ones [22].

In this study, a higher incidence of chest complications was observed in the open group compared to the laparoscopic group regardless of the type of the procedure (therapeutic or non-therapeutic) with no statistical significance ($p=0.2$). Pneumothorax was associated with diaphragmatic injuries in 60% of open group, and 66% of the laparoscopic group.

The incidence of chest infection increases more in the open group due to the higher incidence of upper abdominal pain interfering with the proper expansion of the chest.

**Conclusion:**

Diagnostic laparoscopy for penetrating anterior and TAB stab wounds is a safe emergency procedure with many advantages. However, proper patient selection, presence of experienced surgeons and an adequate instrumentation are essential for a successful patient outcome.
References


الميلخص العربي

تهدف هذه الدراسة إلى المقارنة ما بين استكشاف البطن عن طريق الفتح الجراحي والمنظار الجراحي في حالات الطعنة البطنية الامامية والبطنية العصبية المختارة من حيث وقت الجراحة، الأم ما بعد الجراحة، مدة الأزمة بالمستشفى، مضاعفات الجرح والصدور وجودة إصابات فائقة.

وقد أجريت هذه الدراسة بقسم الطوارئ بمستشفى قصر العيني في الفترة ما بين مارس 2014 ويونيو 2015. تضمنت الدراسة 50 مريض مصاب بطعنة بطنية أمامية وبطنية صدرية، وقد تم تقسيم المرضى بناءً على الطريقة التي تم بها استكشاف البطن إلى مجموعتين: مجموعة منظار الجراحي ومجموعة الفتح الجراحي. وتم تصنيف الجراحات إلى جراحات غير علاجية، إذا كانت الطعنة مختلطة بدون إصابات أو وجود إصابات تم تحتاج لإجراءات علاجية وجرامات علاجية في حالة وجود إصابات تحتاج لإجراءات علاجية.

في هذه الدراسة، تم التحويل من الاستكشاف بالمنظار إلى الفتح الجراحي في أربعة مرضى، وذلك لعدم إمكانية تقييم الأمعاء بدقة الاشتباه في إصابة الأمعاء بسبب وجود صدأ بالبلد، صعوبة السيطرة على النزيف باليد ووجود تجمع دموي بالبلد بدون سبب واضح.

أثبتت هذه الدراسة أن النظام الجراحي كدالة تشخيصية ينفرد على الفتح الجراحي من حيث وقت الجراحة وأم ما بعد الجراحة أما من الناحية العلاجية فقد أثبتت النتائج أن النظام قادر على إصلاح إصابات الكبد والبطن والحجاب الحاجز بالإضافة إلى تقدير على الفتح الجراحي من حيث الأم ما بعد الجراحة وثمة الأزمة بالمستشفى. وقد كانت نسب تهابات الصدرية والتهابات الجرح أعلى في مجموعة الفتح الجراحي دون قيمة إحصائية.

كما أوضحها الدراسة أن العائق الوحيد للمنظار هي مسائل خاصة بالتقنية مثل فحص الأمعاء والطرق العلاجية مما أسفر عن وجود حالات محولة للفتح الجراحي.

يمكن الاستنتاج من هذه الدراسة أن المنظار التشخيصي في حالات الطعنة البطنية الامامية والبطنية العصبية أمن وله مميزات كثيرة كما أن اختيار المريض المناسب، عامل الخيرة وجودة الانتهاز المناسبة هي من العوامل الأساسية لضمان نتائج ناجحة.